PRECIOUS AND SEMIPRECIOUS STONES (GEM MINERALS)

By M. W. von Bernewitz

Although a number of men are employed in the search for gem minerals and in their mining and cutting in the United States, the industry is irregular and of small importance. This country is a large importer of precious and semiprecious stones, receiving annually from foreign nations at least 100 times the domestic output. Like nickel, platinum, and tin domestic production is small, but importations are large, yet what is won from the domestic deposits is varied and of good grade.

This review of gem minerals is revived after being omitted from the Bureau's annual statistical and economic reports for 12 years. During this interim, however, the United States Bureau of Mines has issued 13 publications on precious and semiprecious stones.[1] These cover the following: Occurrence; mode of prospecting, development, and mining; identification; characteristics; grading; production; and domestic and foreign trade. Each paper has a short, selected list of references. Readers are referred to these publications for many details that cannot be given here.

A precious stone is one that has high commercial value because of its beauty, rarity, and permanence. Strictly, the trade regards only the diamond, emerald, opal, pearl, ruby, and sapphire as precious. A semiprecious stone is one that is precious to a lesser degree. This class includes agate, beryl, coral, feldspar gems, fossil wood, garnet, jade, jasper, jet, malachite, quartz gems (as amethyst, hiddenite, and kunzite), serpentine, topaz, tourmaline, turquoise, zircon, and many others. In its mineral museum at Washington, D.C., the Bureau of Mines has a small collection of the stones mentioned and a few others of interest. Many specimens can be seen at the National Museum.

Most of the precious and semiprecious stones make desirable gems when properly cut and mounted as jewelry or in the form of other ornaments. Furthermore, investment in stones of high value has been an age-old method of storing wealth. It has been estimated that the diamonds alone owned by the people of the United States represent resources of 4 billion dollars or more. While gold and currency bow to the rules of prevailing monetary systems, reserves of gems usually are untouched and have a cash value for those who need money.

Production.—Although reliable production figures are available for most foreign countries there has been little attempt to collect them for the United States since 1923. From 1880 to 1924 the output of crude precious and semiprecious stones (largely the latter) in the United States was valued at $9,800,000. The value of the production was highest in 1909 ($534,000) and lowest in 1923 ($60,000). The value of the output has ranged as follows: 1886–92, $119,000 to $312,000 a year; 1897–1909, $130,000 to $534,000 a year; 1911–19, $344,000 to $112,000 a year. In 1921 the value of the production was $518,000.

[1] For a list of these publications see Bibliography on p. 806.

The production of sapphires in Montana has contributed the greater part of the value of the domestic gem output. In 1920 the value of gem stones produced in the United States was $265,000, of which $223,000 represented the value of Montana's production. Six States reported values of several thousand dollars each, and production in 15 States totaled only a few thousand dollars worth of various stones. In all, about 50 varieties of gem stones were reported.

Occurrence.—In the past Alaska has yielded garnet; Arizona, agate, copper-ore gems (azurite, malachite, and chrysocolla), garnet, jasper, obsidian, opal, peridot, and turquoise; Arkansas, diamond, the largest being 11, 17.85, and 40.2 carats (the last was found in the spring of 1924); California ($27,000 in 1929, mostly quartz), beryl, diamond, epidote, kunzite, lapis lazuli, obsidian, quartz, rhodanite, spodumene, topaz, tourmaline, and vesuvianite; Colorado, amazon stone, aquamarine, calamine, fluorite, garnet, hematite, opal, pyrite, quartz, satinspar, topaz, and turquoise; Hawaii, peridot in decomposed lava; Maine, amethyst, beryl, garnet, rock crystal, topaz, and tourmaline; Montana, agate (moss), chalcedony, garnet, iceland spar, sapphire, and topaz; Nevada, opal, turquoise, and variscite; New Mexico, turquoise; New York, garnet; North Carolina, corundum gems, diamond, garnet, zircon, and others; South Carolina, beryl; Texas, agate, opal, and topaz; and Utah, topaz, variscite, or utahlite.

MARKETING CONDITIONS

The marketing of precious stones differs from that of most other materials.[2] First, their value denotes wealth in exceedingly small bulk. Secondly, there is a wonderful variety of precious stones, found over a wide territory and obtained with difficulty, hence the supply is uncertain. After the stones are found, the actual marketing processes depend largely on the special methods of treatment and preparation suitable to the fashions of the time.

For the past 3 years the trend in prices for all gems and precious cut stones has been steadily downward. According to a close observer of the trade, prices were at their lowest ebb during February 1933. The drop in values was reported as a reaction to falling sales. Jewelry was not in demand, and dealers and many private owners found it necessary to dispose of their stones. Since March 1933 much of this distress merchandise has been absorbed, and there appears to have been a slight improvement in prices.

Jewelry manufacturing.—According to a report of the United States Bureau of the Census issued in November 1932, the value of jewelry produced in 1931 decreased 52 percent compared with its value in 1929. For the purposes of the census the jewelry industry embraces the manufacture of articles of precious and semiprecious metals (some plated) as well as the fabrication of articles for personal adornment, such as those requiring gems. As the latter represent considerably higher individual values than most other forms of jewelry stock the effect of the depression on sales of these higher-priced goods probably was more severe than is indicated by the average census figure.

The Jewelers' Circular for March 1933 states that despite the curtailment in buying there is a decided trend toward marked individuality in jewelry styles for 1933 that will distinguish the new styles from those of former years. The decided changes in dress and sil-

[2] Spurr, J. E., and Wormser, F. E., The Marketing of Metals and Minerals (chapter by G. F. Kunz): McGraw-Hill Book Co., New York, 1925, pp. 338–362.

houette and in political, social, and economic conditions have been factors in this trend. The bizarre French creations in precious stones and platinum mountings have little sale in the United States.

Artificial "precious" stones.—Synthetic rubies, sapphires, and spinels now are made in large numbers. Patents have been granted in the United States and Europe for the manufacture of artificial stones and for the surfacing of others. The basis of the synthetic stones is alumina and the coating is fused borax. The substance of nearly every species of transparent gem is essentially colorless, the color being produced by small proportions of impurity. The methods by which these stones are made and the technique for distinguishing them from natural stones is well known.[3] In 1932 German cutters and dealers arranged with a joint sales organization of synthetic jewel manufacturers in Germany, Switzerland, and France to handle the marketing of their artificial gem products.

Industrial diamonds.—The diamond is the important industrial gem stone, and its use is growing. In the United States there are about 40 dealers in industrial diamonds, and imports are increasing. Sales in 1932, however, were subnormal, but large stocks have not accumulated.

Two types of diamonds are used industrially, borts (diamonds of the gem variety but unfit for cutting into gems) and carbons or black diamonds. Borts are used for cutting and drilling glass and porcelain, for fine engraving and drilling tools, for turning tools, and for bearings in watches and meters. Pulverized borts are used for cutting and polishing diamonds and other precious stones. Carbons or black diamonds are used mainly in diamond drills, for truing abrasive wheels, for wire-drawing dies, and for stone saws. Competition from tungsten carbide and other superhard materials has reduced the use of diamonds for wire-drawing and extruding dies for fine copper wire.

Prior to 1928 the world demand for diamonds for drilling purposes was exceeding production. Those from Brazil ranked first for the purpose. In that year African diamonds were sent for trial to the United States. As only one lot proved to be suitable subsequent shipments were subjected to special tests before they were imported. The African stones are alike in appearance and size and weigh one twentieth to one third carat. As many as 56 of them can be set in a drill crown, a larger number than is usual with Brazilian borts. The African stones are cheaper than those from Brazil, and their drilling performance is satisfactory.[4]

Two publications of the United States Bureau of Mines give additional information on diamond drilling in ore formations and petroleum-bearing strata.[5] The report by Hansen describes the types of diamonds used and the setter's work, illustrates bit and reamer settings, tabulates the loss of diamonds per foot of drilling, and gives the cost of drilling. The mining company concerned has done 258,000 feet of drilling in schist, diorite, jasper, and other rock in 23 years, and in the period 1917–31 carbons cost 40 cents per foot drilled, or 22 percent of the total drilling cost.

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[3] Wade, F. B., The Manufacturing Jeweler, Oct. 8, 1931.
[4] Hanifen, J., African Borts Attain Increasing Use in Diamond Drilling: Eng. and Min. Jour. vol., 131 1931, pp. 75–76.
[5] Hansen, M. G., Diamond Drilling at the United Verde: Inf. Circ. 6708, Bureau of Mines, 1933, 18 pp.
Edson, F. A., Diamond Drilling with Especial Reference to Oil-Field Prospecting and Development: Bull. 243, Bureau of Mines, 1926, 170 pp.

Taxes.—Another condition that must be considered in the marketing of gem stones is the extent to which such goods are affected by general taxes levied upon both dealers and purchasers. Section 605 of the Revenue Act of 1932 specifies the taxes payable on diamonds and mountings by retail jewelers and customers and should be consulted by those interested.

IMPORTS AND DOMESTIC TARIFF

Diamonds represent 93 percent of the gem imports into the United States. In 1932 the United States purchased 65 to 70 percent of the world output compared with 75 to 80 percent in 1930. The value of diamond importations since 1913 totals nearly $700,000,000. Gem stones imported since 1922 are valued as follows:

Value of gem stones imported into the United States, 1922–32

Year	Value	Year	Value	Year	Value	Year	Value
1922	$65, 615, 937	1925	$73, 915, 422	1928	$67, 964, 278	1931	$21, 126, 319
1923	74, 147, 897	1926	78, 290, 971	1929	75, 317, 358	1932	12, 771, 091
1924	71, 263, 730	1927	64, 949, 943	1930	38, 641, 693		

Importations by classes for 1929–32 are given in the following table:

Gem stones imported into the United States, by classes, 1929–32

Class	1929		1930		1931		1932	
	Carats	Value	Carats	Value	Carats	Value	Carats	Value
Diamonds:								
Rough or uncut	349, 023	$9, 588, 137	201, 031	$5, 769, 566	85, 249	$3, 851, 698	40, 153	$1, 512, 959
Cut but unset	414, 884	41, 828, 581	297, 063	23, 405, 415	201, 620	11, 939, 291	182, 991	7, 816, 297
Bort and dust	4, 567	89, 363		90, 915		20, 292		
Glaziers', engravers', etc	46, 949	4, 067, 674	145, 862	2, 756, 630	224, 970	2, 490, 879	163, 704	1, 061, 823
Other precious stones, rough or uncut		217, 759		90, 357		106, 127		42, 080
Pearls, not strung or set		10, 345, 420		2, 648, 042		1, 281, 019		552, 908
Other precious and semiprecious stones, cut but not set				[1] 1, 661, 593		1, 200, 155		532, 450
Agate, unmanufactured pounds	11, 255	1, 342	[2] 85	91				
Agate, rock crystal, and other semiprecious stones, unsuitable for jewelry, manufactures of		291, 490		229, 370		109, 731		63, 912
Corals, rubies, cameos, and precious and semiprecious stones, cut but not set		5, 327, 839		853, 625				
Coral, marine, uncut and unmanufactured pounds	1, 859	198	1, 254	193	5, 922	393	1, 779	272
Imitation precious and semiprecious stones:								
Cut or faceted		3, 772, 811		1, 697, 092		1, 454, 679		897, 013
Not cut or faceted, mounted or unmounted		58, 316		51, 980		66, 490		43, 847
Imitation of opaque stones, not faceted				[2] 6, 865		7, 740		5, 137
Half pearls and bottom or filled pearls partly pierced		68, 655		25, 941		17, 114		9, 426
Solid pearls wholly or partly pierced, mounted or unmounted		30, 015		[1] 28, 409				
Solid pearls (n.e.s)				[2] 1, 569		3, 425		1, 367
Emeralds:								
Rough or uncut	2, 304	17, 168	18, 312	72, 240	170, 876	270, 384	14, 830	11, 625
Cut but not set	25, 433	2, 452, 585	11, 244	1, 053, 694	4, 242	182, 350	1, 345	63, 441
Marcasite:								
Real				90, 264		68, 396		105, 037
Imitation				17, 248		34, 034		50, 867
Iridescent solid pearls						[3] 238		528

[1] Jan.–June 17, 1930. Change in tariff June 22. [2] June 22–Dec. 31, 1930. [3] First importation.

Tariff on gem stones.—The rates of duty on gem stones imported into the United States are as follows, according to schedule A, "Statistical Classification of Imports into the United States," Bureau of Foreign and Domestic Commerce, effective January 1, 1933:

Tariff on gem stones

Class	*Rate of duty, percent*
Diamonds:	
Rough or uncut	Free
Cut but not set, suitable for jewelry	10
Glaziers' and engravers', unset, miners'	Free
Pearls and parts, not strung or set	10
Emeralds, rough or uncut	Free
Other precious and semiprecious stones, rough or uncut	Free
Emeralds, cut but not set	10
Other precious and semiprecious stones, cut but not set	10
Imitation precious stones, not cut or faceted, and imitation semiprecious stones, not faceted	60
Imitation precious stones, cut or faceted, and imitation semiprecious stones, faceted	20
Imitation of opaque precious or semiprecious stones, with flat backs and tops, cut and polished but not faceted	60
Imitation pearls, according to make and size	40 to 90
Marcasites ("sulphur diamonds"):	
Real	20
Imitation	20

FOREIGN PRODUCTION

According to Meisner (see Bibliography), 92 percent of the World production of precious stones from 1870 to 1925 was diamonds, 3 percent rubies and sapphires, 2.5 percent emeralds, 0.75 percent each opals and amber, and the remaining 1 percent all other gems combined. South Africa was the most important producer throughout the period due to the preponderance of its diamond output. The following table, summarized from Meisner's study, indicates the effect on production for 1913–26 of the World War, the business recession of 1920–21, and the rise of such producers as the Belgian Congo, Gold Coast, and British Guiana.

World diamond production, 1913–26 [1]

Year	Carats	Year	Carats	Year	Carats	Year	Carats
1913	6,750,000	1917	3,400,000	1921	1,500,000	1925	4,250,000
1914	4,230,000	1918	3,140,000	1922	1,435,000	1926	5,000,000
1915	185,000	1919	3,402,000	1923	3,605,000		
1916	2,650,000	1920	3,615,000	1924	3,840,000		

[1] The total carats listed for the period are equivalent to 10½ short tons.

Meisner also gives the estimated World production of precious and semiprecious stones (theoretical) for a normal or average year as follows:

World production of gem stones in a normal year

Class	Value (marks [1])	Percent of total	Class	Value (marks [1])	Percent of total
Diamond	300,000,000	85.0	Agate	300,000	
Sapphire	7,500,000		Garnet	280,000	
Ruby	1,500,000		Spinel	85,000	
Emerald	2,700,000		Topaz	80,000	
Turquoise	1,000,000		Olivine (peridot)	70,000	
Opal	800,000		Rose quartz	50,000	
Chrysoberyl	210,000		Calc-spar (calcite)	20,000	
Lapis-lazuli	515,000		Moonstone	20,000	
			Others	400,000	
Total precious	314,225,000	89.0	Total semiprecious	6,085,000	2.0
Amber	2,000,000		Art jewels (possibly artificial)	6,000,000	1.8
Jade	1,200,000		Coral	4,000,000	1.3
Rock crystal (quartz)	450,000		Pearl	20,000,000	5.9
Tourmaline	380,000				
Amethyst	350,000				
Beryl	400,000		Grand total	350,310,000	100.0

[1] The mark as used in this calculation represents about 24 cents. On this basis the grand total is therefore estimated to be roughly $90,000,000.

According to Sydney H. Ball [6] the world output of diamonds in 1932 declined 15 percent in weight and 49 percent in value compared with that in 1931. Of the 1932 production underground mines accounted for 5.4 percent of the total weight and 10 percent of the total value, the remainder being produced from alluvial workings. The estimated production in 1932 is shown in the following table:

Estimated world diamond production in 1932, in carats

Country	Underground mines	Alluvial mines	Country	Underground mines	Alluvial mines
South Africa	327,476	481,040	Brazil		20,000
Belgian Congo		3,541,500	Borneo, Australia, French Congo, Venezuela, India, Tanganyika		11,300
Angola		375,000			
South-West Africa		68,000			
Gold Coast		1,126,100			
British Guiana		80,000		327,476	[1] 5,702,940

[1] Roughly equivalent to 1¼ short tons.

AFRICA

Gold Coast.—All diamonds exported from the Gold Coast are sent to England. The total shipments for 1932 declined below those in 1931, the year of record shipment (880,479 carats). The value of the stones exported in 1931 was not as great as that of the 861,119 carats exported in 1930. The industry has made remarkable growth in the past decade; exports were 102 carats 12 years ago. Diamond recovery from the gravels and clays in Gold Coast Colony is described by E. D. Candlish in The Mining Magazine for June 1931, pages 333–342. These diamonds are found over a wide area, are small (many of them being 0.1 to 0.5 carat), but are of good quality.

South Africa.—The African diamond industry for the first half of 1932 was reviewed in The South African Mining and Engineering

[6] Ball, Sydney H., The Diamond Review for 1932: Nat. Jewelers' Publicity Assoc., Newark, N.J., 1933 49 pp.

Journal (Dec. 31, 1932, pp. 289, 291–292). In this review it is estimated that the value of production during 1932 decreased 58 percent for mined diamonds and 43 percent for alluvial stones. The highest output from the underground mines, valued at £12,290,000, was reported in 1920 and from the alluvial mines, £11,062,000, in 1928. The respective figures in 1931 were £2,244,000 and £1,937,000. During the 2½ years ended December 31, 1932, all diamonds produced amounted to 5,829,248 carats, but only 60 percent of these stones were sold; this excess of production over sales has been a feature of the diamond market for sometime past. The increased supplies have been due partly to new developments such as the astonishing expansion in alluvial production since the Lichtenburg discoveries in 1926 and later operations on the Namaqualand coast.

Except in State properties and alluvial mines all production in South Africa has ceased. Producers outside of the Union, including Belgian Congo, have curtailed production and deliveries of diamonds. The Government of South Africa cooperated in this contingency. The Diamond Corporation succeeded the Old Diamond Syndicate of London and is the sole outlet for South African diamonds. It has adopted a standard assortment and fixed standard prices in gold. Effort has been made toward better stabilization in the industry, and in October 1932, according to the Jewelers' Circular for December 1932, the London diamond trade was optimistic; prices and sales advanced, and there was a scarcity of many small sizes and qualities. The Netherlands market also improved.

SOUTH AMERICA

Brazil.—Industrial diamonds (carbons) account for about nine tenths of all diamonds shipped from Brazil. The price of these stones increased steadily for the period 1922–29, after which users in the United States began to substitute other materials. As a result of falling demand there has been a decided decline in the mining of precious and industrial diamonds in Brazil. Diamond exports in 1930 were valued at $432,729 compared with $1,112,000 in 1929, $484,000 in 1928, $145,000 in 1927, and $391,000 in 1926. Carbonados exported were 20,925 carats in 1928, 24,608 carats in 1927, and 21,313 carats in 1926. The value of exports averaged about $62 a carat.

Colombia.—According to P. W. Ranier and others,[7] the Chivor emerald field is on the eastern slope of the Andes, Colombia, at an altitude of 8,000 feet. The emeralds occur irregularly in 3-inch veins in a thick bed of shales and are picked out by hand after the veins have been exposed. The emeralds are classified according to colors, ranging from color 1, the darkest green, to color 5, a very pale green. A very dark green emerald may bring hundreds of dollars a carat, whereas a very pale green stone of 5 carats may bring only $5. Colors 2 and 3 sell for good prices. Few emeralds have color 1, a fifth have color 5, a quarter each have colors 3 and 4, and a tenth have color 2. Europe and India are good markets for emeralds of the cheaper quality and lighter colors; the United States is the best market for the fine stones.

[7] Ranier, P. W., and others, The Chivor-Somondoco Emerald Mines of Colombia: Tech. Pub. 258, Am. Inst. Min. and Met. Eng., 1930, 21 pp.

AUSTRALIA

Accurate figures on precious stones produced in Australia are difficult to obtain according to the Official Year Book of the Commonwealth of Australia. Most of the diamonds come from certain gold gravels of New South Wales. This State also is the most important opal producer of the world. During 1928 three fire opals were found which weighed 790, 590, and 232 carats, respectively. Queensland is the largest producer of sapphires. The tin gravels of Tasmania yield small sapphires, but these are scarcely worth recovering.

EUROPE

Russia.—The precious and ornamental stones of Russia are reviewed by Lavrov.[8] The Ural, Transbaikalia, Altai, and other districts produce gems and ornamental stones.

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[9] An Information Circular on amber awaits publication, and a Bulletin on diamonds is in preparation.

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By Sydney H. Ball

SUMMARY OUTLINE

Precious and semiprecious stones include minerals used primarily for personal adornment and decorative purposes. To be so prized the stones must possess beauty of color and "fire" or play of colors, must not be too common, and must be hard enough to withstand ordinary wear. Among the less regal members of the group, fashion may temporarily determine the popularity of a gemstone. The quality of hardness also accounts for the many industrial uses of the diamond and, to a less extent, the ruby and sapphire.

Almost 100 mineral substances have been used for decorative purposes, and while there is no hard and fast division as to precious and semiprecious stones, the diamond, the emerald, the ruby, and the sapphire are usually included in the former and frequently, by courtesy, an organic substance, the pearl. These gems, however, are sometimes equaled in beauty by exceptionally fine opals, aquamarines, tourmalines, spinels, chrysoberyls (including cat's eye and alexandrite), and spodumenes (hiddenite and kunzite).

The diamond industry is much more highly organized than that of any other precious stone, and the diamond output represents almost 95 percent of the world's gem production.

Production in the United States.—For well over 2,000 years gem mining has been a minor industry in America as the American Indian, no less than his white successor, was an admirer of gems. The industry, however, has never been an important one in the United States. Statistics are not at hand for recent years, but from 1880 to 1924 the American production was valued at $9,800,000, a yearly average of $223,000 with a maximum of $534,000 in 1909 and a minimum of $60,000 in 1923. In 1933 the value of the production was probably under $20,000 and consisted largely of rose quartz from South Dakota, agatized wood from Arizona, a small quantity of turquoise from the Southwest, a few sapphires and agate for the tourist trade from Montana, amazonstone from Colorado, and a little rose quartz from California.

Virtually all of the known precious and semiprecious stones have been found in the United States, but important deposits are unusual. Among the more notable American occurrences responsible for a certain production are sapphires in Montana, diamonds in Arkansas, tourmalines in Maine and California, hiddenite in North Carolina, kunzite in California, amazonstone in Colorado, rose quartz in South Dakota and California, and turquoise in New Mexico, Arizona, and Nevada. The Montana sapphire mines have been responsible for the major part of this country's production, the gems being used partly in jewelry but largely industrially as watch jewels.

Trade in precious stones in 1933.—The year 1933 was slack in the precious-stone industry due to the world-wide depression and the shifting of currency values and high tariffs. On the whole, however, employment was better in 1933 than in 1932, and the sales trend is upward. In America, jewelry sales, judging from the excise tax from July 1, 1933 to March 31, 1934, were $37,239,917, a 57-percent increase over the corresponding period of 1932–33.

Imports and domestic tariff.—Imports of precious stones into the United States in 1933 were as follows:

	Value
Diamonds:	
Rough, uncut, 31,595 carats	$1, 662, 224
Cut, but not set, 178,937 carats	8, 360, 283
Glaziers', engravers', and miners', not set, 260,784 carats	1, 249, 200
Pearls and parts, not strung or set	776, 141
Other precious stones:	
Rough, uncut	76, 038
Cut, but not set	644, 475
Imitation precious stones, except opaque	932, 189
Imitation precious and semiprecious stones, opaque, including imitation pearls	11, 487
Marcasites	39, 884

The rate of duty on various types of gems and their imitations remains the same as that given in Minerals Yearbook, 1932–33, page 803.

Codes under the NRA.—The jewelry industry is now operating under a number of codes; for instance, the diamond dealers and the diamond cutters each have their own codes. The Code of Fair Competition for the Precious Jewelry Producing Industry has rather drastic articles as to trade terminology, fair practices as to advertising, marketing, and sales terms. The definition of certain terms relating to precious stones in the Code of Fair Competition for the Retail Jewelry Trade is particularly interesting; the code forbids auctions except in case of dire necessity or for legitimate liquidation.

American jewelry tax.—The Federal 10-percent tax continued throughout 1933; it has netted the Government little revenue—only $3,068,494 was collected in 1932. There are indications that the tax is a difficult one to administer and that its effects are felt sharply by the jewelry business in the United States in which 1,261 houses failed in 1932 with liabilities of $35,627,308.

Resolutions of Fourth International Jewelers Congress, Rome, May 1933.—The congress, among other resolutions, refused to adopt the definitions of "perfect", "blue white", "commercial white", and other terms used by American diamond dealers; all diamonds are to be weighed in metric carats.

Synthetic and imitation stones must be offered and invoiced as such, and the words "synthetic" and "imitation" must be written in the same character as the name of the stone involved.

The congress also adopted certain definitions for various precious stones, eliminating the use of the word "olivine" for members of the chrysolite family and confining its use to the green garnet, uvarovite; also an identification service for diamonds, pearls, and precious stones will be fostered by the congress.

DIAMOND

All indexes of the diamond industry improved in 1933 compared to those of 1932. Among favorable factors were a curtailed production; a slight decrease in world stocks; better prices for rough and cut goods; larger sales of rough and cut goods, as indicated by increased American imports, and higher stock-market valuation of shares with several companies returning to the dividend list. The improvement is tangible, but the industry can only improve markedly provided prosperity returns to America, which normally should absorb over 75 percent, in value, of the world's diamonds.

The known reserves of diamonds are not excessive, being of the order of those of gold, zinc, and lead rather than of copper or coal. During the year no discoveries of importance were made, and as the world becomes better known, the possibility of finding new fields of importance that might greatly disturb the market becomes progressively less. The centralization and unification of the industry continued in 1933, and hereafter the production of the Government-owned South African mines is to be sold through the Diamond Corporation (see p. 1087).

The low price of small stones during the past 2 years has led many to become "diamond conscious" for the first time, and at some future date ideas of size, quality, and cut will improve to the benefit of the industry. As some small measure of prosperity returns it is expected that many will be disposed to satisfy their long-deferred desire for luxuries.

Share dealings.—Except in June and July, when sales were relatively large, 1933 was a year of small dealings in diamond-mining shares. This was due to continental buying, where such shares have always been popular. The appreciable advance of January was lost in February; from March to June prices rose; they receded in July, gained in August and September, and suffered a slight loss in the final quarter of the year. Diamond shares gained about 32 percent in price during the year. Five selected stocks at the end of the year were about 33 percent of the all-time high (1927) and 363 percent of the all-time low (June 1932). Of the 13 principal diamond-mining companies, 8 are paying dividends.

Market.—Some 95 percent of the output of the world's diamond mines is sold to the Diamond Corporation of London, and it in turn sells to brokers and larger cutters. In 1933, as usual, the corporation only put on the market such quantities of rough stones as could be readily absorbed and refrained from selling for several extended periods in the year. The corporation continued to assist in coordinating production with demand and in determining the quotas of each producer, also to lead in other matters pertaining to the good of the industry.

It further held itself ready to take off the market the production of the few independent producers still operating, provided this seemed desirable. When England, South Africa, and the United States went off the gold standard the corporation raised the price of diamonds, produced under the gold standard, in the currencies of those countries commensurately. When South Africa went off the gold standard the corporation, fearing the price structure might be injured by alluvial diamonds produced at depreciated currency costs, instructed its buyers to purchase alluvial stones at rates obtaining when South Africa was on the gold standard. In June the corporation decided to sort Congo goods in the same way as South African. Few sales agencies know their products better or handle their sales more astutely than the Diamond Corporation.

In 1933 the corporation's sales of rough stones, while by no means noteworthy, were appreciably greater than those in 1932. In January, June, July, and October sales were large, most of the other months being quiet. Prices were firm throughout the year, and the price of large, rough stones was increased 20 percent in June with a slight increase in the smaller sizes.

World sales of cut goods were relatively satisfactory and doubled those in 1932, due partly to spurts of investment buying in America, Germany, and France, as confidence in the currencies was temporarily lost. In January and February sales were satisfactory, and June to October were good months. In May the price of large stones was increased 20 percent and that of smaller stones raised, although late in the year the price of the latter dropped somewhat.

In 1933 investment buying was large due to disturbances in currency values, for in times of financial stress, as in those of revolution, diamonds, particularly fine stones, are among the commodities purchased to obviate loss through currency inflation. In the Paris "Vu", Lewisohn in listing the world's richest men emphasizes the relatively small losses sustained in the past few years by the leading Indian princes, who have always kept a substantial part of their fortunes in gold and precious stones, compared to the heavy losses sustained by western financial leaders with fortunes in stocks and bonds.

From July to the end of the year fear for stability of the dollar caused some Americans to purchase diamonds. The purchasers were favorably impressed by the unified control of production and sales in the industry, the relative stability of diamond prices during the panic, and the expectation of price appreciation provided currency depreciation took place. It may be that the substantial prices received for diamonds by friends forced to liquidate during the panic, as opposed to the smaller salvage value of other luxuries, also influenced purchasers. Provided the original purchase was made a decade ago (see fig. 106), the owner doubtless even profited by the distress sale. The diamond is a commodity largely immune to the fatal consequences of currency fluctuations, and the portability of the stones and their ready translation into cash in any market likewise are important considerations.

Investment buying in France became apparent in February and continued throughout the year. Investment buying also occurred in England during the summer. Such buying in America, France, Germany, Hungary, and England partly caused the shortage of fine goods, and price advances. It is reported that the Jewish emigrés from Germany during the past year were not permitted to take gold out of the country; however, many had converted their fortunes into diamonds and were thus able to leave with part of their capital to start anew in other lands.

As already mentioned, the low price of small stones during the past 2 years has led to diamond consciousness; at some future date ideas of size, quality, and cut will improve, to the benefit of the industry. Moreover, many young people who have become engaged during the past 4 years have deferred purchasing an engagement ring until more prosperous times, and eventually the diamond merchant will benefit. With repeal, dining out is becoming more prevalent in the United States and with it the more frequent use of formal gowns and jewelry.

Stocks.—A year ago the writer estimated that the total diamond stocks held by the Diamond Corporation of London, the South African producers including the Government, producers in other countries, and the cutters in Antwerp and Amsterdam were worth about \$100,000,000. It is believed that in 1933 about as many rough diamonds were sold as were produced and that the stock on January 1, 1934, is no greater in carats than it was a year ago; due to higher prices, however, the value has probably increased. Sales by the corporation are not made public, but in 1933 they are understood to have exceeded £2,000,000, a higher value than that for 1932, which in turn showed a gain over 1931.

In Antwerp and Amsterdam, American buyers found an unusually restricted assortment of cut goods; indeed, from time to time throughout the year there were shortages in certain lines. In the United States retail stocks continued very low; the same is true of stocks of the American importer and wholesaler. The British retailer likewise carried barely enough stock to transact business, as did retailers in other centers such as Budapest, Paris, and Rome. In 1933, therefore, world diamond stocks, including those of the corporation and those in jewelers' hands, decreased.

Prices.—Prices of both rough and cut stones were firm for the first 3 months of the year. In May good cut stones of 3 carats or more increased 20 percent in price, which, of course, reacted favorably upon the price of rough stones. In May "seconds" sold by the New York loan societies brought surprisingly good prices, a condition noted in London in March and April.

In consequence of the price advances noted and the depreciation of the dollar American buyers arriving in Europe in the summer found prices in American currency 50 to 70 percent above those in May. Such prices curtailed American buying but tended to mark up stones in stock in America. In America the recent low of diamond prices was reached in June 1932 and extended to March 1933. A fine 1-carat brilliant, which in 1928–29 sold for \$750, in the period of low prices brought only \$500; the price by September 1933, however, had increased to about \$650. Figure 106 shows the price of a 1-carat cut stone of good quality from 1550 A.D. to date.

Century of Progress diamond exhibit.—The industry's exhibit was one of the major attractions at the Chicago Century of Progress; wide interest was shown in the diamond mine, the grease tables and the diamond-cutting exhibit, the diorama of the Kimberley opencut, and the painting of a Congo mine. Among the fine gems shown were the Tiffany Yellow and the beautiful Maximilian diamond; there was also a rather complete assortment of rough gems. These stones were protected by the latest type of automatically controlled safes, tear gas, electric eye and burglar-proof glass, and heavily armed guards. The exhibit of the use of industrial gems was unusually complete.

Imports into the United States.—In 1933 diamonds, cut and uncut accounted for a little over 80 percent of the imports of all precious stones, pearls, and imitation precious stones; if the imitation stones are excluded diamonds accounted for 87 percent of the total imports.

Diamonds imported into the United States in 1933, by countries

Country	Rough or uncut			Cut, but not set		
	Carats	Value	Value per carat	Carats	Value	Value per carat
Belgium	10,432	$591,866	$56.73	131,942	$5,887,244	$44.62
Brazil	471	1,000	2.12			
British Guiana	190	1,900	10.00			
Canada				25	1,003	40.12
France				478	39,954	83.58
Germany	105	2,144	19.46	47	1,948	41.45
Netherlands	4,196	275,994	61.01	45,609	2,314,588	50.75
Switzerland				12	1,158	96.50
Union of South Africa	13,423	704,278	52.47	177	14,968	84.56
United Kingdom	2,015	63,974	31.75	647	99,420	153.66
	[1] 31,595	[1] 1,662,224	52.61	178,937	8,360,283	46.69

[1] Includes 763 carats valued at $21,068 not distributed by country of origin.

Total imports of all kinds of goods into the United States in 1933 were 32.5 percent of the average for 1923–25; the value of diamond imports in 1933 was only 18.9 percent of the 1923–25 average and 19.3 percent of the 1929 value but showed a gain of 107.3 percent over 1932.

In 1933 Belgium (70.4 percent) and the Netherlands (26.5 percent) accounted for 97 percent of the American imports of cut stones. The Union of South Africa accounted for 42.5 percent of the rough stones imported, and Belgium and the Netherlands accounted for 35.7 and 16.7 percent, respectively.

The value per carat of cut stones imported into the United States reached a peak of $100.07 in 1929. For the succeeding 3 years the value per carat fell, due partly to decreases in diamond prices but largely to diminished purchasing power in the United States which caused Americans to purchase smaller stones of poorer quality. The slight increase in the 1933 price over that of 1932 is encouraging.

Imports of rough diamonds vary greatly from year to year and normally do not depend on good or bad times. The value of imports reached their peak in 1926; since then the general tendency has been downward. In 1933, however, the value of imports slightly exceeded that in 1932. The high point in quantity of imports was reached in 1929. The quality of stones imported, as shown by price per carat, decreased from 1926 to 1930, picked up appreciably in 1931, fell again in 1932, but rose sharply in 1933 when unusually fine rough stones were imported.

As usual, August and September were months of large importation due to stocking up for the Christmas trade.

Canada is less "diamond conscious" than America but imports a small quantity of cut diamonds. Imports into Canada, which in 1930 were valued at $2,014,713, had fallen by 1933 to $331,878.

Diamond cutting.—The world diamond-cutting industry had a better year in 1933 than in 1932. Unemployment was less acute, and

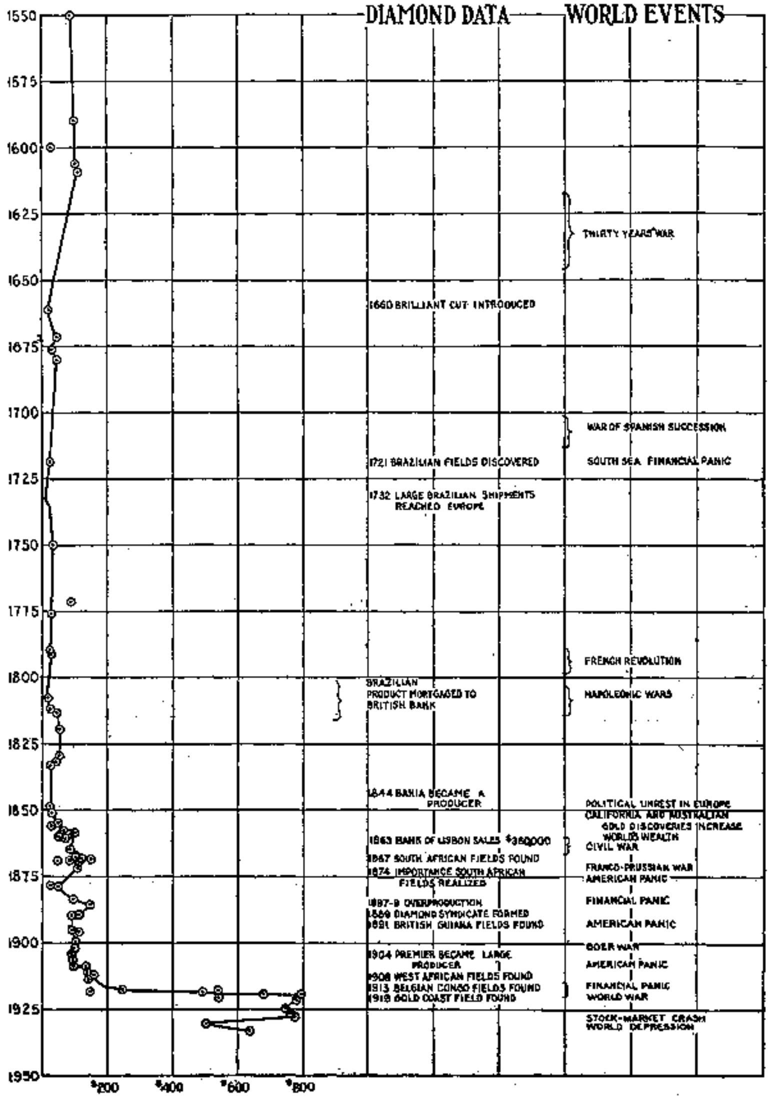

FIGURE 106.—Trend of diamond quotations, 1550–1933. Data represent the price of a fine 1-carat cut stone.

the master cutters did better financially, although the profit in cutting rough stones was still discouragingly small. However, cutters are partly the creators of their own troubles, for as soon as a particular cut, size, or grade is in demand all hasten to produce it, and a surplus with weakened prices too often results.

Employment in Antwerp averaged about 41 percent of the Union's membership (1932, 27 percent) and in Amsterdam about 27 percent (1932, 15 percent). In May, owing to the Nazi anti-Semitic attitude, the diamond merchants of Amsterdam and Antwerp, largely Jews, refused to send diamonds to Germany for cutting, thus benefiting the artisans of their own cities. In midsummer a number of German-Jew cutters fled from Germany and settled in Antwerp.

Antwerp with 20,000 to 25,000 artisans, Amsterdam with 5,000, and Hanau and other German cities with 3,500 to 4,000 are the principal cutting centers. Kimberley, Capetown, Johannesburg, New York, Paris, London, the Jura Mountains, and Geneva are minor cutting centers. There are also a few cutters at Rio de Janeiro and in cities of India and Borneo. In 1933 the South African subsidized industry continued on its stormy way. As the South African master cutters must purchase their rough stone at prices comparable to those paid by European cutters hereafter, less 10-percent export tax, their advantageous positions will largely disappear.

The Comptoir Diamantaire Anversois (capital 30,000,000 francs) has been formed to distribute credits better in the Antwerp market. The Hollanders likewise have formed a central organization (capital 6,000,000 guilders) for the purchase of rough stones and the sale of polished goods, which is also to subsidize the cutting of small stones. In 1933 the Germans set up a syndicate to buy rough stones to make their trade independent of Antwerp and Amsterdam.

World production.—The world's production of diamonds in 1933 was approximately 3,775,000 carats, worth about $14,100,000.

The following table gives, with the accuracy available statistics permit, the diamond production in carats for the past 4 years.

Production of diamonds by countries, 1930–33, in carats [1]

Country	1930	1931	1932	1933
South Africa:				
Mines	2,242,460	1,470,376	307,431	14,149
Alluvial	918,706	647,044	488,096	492,404
	[2] 3,163,590	[2] 2,119,155	[2] 798,382	506,553
Angola	329,823	351,495	367,334	[3] 374,000
Brazil	115,000	80,000	34,000	(4)
British Guiana	110,042	63,479	61,780	(4)
Congo	2,519,300	3,528,200	3,990,069	[3] 1,931,000
Gold Coast [5]	861,119	880,479	842,297	863,722
Sierra Leone			749	32,017
South-West Africa	415,047	71,532	17,944	
Tanganyika	13,107	7,790	1,391	[3] 1,250
Miscellaneous [6]	3,000	3,600	3,725	1,825
Grand total	7,530,028	7,105,730	6,117,671	[7] 3,774,367

[1] In 1933 Rhodesia disappeared as a producer, and Sierra Leone appears for the first time as a producer of some importance; Tanganyika Territory is now unimportant. As the South African pipe mines were shut down, the year's production came from the alluvial mines except for about one-fifth of 1 percent produced by debris washers (i.e., tailings treatment).

[2] Includes a small quantity of diamonds recovered from tailings re-treatment.

[3] Estimated.

[4] Figures not available.

[5] Exports year ending Mar. 31.

[6] Includes India, Borneo, New South Wales, and in certain years Venezuela, French Equatorial Africa, Arkansas, and Rhodesia.

[7] Includes estimates for Brazil and British Guiana.

In quantity and value the 1933 production was about 62 percent and 81.3 percent, respectively, of that in 1932. The value of the 1933 output was about one-fifth that of normal years; an unusually large percentage of the production was bort, and material suitable for cutting amounted to only about 55 percent of comparable production in 1932. Although the South African pipe mines were shut down and most other producers curtailed their production, further curtailment appears necessary. Even if world demand increases, there is a considerable stock to liquidate.

Diamond producers have been in a difficult position for the past 4 years; many companies have closed down, and a few weak ones have been liquidated. This has been due partly to loss of sales volume but largely to low prices received for the product, companies producing finer stones having suffered most. However, prices received by producers in 1933 were better than those obtained in 1932. Further "seconds" appeared on the market from time to time; for instance, in February and March 1933 old cut stones from Russia reached Paris and Antwerp, although this source must soon be exhausted.

South African conference.—On May 22, 1933, Patrick Duncan, Minister of Mines of the South African Government, Sir Ernest Oppenheimer, and other representatives of the larger South African mines began a conference which reached a provisional agreement in September, replacing the Inter-Producers' agreement and the latter's sales agreement with the corporation. Although still unsigned, its articles are now operative. The Union Government, the Administrator of South-West Africa, the Diamond Corporation, and the principal producers are to form a Diamond Producers' Association with a board composed of 2 representatives of the companies, 1 of the Union Government, 1 of the South-West African administration, and 1 of the Diamond Corporation. Stocks are to be sorted at a single office at Kimberley, and sales quotas for each producer, including the Government as one of the producers, are established. Sales are to be made through The Diamond Trading Co., Ltd., controlled by the corporation, including sales to South African cutters (at London prices less the export tax). The board, to maintain prices, can purchase alluvial goods in the open market. The first shipment under the agreement is to be shown in London in March 1934. The representatives of the coalition government throughout the negotiations showed their desire to safeguard the stability of the diamond industry. Apparently it is understood that for the time being the cutting industry in South Africa is not to be expanded, that few new alluvial fields are to be opened to exploitation during the depression, and that the Government accepts a quota for its Namaqualand mines. The Diamond Corporation, to allay fear that its stock might be thrown upon the market, agreed to consider itself a producer and like other producers to accept a sales quota. In other words, the stock will be liquidated over a period of years. Early in October Mr. Havenga, Minister of Finance for the Union, stated that once demand improved markedly the Government would forego its Namaqualand quota in favor of the Kimberley, Jagersfontein, and Koffiefontein pipe mines.

It is expected that the selling quotas will be as follows: South African Government 10 percent, Diamond Corporation 31½ percent, De Beers 30 percent, Consolidated South-West Africa 14½ percent, Jagersfontein 6 percent, Premier 6 percent, and Cape Coast Exploration 2 percent.

South African production.—South Africa in 1933 produced 506,552.64 carats worth about £1,560,404. This is only 9 percent of the 1928 production. Outside of a few gems recovered from mine tailings (14,149 carats valued at £7,589) the production came from alluvial diggings, as all of the pipe mines were shut down.

The production during the last half of the year somewhat exceeded that of the first half due to better average prices. Transvaal and Cape Colony each furnished about 49 percent of the total value and the Orange Free State the remainder; Transvaal, however, produced about 73 percent of the quantity in carats and Cape Colony 23 percent.

Production and sales of diamonds in South Africa, 1933

	Production		Sales		
	Carats	Value [1]	Carats	Value	Value per carat
					S. d.
Transvaal	371, 243	£757, 433	414, 686	£862, 472	41 7
Cape Colony	118, 548	776, 622	170, 084	952, 812	112 0
Orange Free State	16, 760	26, 349	61, 273	108, 563	35 5
	506, 551	1, 560, 404	646, 043	1, 923, 847	59 7

[1] Estimated.

The only pipe production, that from debris washing, was from the Cape—3,022 carats, valued at £2,523 (16s. 8d. per carat)—and from the Orange Free State—11,127 carats, valued at £5,066 (9 s. 1d. per carat).

Production of diamonds in South Africa in 1933, by alluvial fields

Field	Carats	Value	Value per carat	Field	Carats	Value	Value per carat
Transvaal:			*S. d.*	Cape Colony—Con.			*S. d.*
Klerksdorp	57, 057. 75	£253, 668	88 11	Taungs	22. 75	£104	
Lichtenburg	304, 858. 00	493, 402	32 4	Gordonia	366. 50	1, 916	
Pretoria	9, 327. 50	10, 363	22 3	Kenhardt	15. 25	52	
	371, 243. 25	757, 433	40 10		114, 169. 50	772, 640	135 4
Cape Colony:				Orange Free State:			
Kimberley	8, 482. 75	47, 148	111 2	Boshof	2, 231. 50	10, 977	98 5
Namaqualand	50, 687. 45	393, 221	155 2	Winburg	2, 964. 40	7, 955	53 8
Barkly West	43, 778. 00	269, 891	123 4	Hoopstad	194. 00	1, 170	120 7
Herbert	6, 711. 00	33, 822	100 10	Kroonstad	153. 26	709	92 6
Hay	61. 50	360	117 1	Bethulie	9. 50	30	
Prieska	1, 003. 50	6, 913	137 9	Vredefort	46. 01	307	
Hopetown	2, 305. 30	17, 343	150 6	Philippolis	34. 75	135	
Mafeking	699. 75	1, 674	47 10				
Vryburg	35. 75	196			5, 633. 42	21, 283	75 7

To December 31, 1933 South Africa has had a total recorded production (in addition to stolen and smuggled stones) of diamonds valued at some £310,200,000, or well over one-fourth of its gold production and almost one-fifth of its total mineral output. During the

14 years, 1920–33, South Africa has produced 33,581,481 carats and sold 29,951,531, an excess production of 3,629,950 carats. The lack of balance between production and sales, which was first apparent in 1927, was due to the exploitation of the Lichtenburg and Namaqualand alluvial fields. Exports in 1932 were £1,955,523 and in 1933 about £2,075,000.

Due to better average prices 1933 was a less distressing year among the alluvial miners than 1932, and by midsummer higher prices increased somewhat the number of diggers. The Government has assured the industry that few new alluvial areas will be thrown open to mining until the depression is over, a policy generally followed in 1933. On April 28, 1933 claims, rendered void, on the Grasfontein diggings, Lichtenburg district, became relocatable to qualified citizens. On June 17 the farms Nooitgedacht and Winkelhoek in the Zwartruggens district, Transvaal, were proclaimed alluvial diggings. In addition to the owners' and discoverers' rights, 1,212 claims were to be allotted by ballot on July 14 to 606 diggers qualified by residence in the Lichtenburg, Klerksdorp, and Rustenburg districts. Late in 1933 a syndicate composed of Standerton people found diamonds on the farm Vaalbank on the Vaal River, east of Vereeniging.

On January 17, 1934 general interest was aroused by the finding of the Jonker Diamond at Elandsfontein near the Premier mine, the surprise being the greater as the field was considered a low-grade one. This egg-shapped stone, said to be flawless and of fine color, weighs 726 carats and is the fourth largest diamond ever found. It was sold to Sir Ernest Oppenheimer, representing the Diamond Corporation, for £63,000 or about $434 a carat, an extremely high price for rough stones, particularly as the loss in cutting will be high. That such a reward came to an old digger down on his luck is one of the romances of diamond mining. The state benefitted to the extent of £27,600 by the sale. A 287-carat stone had been found on the same diggings a few days before by another digger named Pohl. Naturally, a rush to the field followed, but most were disappointed as claims have been allotted only to those with residential qualifications.

To indicate how recent large-scale diamond mining is it may be recalled that Erasmus Stephanus Jacobs, who as a small boy in 1867 found the first South African diamond, died at Beaconsfield, South Africa, in May 1933.

During 1933 the South African Government Namaqualand mines were operated on a reduced scale; emphasis was centered on better recovery and prevention of theft and on development to areas covered by deep overburden. Recent Namaqualand production has been as follows:

Year	Carats	Value	Value per carat		
			£	s.	d
1929	265,844	£1,748,465	6	11	6½
1930	142,125	1,274,364	8	19	4
1931	137,895	940,946	6	16	4
1932	99,196.6	643,795	6	9	10
1933	50,687.45	393,221	7	16	2

De Beers Consolidated Mines, by far the most important unit of diamond production, Premier, New Jagersfontein, and the other underground ("pipe") mines of South Africa were shut down during the year, but most of them bettered their financial position through sales of stones on hand. New Vaal River, a producer of fine river stones, declared the first dividend in 1933 that has been paid since 1928. Nooitgedacht Diamonds, one of the newer alluvial mining companies, paid a maiden dividend. Cape Coast Exploration, while its Namaqualand property is temporarily down, made a reasonable profit in 1933 and paid an initial dividend on January 26, 1934.

Belgian Congo-Angola.—The Central Africa diamond field (Belgian Congo and Angola) began to show the effects of the curtailment program begun in the fall of 1932 and had a smaller production than in 1932, but for the third year in succession it was the largest diamond producer of the world, although the value of its production was surpassed by that of South Africa. In 1932 this field's total production passed the all-time production of India and in 1933 that of Brazil.

By the introduction of machinery the mines are reducing costs and the labor force necessary for operation. Giants sluice off the overburden at a number of mines. Late in 1933 the Belgian Congo export tax was reported to have been increased from 3 to 6 percent. All six operating companies are dividend payers and have a long life before them.

The Forminière (Société Internationale Forestière et Minière du Congo) is the original company; besides important diamond production, it has interests in Congo tin, gold mining, plantation, trading, and ranching enterprises. Since its foundation the company has paid the colony over 193,000,000 francs, and the stockholders have received about 82,500,000 francs. In addition, the company has spent over 47,000,000 francs in road building and in a sanitary campaign. Dividends paid stockholders have more than doubled their original investment. Diamond production for the past 5 years has been approximately as follows: 1929, 324,000 carats; 1930, 328,000 carats; 1931, 429,000 carats; 1932, 490,000 carats; and 1933, estimated 402,600 carats. In 1933 an average of 16 mines was operated compared to 23 in 1932.

Beceka (Société Minière du Beceka) produces industrial diamonds mainly, less than 10 percent of its production being suitable for cutting. Its production in 1929 was 1,400,000 carats, in 1930 about 1,969,500 carats, in 1931 about 2,885,095 carats, in 1932 about 3,188,000 carats, and in 1933 1,413,500 carats (estimated).

Kasai-Luebo-Lueta companies (Société Minière du Kasai, Société Minière du Luebo, Société Minière du Lueta) exploit their concession as a unit through the Forminière, an interesting example of profitable unit operation of three properties which if operated separately would be doubtfully profitable.

In the gold placers of northeastern and eastern Congo a few rather fine diamonds are recovered as a byproduct. To the west of the Kasai field the Sobemco (Société de Recherches Minières au Congo) late last year found diamonds in the upper drainage of the Wamba River.

In Portuguese West Africa the Forminière groups and English (the Oppenheimer group), French, and Portuguese financiers own

Diamang (Companhia de Diamantes de Angola). Operating results in recent years were as follows:

Results of diamond operations in Portuguese West Africa, 1927–32

Year	Cubic meters treated	Carats produced	Carats per cubic meter	Net profit	Dividend per £ share
					S.
1927	203, 492	201, 511	0. 99	£108, 433	1
1928	231, 980	237, 511	1. 02	109, 110	1
1929	264, 323	311, 933	1. 18	122, 032	1
1930	341, 708	329, 823	. 97	109, 480	1
1931	397, 526	351, 495	. 89	105, 949	1
1932	407, 945	367, 334	. 90	107, 908	1

The 1933 production is estimated at about 373,600 carats, notwithstanding curtailment begun about October 1, 1932. In 1933, 100 whites and 5,011 blacks were employed. From the formation of the company in 1917 to December 31, 1933 the production has been 3,031,250 carats. The Diamang field is in the northeast corner of the colony. Diamonds also occur, although not in commercial quantities, in the extreme southwest corner, the south-central part and the eastern part of the colony.

Gold Coast.—The Gold Coast diamond deposits, discovered in February 1919, are said to be known over an area of some 20,000 square miles. The stones are small (15 to 25 per carat) but of good quality. The largest diamond yet found weighed 9 carats and was worth £15. 5s. The total exports from 1919 to 1933 have been 5,001,460 carats valued at £3,956,594. The estimated gross production in 1933 was about 1,100,000 carats.

All exploitable deposits so far known occur in the Birrim Valley, although a few stones have been found at several other places in the colony. The diamonds occur in stream gravels and drift overlying pre-Cambrian schists, basic lava members in the latter being considered the source. Costs of the principal producers per carat have been reduced appreciably. The producers in 1933 were the Consolidated African Selection Trust, West African Diamond Syndicate, the Holland Syndicate and Cayco (London), Ltd., and the Akim Ashanti Mining Co. Markwa, Ltd., owns five mining leases in the Birrim Valley.

The predominant producer is the Consolidated African Selection Trust, with concessions covering approximately 54 square miles in the Birrim Valley. It also owns about 32 percent of the stock of Cape Coast Exploration in Namaqualand and has valuable diamond deposits in Sierra Leone. The latter produce relatively large stones, so that the company will present for sale a good assortment in sizes. In the Gold Coast it employs about 18 whites and 1,200 blacks. The company does not give out production figures but, in addition to storing some "rubbish" in Africa, it exports about 630,000 carats. The year 1933 is reported to have been satisfactory and the company is increasing its dividend.

The West African Diamond Syndicate in 1933 produced about 220,000 carats, a slight decrease compared to the 228,000 carats produced in 1932. The company treats its concentrates in a two-stage magnetic separator and has decreased theft by concentrating all diamond picking at a single station to which concentrates are sent in locked containers.

South-West Africa.—The mandated area of South-West Africa has been particularly hard hit by the world depression, as it depended largely for its revenue upon copper and diamond mining, the latter usually accounting for 45 to over 60 percent of the exports. Revenue from copper and diamonds, which was £240,000 in 1926, fell to £10,348 in 1932–33. Production of diamonds in recent years is given in the following table:

Production and sales of diamonds in South-West Africa, 1926–32

Year	Production			Sales		
	Carats	Value	Stones per carat	Carats	Value	Value per carat
						S. d.
1926	683,801		6.7	726,808	£2,050,688	56 5
1927	723,877		5.9	577,341	1,620,862	56 2
1928	503,142		6.3	564,383	1,389,864	49 3
1929	597,187		5.3	533,101	1,617,698	60 8
1930	415,047		5.8	214,036	640,253	59 10
1931	71,532	£208,081	4.8	103,000	300,000	58 2
1932	17,944	85,503	.9	44,000	211,000	95 4

The principal producer, Consolidated Diamond Mines of South-West Africa, shut down its mine in 1932, although in 1932 and 1933 it continued successful development work north of the Orange River. When times again become better it will be one of the first companies participating in the Diamond Corporation to recover, as the company has large reserves of a well-varied assortment of diamonds which can be mined cheaply.

Miscellaneous producers.—Due to low diamond prices many persons have turned to gold mining; in consequence, British Guiana's diamond production was small in 1933. The colony has built a road into the Potaro River field and is to build a branch therefrom to the Mazaruni field. State aid is being given to some of the gold and diamond miners.

"Gemstones" (Imperial Institute, London, 1933) gives the following estimates of Brazil's diamond production:

Year	Gem (carats)	Low grade and bort (carats)	Carbonado (carats)	Year	Gem (carats)	Low grade and bort (carats)	Carbonado (carats)
1928	65,000	100,000	25,000	1931	30,000	50,000	10,000
1929	50,000	75,000	19,000	1932	15,000	19,000	3,000
1930	45,000	70,000	17,500				

Matto Grosso and Goyaz were the principal producers, followed by Bahia, Minas Geraes, and Parana. The 1933 production probably did not exceed that in 1932. In September 1933 it was rumored that stones of extraordinary size, said to be diamonds, had been found recently near the headwaters of the Saobento River, Minas Geraes.

One was said to weigh 2,700 carats and another 400 carats, and five other large stones were reported.

Diamonds were first found in Sierra Leone by members of the Colonial Geological Survey in 1930. They occur in the gravel of Kenja River and in the Kono district near the French Guinea border. Prospecting was begun in 1931 by the Consolidated African Selection Trust, the principal producer on the Gold Coast. Late in 1932 the company applied for a mining lease on 252 acres, and in 1933 the colonial government announced that an agreement providing for exploitation of the diamond deposits and marketing of the product was to be signed with the company. The colony is to participate in the profits of this monopoly. Consolidated will form a separate company to work the Sierra Leone deposits. The first stones, which are of excellent quality and good size, were exported in October 1932. Exports in 1932 amounted to 749 carats valued at £1,565 or £2 1s. 10d. per carat. The 1933 production was 32,017 carats worth some £82,000 or about 53s. per carat. The production for the first 9 months came from Shongbo, but in September a second deposit was opened up. An average of about 125 men was employed in prospecting.

The 1933 production of Tanganyika Territory, a declining producer, was about 1,250 carats valued at about £2,730. The principal production has come from the Mabuki gravel deposit. Kimberlite occurs near Mabuki and in the Shinyanga district some 60 miles to the south, and of the 20 known occurrences some are slightly diamondiferous. The colony's total production has been about 100,000 carats, the largest stone weighing 92.5 carats. The principal producer has been the Tanganyika Diamonds, Ltd., which more recently has turned to gold mining.

The first diamond in French Equatorial Africa was found in 1915 near Ippy in the Oubangui-Chari region, but the discovery was unimportant. In 1928, however, a geologist of the Compagnie Equatoriale de Mines found somewhat more important deposits north of Bria.[1] Other reports suggest that the deposits owned by the Equatoriale or its subsidiaries are of small yardage and not of high content. In 1930 washing tests were begun, and in 1931 diamonds were recovered in prospecting. Production has been as follows: 1930, 34 carats; 1931, 1,260 carats; and 1932, 1,644 carats. French official sources report that due to low prices the mines were shut down in 1932. The stones are of good quality, averaging about one-fifth carat each. The stones now found in the stream gravels were components of a conglomerate lens in sandstone, resembling the Congo Lubilash formation. The original source of the diamond is unknown, but Dr. Polinard considers its derivation from a basic igneous rock improbable. The geologic, although not the commercial, similarity to the Kasai (Belgian Congo) deposits is striking. Other stones are reported to have been found in French Equatorial Africa about 120 miles farther north.

Diamonds have been reported to exist on the Ivory Coast. A small stone or stones have been found in the Kakamega gold field, Kenya.

India, once the premier diamond producer of the world, now has a production of only about 675 carats a year. In 1931 it produced 639 carats, worth £2,569 (80s. 5d. per carat), and in 1932, 1,254 carats. For some time the Penna State, central India, has been the principal

[1] Middleton, J. L., Diamonds in Equatorial Africa: Eng. and Min. Jour., May 1932, p. 285.

producer. India now imports a considerable quantity of diamonds, recent imports being as follows:

1928	£654, 259
1929	654, 413
1930	377, 936
1931	304, 529
1932	428, 855

Borneo, once an important diamond producer, still furnishes a few stones, and its cutting industry imports a fair quantity of rough stone from South Africa. During the past 10 years its production has averaged about 460 carats. The 1931 production was 294 carats worth £1,663 (113 s. per carat) and that of 1932, 274 carats.

New South Wales in 1930 produced 677 carats (worth £714); in 1931, 725 carats (worth £694); and in 1932, 251 carats (worth £252). The price, about 20 shillings per carat, does not indicate very fine stones.

Rhodesia had produced from the year of discovery, 1903, to December 31, 1933, some 15,781 carats, worth £75,253. In 1932 and 1933 there was no production, and the only commercial deposit, Samabula Forest, appears to be about exhausted.

Production from near Murfreesboro, Ark., United States of America, was about 300 carats of diamonds and bort in 1932. The mines were not operating in 1933.

Venezuela presumably produced a few hundred carats of diamonds in 1933 from the region contiguous to British Guiana.

Industrial diamonds.—The demand for diamonds for industrial purposes is a good barometer of business activity, and the increased sales in 1933, first noted in Germany and later in America and England, indicate world revival of business. There is a scarcity of industrial stones, as the South African pipe mines are shut down and Brazilian carbonado production was only one-third of normal. Demand became good in March and continued rather strong throughout the year, with shortages in better grades.

Imports of industrial diamonds into the United States during the past 8 years are given in the following table. The price per carat has fallen from 1929 to date due to the larger imports of very small and hence low-priced, off-color gem stones for diamond drilling.

Industrial diamonds imported into the United States, 1926–33 [1]

Year	Carats	Value	Value per carat	Year	Carats	Value	Value per carat
1926	41, 475	$1, 939, 735	$46. 77	1930	145, 958	$2, 756, 630	$18. 89
1927	34, 645	2, 149, 912	62. 06	1931	224, 970	2, 400, 879	10. 67
1928	38, 342	2, 756, 895	71. 90	1932	163, 704	1, 061, 823	6. 48
1929	46, 901	4, 060, 577	86. 58	1933	258, 300	1, 246, 748	4. 83

[1] Includes glaziers', engravers', and miners' diamonds.

Several makers of oil-burning furnaces find the best possible atomizer is a diamond with a hole bored in it. Ordinary nozzles have a short life, but even without resetting a diamond nozzle will last 5 years. In laboratory tests under high temperature, oil charged with carborundum and containing 1 percent sulphuric acid was forced under pressure through the orifice in the diamond. Such a test, together with the fact that diamond tools are used in truing carborundum wheels, shows the great difference in hardness of the two substances. The diamonds used are off-color gem stones, and holes in them are generally from 0.013 to 0.0025 inch in diameter. As several important makers of oil burners have standardized on such nozzles and as about 1 family in 30 in the United States has an oil burner, the quantity of industrial diamonds likely to be consumed in this new use may be large.

For a number of years attempts have been made to introduce diamonds more generally in the superabrasive field. A great deal of experimental work has been done in an effort to shape diamond dust or grains held together by a suitable binder into grinders, lapping wheels, tools, etc. Until recently, attempts to find a suitable binder have been unsuccessful, but at present Swiss and German manufacturers are marketing such products, which are reported to be giving satisfactory service.

The use of diamonds in the automobile industry is expanding, as it is in many scientific processes, such as testing heat-hardened metal parts, testing smoothness of metallic automobile parts, and preparing microscopic slides.

The demand for black diamonds (carbonado) was much less in 1933 than a couple of years ago owing to the use of small gem stones in diamond drilling. The price of carbonado has decreased markedly in the same period; 2-carat stones selling for $175 per carat in 1929 now are worth about $75 to $90. Carbonado, which once brought $65 a carat in the Bahia fields, late in 1931 brought $30 a carat and in 1933, $12 to $20 a carat. Brazilian production and exportation has decreased greatly, and small shipments only reach the Amsterdam market. As carbonado has a definite place in truing wheels and other industrial uses, there is always a certain demand, and available stocks are small.

AMBER

Sales of amber increased greatly in 1933 and as stocks were reduced the German amber-mining industry expanded markedly early in 1934. At Palmmicken, East Prussia, the principal center, 375 men are employed, and they are working 40 rather than 20 hours a week.

The South Manchurian Railway engineers estimate that the coal deposits of Fushun contain about 435,000 tons of amber. At present about 4 tons a day are being produced. The amber is used almost exclusively in making lacquer and suffices for about one-half of Japan's requirements.

AMETHYST

Early in 1933 a Mexican company began to exploit amethyst deposits northwest of Taxco, Guerrero. Some of the material is reported to be fine and is in demand among local jewelers.

EMERALD

Colombia for centuries has been the source of the world's finest emeralds. In 1933 the Muzo mine, which has been shut down for some years, was reopened with a production worth about $25,000. This was done under the direction of P. W. Rainier, Government mining engineer, who also sampled the debris from former mining with favorable results. An American group markets the production of the Government mines by contract on a commission basis. The Colombian Emerald Co. produced from its Chivor mine about 4,000 carats in 1933.

SAPPHIRE

A number of miners worked the Anakie (Queensland) sapphire fields in 1933, the most active center being Iguana Flat. The production approximated £4,000. First blues in the rough sold for £7 per ounce and second blues for 7 shillings per ounce. Most of the product was exported to France and Switzerland. Among the more notable finds were a blue sapphire of 498 carats and a zircon of 259 carats.

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PRECIOUS AND SEMIPRECIOUS STONES (GEM MINERALS)

By Sydney H. Ball

SUMMARY OUTLINE

Precious and semiprecious stones include minerals used primarily for personal adornment and decorative purposes. To be so prized the stones must have beauty and "fire" or play of color, must not be too common, and must be hard enough to withstand ordinary wear. Among the less regal members of the group fashion temporarily may determine the popularity of a gem stone. The quality of hardness also accounts for the many industrial uses of diamonds and, to a smaller extent, of rubies and sapphires.

Almost 100 mineral substances have been used for decorative purposes, and although there is no hard and fast division of precious and semi-precious stones, diamonds, emeralds, rubies, and sapphires usually are included in the former group and frequently, by courtesy, pearls, an organic substance. These gems, however, sometimes are equaled in beauty by exceptionally fine opals, aquamarines, tourmalines, spinels, chrysoberyls (including cat's-eye and alexandrite), and spodumenes (hiddenite and kunzite).

The diamond industry is organized much more highly than that of any other precious stone, and the diamond output represents almost 95 percent of the world's gem production.

HISTORICAL SUMMARY

Through the ages the precious stone industry has seen notable changes both as to the principal gem mined and the country of its source. From about 25000 to 3400 B. C. the Baltic amber mines dominated the industry. For the next 1425 years the turquoise mines of the Sinai Peninsula were the most important gem mines in the world. From about 1925 to 800 B. C., the emerald mines of the Egyptian Red Sea coast were unrivaled. Thereafter, until 1725 A. D., India and Ceylon, with their diamond, ruby, and sapphire mines, were the world's leading gem producers. They lost this position to the Brazilian diamond mines, which in turn were supplanted in 1870 by the South African diamond mines. For the past 3 years closing of the South African pipe mines has perhaps shifted the weighted center of the world's gem production to northeastern Angola.

United States.—In contrast to its wealth in most mineral resources, the United States is notably poor in precious stones, having no deposits of first rank. The Montana sapphire deposits, the Southwest turquoise mines, the Maine tourmaline mines, and the southern California tourmaline and kunzite mines have produced gems, but no deposit has been found comparable to the Brazilian or South African diamond fields. A few diamonds have been discovered in Arkansas, but mining activity has been sporadic. Semiprecious stones occur near many resorts, but the tourist purchaser of the "local" product more than likely buys a South American stone cut in Germany and mounted in Providence, R. I.

In spite of the fact that no outstanding deposits of any one stone has been located in the United States, probably no other country has yielded such a wide variety of precious and semiprecious stones; more than 60 distinct species have been produced commercially. Gem mining is an old, if not important, American industry. When white men began their conquest of America they found that the Indians of North and South America used about as many decorative and precious stones as were known at that time to the people of Europe, Asia, and Africa. Certain deposits were worked at least 2,000 years ago; one turquoise mine was a major mining project before the Spaniards arrived in America.

Adequate statistics are available only from 1880 to 1924, and during those 45 years about $9,800,000 worth of gems were produced; the peak year was 1909 ($534,000) and the year of least production, 1923 ($60,000); these figures cover the most active period of gem mining in the United States. Including estimates of production from 1925 to the present the total value of precious stones produced in the United States has been about $10,500,000. Montana, the largest producing State, has been responsible for about 48 percent of the total value, followed by California and Nevada with 23 and 8 percent, respectively.

From 1883 to 1921 the United States produced sapphires (as well as a few rubies) valued at $3,018,406; turquoise and matrix, $2,088,262; quartz gems, $1,894,289; tourmaline, $822,955; garnet, $173,979; beryl, $138,186; and variscite, $125,718.

The Mount Mica tourmaline locality in Maine has been worked in a desultory manner since it was discovered in 1820, but the first American gem-mining concern was the Emerald & Hiddenite Mining Co., which exploited the emerald and hiddenite deposit at Stony Point, N. C., from 1880 to 1888. However, its total production is said to have been valued at only $22,500. Since then several other companies have been formed to mine emeralds in North Carolina.

About 1900, there were extensive mining operations at several turquoise mines of the Southwest, notably at Los Cerillos and in the

Burro Mountains, N. Mex. Good-quality material was recovered in appreciable quantities, and if turquoise should regain its former popularity the mines no doubt would be reopened.

Fifty years ago the agatized wood of Arizona was cut and polished on a scale that threatened to destroy the beauty of the petrified forest, but this menace disappeared when the forest became a national park.

Sapphires were found first in Montana in 1865 in the sluice boxes of placer mines along the Missouri River. From 1880 to 1890 several thousand dollars worth were produced annually as a byproduct of placer mining. Shortly after 1890 the gem was found to occur in a basic igneous dike, and in 1896 an English company began mining. The work was suspended in 1929, but production in some of the intervening years reached $450,000 annually. Some brilliantly attractive, though rather pale, gems were recovered and sold in London, Paris, and New York, although 85 percent by weight of the production was shipped to Switzerland to be cut into jewels for watches.

In 1906 diamonds were found near Murfreesboro, Pike County, Ark., the source being a rock very similar to the kimberlite of the

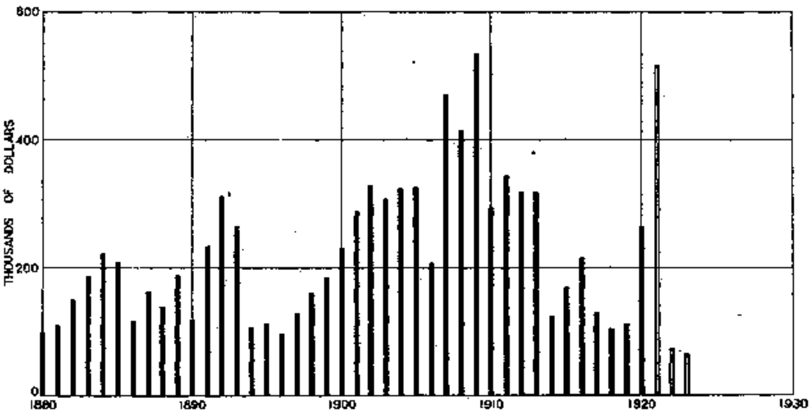

FIGURE 129.—Value of precious and semiprecious stones produced in the United States, 1880–1923.

South African pipes. Several companies were formed at once, but to date production has totaled only about 10,000 carats, and for the past 2 years none of the companies have operated.

Beautiful tourmaline of various colors has been produced at Mesa Grande, San Diego County, Calif., and the pink variety has been exported to China for cutting. Kunzite, the attractive, transparent, lilac spodumene, is obtained from the same district. The Virgin Valley, Nev., has produced some fine black opals and Latah County, Idaho, some attractive gem opals. The moss agates of Montana and Wyoming are as fine as any in the world. A number of other semiprecious stones of American origin come on the market from time to time, notably aquamarine and golden beryl, agates and other quartz gems, amazon stone, malachite, and azurite. The ornamental use of gold quartz originated in California over 80 years ago. The deep blue benitoite (California), the emerald-green hiddenite (North Carolina), the yellowish green variscite (Utah), and the rose-red rhodolite (North Carolina) are found only in the United States.

In addition to the output of gem-mining companies mineral collectors from time to time find gems worthy of cutting, and farmers near Hot Springs, Ark., collect and even mine considerable quantities of rock crystal. Other gems are byproducts of mica, feldspar, or corundum mining.

Canada.—Canada is perhaps even poorer in precious stones than the United States, and little gem mining has been done; however, there are deposits of amazon stone, albite (the iridescent variety, peristerite), sodalite, rose quartz, garnet, and agate, the product of which when cut makes attractive beads.[1] Small amounts of rose quartz are reported to have been shipped to Germany late in 1933 or early in 1934 from the Winnipeg River area, Manitoba.[2]

Mexico.—Mexico is almost equally poor in precious stones, although opals have been mined and cut for centuries. The opals, while attractive, scarcely are comparable to those of Hungary and Australia.

Production in the United States.—The value of precious stones produced in the United States in 1934 probably did not exceed $3,000, including 2,000 pounds of rose quartz from South Dakota; amazon stone from Amelia Courthouse, Va.; variscite from Utah; vesuvianite from Tulare County, Calif.; topaz from Fresno County, Calif.; four diamonds from the California gold placers; and agatized wood from Arizona. Amateur lapidaries also collected and cut some semiprecious stones from other States. Spencer[3] describes a new gem stone, pollucite (an acid silicate of caesium and aluminum) from Newry, Oxford County, Maine. The cut stone, a brilliant of 1.725 carats, is colorless and flawless with a brilliant luster.

Imports.—According to the Bureau of Foreign and Domestic Commerce, imports of precious stones into the United States in 1934 were as follows:

	Carats	Value
Diamonds:		
Rough, uncut	43, 754	$2, 739, 278
Cut, but not set	208, 916	9, 900, 900
Glaziers', engravers', and miners', not set	520, 889	2, 810, 281
Pearls and parts, not strung or set		477, 018
Other precious stones:		
Rough, uncut		115, 333
Cut, but not set		774, 238
Imitation precious stones, except opaque		1, 051, 608
Imitation precious and semiprecious stones, opaque, including imitation pearls		24, 992
Marcasites		14, 956

The rate of duty on various types of gems and their imitations remains the same as that given in Minerals Yearbook, 1932–33, page 803.

Status of jewelry trade.—Judged by sales as well as number of employees and wages paid, the jewelry trade had an appreciably better year in 1934 than in 1933. Jewelry sales were larger than those of 1933, but only about 45 percent of those of 1929. The increase was largely in low-priced goods, but an occasional fine gem was sold, and toward the end of the year there was a distinct improvement in the demand for fine jewelry. Furthermore, for the first time in several years jewelers were able to mark up their inventories, due to an upward price trend. Manufacturing jewelers had a reasonably satis-

[1] Parsons, A. L., University of Toronto Studies 36: Contrib. to Canadian Mineral., 1934, pp. 13–21.
[2] Hutt, G. M., and Seibert, F. V., Bull. Canadian Min. and Met., June 1934, p. 330.
[3] Spencer, L. J., Gemmologist, April 1934, pp. 263–264.

factory year, and from September to December many of them operated their plants to capacity.

Taxes and codes.—On May 10, 1934 the Federal Government removed the 10-percent sales tax on jewelry sold for less than $25 and on materials for watches and clocks. For the fiscal year ended June 30, 1934 the tax was collected on sales of $46,685,570, including those articles sold at a wholesale price of more than $3. New York contributed 39.6 percent of the total, Illinois 12.3 percent, and Massachusetts and Pennsylvania 7.7 percent each.

The jewelry industry in 1934 operated under several codes. Although entailing an additional expense to the code members and meeting objection from a few individuals the codes in general have improved the morale of the industry. Provisions for adjusting certain discrepancies between the various codes would have been helpful.

Foreign tariffs and taxes.—On July 6, 1934, the Doumergue government suppressed the "luxury" tax, to the advantage of established French jewelers and the discomfort of jewelers who did not maintain their own establishments.

In South Africa most industries pay an income tax of 2s. 6d. per £1, but diamond mines pay 3s. and gold mines 4s.

The high Indian duties are bringing many smuggled stones on the local market, which is disadvantageous to honest jewel merchants.

On December 24, 1934, Italy prohibited the importation of all precious stones but in February 1935 changed to a plan of controlled imports. This measure hurts not only the diamond-cutting centers of the world but the 40,000 employees of the Italian jewelry industry as well. In the past, Italy has had a considerable jewelry export trade with South America and the Balkans, although imports of unmounted precious stones were double exports in 1934.

Czechoslovakia, in an attempt to preserve its trade balance, prohibited the imports of precious stones early in 1935. Jewelers therefore depend on stocks or on stones derived from old pieces of jewelry.

Imports into Germany are so complicated by government restrictions as to payment that the situation virtually amounts to an embargo.

Identification of jewelry.—At the conference of the International Association of Manufacturers, Wholesalers, and Retailers of Jewelry, Gold, and Silverware in May 1934 at The Hague it was proposed to mark all precious stones, an idea apparently sponsored by the Germans. Others considered that it would be vandalism to mar flawless gems but agreed that it might be a good idea to mark synthetic stones. Additional methods of identifying fine stones were considered, and it was reported that an English expert, P. Antrobus, has made plaster casts of some 50,000 of the finest pieces of jewelry owned in Great Britain, as well as detailed descriptions of the stones.

Fashions in jewels.—Bar clips, ear clips, long diamond pendant earrings, and solitaire diamonds for hair ornaments were popular adornments during 1934. Designs were inclined to affect the bizarre, with Hindoo, Cambodian, Egyptian, or Russian motifs. Diamonds and sapphires, the latter the stone of Princess Marina's engagement ring, were particularly popular. Toward the end of the year there was a distinct trend toward the use of single large jewels of fine quality. In diamonds, the brilliant appears to be gaining in favor over the square or emerald cut. In demanding large stones of the finest quality, women of today in part may be activated by their investment value.

Traditionally the use of platinum is linked with fine diamond jewelry, the demand for which was subnormal in 1934. Due to the high price of gold, however, platinum was used in 1934 for rings and other jewelry, cigarette cases, and other personal ornaments customarily made of gold.

Century of Progress exhibit.—In 1934, as in 1933, diamonds were featured at the Chicago Century of Progress. The more important features of the 1933 exhibit were retained, and the addition of the exquisite La Favorite (50.28 carats) brought the value of large diamonds on exhibit—including the Tiffany Yellow (128.5 carats) and the blue-white Maximilian diamond (42 carats)—to over $2,500,000. Diamond cutting was done in the streets of Amsterdam concession, and Mme. Sarah Bernhardt's jewels were displayed in Burma House in the English Village.

DIAMOND

Conditions in the diamond industry improved moderately in 1934. Real prosperity, however, depends upon resumption of normal business, particularly in the United States. Unification of the production and sales branches of the industry progressed during the year. Two factors were disturbing—a slight increase in production without, however, adding to stocks; and the tendency of the cutting industry, organized to meet great demand, to sacrifice present profits to maintain its existence.

A poor beginning in the first 5 months of the year was more than balanced by the reasonably good and at times excellent business of the last 7 months. Sales of rough diamonds by the corporation were appreciably higher than in 1933; exports from South Africa were 30 percent higher; imports into the United States increased 26 percent; and world retail sales were 20 to 25 percent above those of 1933. Stocks in the hands of retailers are now low, and provided conditions improve sales of rough should be large in 1935. Prices fluctuated considerably during the year. Rough was about the same at the end of the year as at the beginning; fine-cut stones increased slightly; and small polished stones, due to too keen competition among the cutters, dropped a little.

Share dealings.—Trading in diamond shares was of small volume during 1934 except in January, November, and December. Share prices advanced from the beginning of the year until mid-February; then the general price trend was downward until November. Prices, however, increased appreciably in December. Six of ten important diamond shares advanced during the year, notably West African Diamond Syndicate, Angolas (Diamang), and De Beers preferred; and four lost, Jagersfontein and Consolidated Diamond Mines being the heaviest losers. The net result for the year was an average advance of about 9 percent. At the end of 1934 five selected stocks were about 36 percent of the all-time high (1927) and 406 percent of the all-time low (June 1932). Of the 18 principal diamond-mining companies 10 paid dividends.

Market.—About 95 percent of the world's diamond production is purchased by the Diamond Corporation, London, which in turn sells to brokers and large cutters. In 1934, as usual, the corporation was astute, keeping prices of rough firm and rarely selling rough except when the resulting cut product could be absorbed. By making no concessions as to the price of rough the corporation doubtless will aid in raising the price of cut stones to a level profitable to the cutters. During the summer polished goods were too low by 15 to 20 percent in comparison to rough, a differential since decreased.

The Diamond Trading Co., the new selling subsidiary of the corporation, made its first sale under the new sorting agreement on May 8, 1934. Although the corporation does not publish its sales they are understood to have been about £4,000,000, a relatively low figure, but considerably higher than in 1933. The large stock of rough held by the corporation decreased slightly for the first time in several years.

Contracts with non-South African producers terminated at the end of 1934, but new contracts have been negotiated. It is stated that the corporation is to make five-eighths of its sales from stones produced by the South African mines and three-eighths from the outside producers (Congo, Angola, and Gold Coast).

The market outlook inspired confidence at the beginning of the year due to the producers' agreement consummated late in 1933 and to expectation of a better American market. January and February sales were appreciable, but quantities of Russian "seconds" reached western Europe in the first 4 months of the year, and it was not until June and July that considerable sales of rough again were made. September, October, and November were months of large sales, the best the corporation has had in several years and much higher than seasonal. December, as usual, was a dull month, but large sales of rough were made early in 1935, so that the trade is inclined to face the future confidently.

The poor market for cut stones during the first 5 months was offset by distinctly better business for the balance of the year. The first 4 months were quiet to dull, with too much cut offered on a thin market. Improvement was noted in May and from then on confidence grew, culminating in large sales in September, October, and November with price increases in certain types and an actual shortage of supply in others.

In the United States more interest was shown in diamonds in 1934 than in 1933. Except from May to September wholesale sales in New York were appreciably greater compared with corresponding months in 1933. The average monthly gain over 1933 was 19.2 percent. For the first half of the year the increase was due to larger sales of cheaper goods. In October, American buyers in Europe bought heavily of good quality meleés and large stones in anticipation of the Christmas trade, and by December American buying reminded European centers of old times. The Christmas trade improved 25 to 30 percent over 1933, with much inquiry for and some buying of large stones.

Diamond sales in Great Britain in 1934 exceeded those of 1933 by perhaps 25 percent, the diamond trade evidently being slowly on the upgrade. The market was strong late in the year due to the marriage of the Duke of Kent and Princess Marina. Sales in other European countries improved, except in France, Germany, and Russia. For the past 3 years India has been even a larger buyer than usual.

Imports of precious stones into India, largely diamonds from Belgium, were about $2,000,000 in the fiscal year 1933–34.

The purchase of precious stones, especially diamonds, as a hedge against inflation was more wide-spread in America in 1934 than in 1933. The stones purchased were fine, unset stones of 1 to 10 carats, the type of most stable price. Many sales of rough in December were to satisfy the desires of continental investors, as was also the demand for large stones from June to August. Germany, Hungary, and France undoubtedly bought many fine diamonds as investments during the year.

Following England's abandonment of the gold standard in the fall of 1931 India sent large quantities of gold to England. A large part of the proceeds of these sales was used in purchasing fine diamonds, rubies, emeralds, and sapphires.

Stocks.—The Diamond Corporation's stocks, as well as those of producers and cutters in Amsterdam and Antwerp, remained large, probably a little less than they have been for the past 3 years or approximately about $100,000,000. In America, wholesalers' stocks are believed to have increased nearly 10 percent in 1934 but are still low. Retailers' stocks also are very small and if the present demand continues must be increased materially. This is equally true of retailers in England, Italy, Austria, and Hungary. Should real prosperity return to the trade large purchases must be made from the corporation and the cutters who buy from it.

Prices.—The price of rough began to sag slightly in February and did not recover until May, with the result that prices for the first half of 1934 were less than in the corresponding period of 1933 by perhaps 10 percent. From May to October prices were firm, and in October certain types were advanced from 5 to 7½ percent. In short, rough ended the year at about the same price as the beginning, but with promise of improvement in future. Prices for fine large cut were firm throughout the year. The price of large cut stones is determined by the price of rough, but due to the large amount of labor involved the cost of polishing is the major factor that determines the price of small stones. Due to the dumping of small cut stones by the German cutting industry, with its low labor costs, and also to the keen competition of Amsterdam and Antwerp cutters, the price of small cut fell from January to April, and in June such goods were selling in America at distress prices. In Europe, however, prices for certain classes of small stones became firm by May, and thereafter the price tendency was upward. The net result of fluctuations during the year was a slight increase in the price of large stones and a small decrease in that of small stones.

Imports into the United States.—In 1934 cut and uncut diamonds (not including industrial stones) comprised 84 percent of the imports of all precious stones, pearls, and imitation stones; excluding imitation stones as well, diamonds accounted for 90 percent of the total.

The value increased 126 percent from 1933, although it was equivalent to only 44 percent of the 1929 total. The price per carat of both cut and uncut exceeded the corresponding 1933 figure, and that of the rough was unusually high. The total value of imports of rough and cut diamonds in 1934 was $12,640,178.

Diamonds imported into the United States in 1934, by countries

Country	Rough, or uncut			Cut, but not set		
	Carats	Value		Carats	Value	
		Total	Per carat		Total	Per carat
Belgium	23,397	$1,649,493	$70.50	145,266	$6,785,871	$46.71
British Guiana	259	3,600	13.90			
Canada	5,234	57,684	11.02	335	23,786	71.00
France	464	137,002	295.26	301	22,854	75.93
Germany				79	8,972	113.57
Italy				37	7,823	211.43
Mexico				4	510	127.50
Netherlands	3,862	257,757	66.74	62,523	3,028,815	48.44
Switzerland				2	172	86.00
Union of South Africa	6,903	407,557	59.04	66	6,796	102.97
United Kingdom	3,635	226,185	62.22	303	15,301	50.50
	43,754	2,739,278	62.61	208,916	9,900,900	47.39

In 1934, Belgium with 68.6 percent and Netherlands with 30.6 percent accounted for 99.2 percent of the American imports of cut stones. The chief sources of rough were: Belgium, 58.7 percent; Union of South Africa, 14.5 percent; Netherlands, 9 percent; and United Kingdom, 8 percent.

The value per carat of cut imported into the United States reached a peak of $100.07 in 1929. For the succeeding 3 years the value per carat fell, due in part to decreases in diamond prices but largely to the diminished purchasing power in the United States, resulting in purchases of smaller stones of poorer quality. The slight increase in the 1934 price per carat compared with 1932 and 1933 is encouraging.

Imports of rough vary greatly from year to year and normally do not depend directly on good or bad times. Imports reached their peak value in 1926, then decreased to 1932, but have increased somewhat in the past 2 years. The peak in total carats imported was reached in 1929. As indicated by the value per carat the quality of stones imported decreased from 1926 to 1930, picked up appreciably in 1931, fell again in 1932, and then rose sharply in 1933 and 1934.

As usual, the heaviest imports were in the fall in preparation for the Christmas trade.

Per-capita diamond consumption in Canada is about one-half that of the United States. In 1934 imports into Canada were valued at $544,540, an increase of 64 percent over 1933.

Diamond cutting.—The diamond-cutting industry experienced difficulties in 1934. Few cutters made profits, and bickering was rampant, although unemployment was slightly less acute. The number of cutters now exceeds that in peak years, and the master cutters are inclined to polish goods without regard either to profit or world demand. Once a particular cut, size, or grade is desired all rush in to produce it, and a surplus with weakened prices frequently results.

Employment in Antwerp averaged about 42.5 percent of the union membership (41 percent in 1933) and in Amsterdam 33.5 percent (27 percent in 1933). Antwerp with 20,000 to 25,000 artisans, Amsterdam with 5,000, and Hanau and other German cities with 4,500, are the principal cutting centers. Kimberley, Capetown, Johannesburg, New York, Paris, London, Jura Mountains, Geneva, Rio de Janeiro and

Diamantina, and several cities in India and Borneo are minor cutting centers.

Antwerp suffers from German competition; furthermore the cottage industry now scattered throughout Belgium cuts small goods at ridiculously low prices and union hours are unknown. In May and again in October representatives of the Belgian and German industries met at Luxemburg, but the Belgians' efforts to equalize wages in the two countries failed. The Antwerp diamond clubs have forbidden their members to send rough to Germany to be cut, but diamonds are easily smuggled across boundary lines. On October 26 the Belgian Government attempted to stop German "dumping" by requiring all obligations to German manufacturers to be paid through the Belgian National Bank with marks at the regular exchange rate. A Belgian professional school in which young and old workmen will learn improved technique and in which mechanical methods of cutting are taught was founded on March 28, 1934. The Antwerp Diamond Corporation (Comptoir Diamantaire Anversois) formed late in January 1934 (capital 30,000,000 francs) will obtain a better distribution of credit, particularly in the diamond market but also in that of other gems as well as precious metals.

The Amsterdam industry was even less prosperous than that of Antwerp, as it had to compete not only with Germany but also with Belgium, where lower wages are paid than in Holland. The subsidy to cutting of small stones and the contribution by the Dutch Government and the city of Amsterdam of 10 guilders a week per man has, however, resulted in relatively less unemployment in Amsterdam in 1934 than in 1933. Under the circumstances, the diamond cutters union agreed to substantial wage cuts.

At Hanau, Idar, and Brucken, Germany, small stones are cut well and cheaply because the industry is highly mechanized and wages are low. Unemployment, however, has been high; only 10 percent of the cutters were employed early in 1934, but later the situation improved and about 30 percent were employed. Not only did the German Government assist the master workmen by permitting them to pay their men in depreciated currency but it flooded Antwerp with circulars setting forth the advantage of having cutting done in Germany and having the work paid in "dollar bonds." In future German competition may be even more severe, for the industry has been rounded out by the addition of sawing and grinding units.

The South African cutting industry is slowly dying. The number of employees has dropped from 676 in 1929 to only 250 in 1934. The government apparently has definitely abandoned additional fostering of the industry.

The increase of 65 percent of rough imported into the United States in 1934 compared with 1933 suggests that the American cutting industry may revive. In 1934, 60 to 75 artisans were employed spasmodically.

The Parisian industry is virtually at a standstill.

Attempts at artificial production.—Usually every year at least one chemist reports that he has made artificial diamonds. M. K. Hoffman, a German mineralogist, repeated Dr. Henri Moissan's famous experiments and produced synthetic "diamonds." Tests, however, showed that these minute carbon particles had a refractive index of but 1.74 (diamond, 2.4) and hence were not diamonds but apparently some other form of carbon. Hans Karabacek, a Viennese inventor, claimed in 1934 (German patent 589144) to have made diamonds up to 0.25 carat. He melted iron filings, blast-furnace slag, and carbon under a pressure of 20 to 35 tons per square inch and at rather moderate temperatures (900° to 1,000° C.) and then added carbon monoxide or carbon dioxide.

World production.—World production of diamonds in 1934 was approximately 4,179,581 carats valued at $18,469,923, an increase of 21 percent in quantity and 33 percent in value compared with 1933.

The following table gives, with the accuracy available statistics permit, diamond production for the past 5 years in carats:

Production of diamonds by countries, 1930–34, in carats

Country	1930	1931	1932	1933	1934
South Africa:					
Mines	2,242,460	1,470,376	307,431	14,149	430,897
Alluvial	918,706	647,044	488,096	492,404	9,413
	[1] 3,163,590	[1] 2,119,155	[1] 798,382	506,553	440,310
Angola	329,823	351,495	367,334	[2] 374,000	453,000
Brazil	115,000	80,000	34,000	[2] 30,000	[2] 30,000
British Guiana	110,042	63,479	61,780	48,569	[2] 44,818
Congo	2,519,300	3,528,200	3,990,069	1,604,700	1,992,865
Gold Coast [3]	861,119	880,479	842,297	863,722	1,142,268
Sierra Leone			749	32,017	70,000
South-West Africa	415,047	71,532	17,944		1,100
Tanganyika	13,107	7,790	1,391	[2] 1,250	1,220
Miscellaneous [4]	3,000	3,600	3,725	1,825	4,000
Grand total	7,530,028	7,105,730	6,117,671	3,462,636	4,179,581

[1] Includes a small quantity of diamonds recovered from re-treatment of tailings.
[2] Estimated.
[3] Exports year ended Mar. 31.
[4] 1930–33, includes India, Borneo, New South Wales, and in certain years Venezuela, French Equatorial Africa, United States (Arkansas), and Rhodesia; 1934, includes Borneo, India, New South Wales, Venezuela, Rhodesia, United States (California).

The increased production over that of 1933 came from Sierra Leone, a new and growing producer, Gold Coast, Angola, and Congo. The value of the 1934 production was only about one-fourth and the quantity about one-half that of an average predepression year due in part to lower prices now received by the producers compared to those of former years but mainly to the relatively large percentage of bort produced by one of the Congo producers and by the Gold Coast.

In addition to newly mined diamonds there is also available to consumers a considerable quantity of "seconds." A few diamonds come on the market for resale every year, but, in addition, for the past 8 years Russia has sent many diamonds to western Europe. In the first 4 months of 1934 the amount received was so great that it was a distinct menace to the stability of the market. Since then shipments from this source have been halted, at least temporarily, but further sales by the Soviet Government are to be expected in future.

South African sales agreement.—The agreement [4] entered into by the South African Government and the South African producers was signed in 1934. Parties to the agreement are the Union Government, the Administrator of Southwest Africa, the Diamond Corporation, and the Diamond Producers' Association, with a board composed of 2 representatives of the companies, 2 of the governments, and 1 of the

[4] Minerals Yearbook, 1934, p. 1087.

Diamond Corporation. Stocks are sorted at a single office at Kimberley, and sales quotas for each producer, including the Government as one of the producers, have been established. Sales, including sales to South African cutters (at London prices less the export tax), are made through The Diamond Trading Co., Ltd., owned by the Diamond Corporation. The Trading Co. maintains offices in London and Kimberley. To maintain prices the board can purchase alluvial goods in the open market and can on the other hand fix minimum prices for the sale of its diamonds. Throughout the negotiations the representatives of the coalition government showed their desire to safeguard the stability of the diamond industry. Apparently, it is understood that for the time being the cutting industry in South Africa is not to be expanded, that few new alluvial fields are to be opened to exploitation during the depression, and that the Government accepts a quota for its Namaqualand mines present and future. The Diamond Corporation, to allay fear that its stock might be thrown upon the market, agrees to consider itself a producer and like other producers to accept a sales quota. In other words, the corporation stock will be liquidated over a period of years. Havenga, minister of finance for the Union, stated that once demand improved markedly the Government would forego its Namaqualand quota in favor of the Kimberley, Jagersfontein, and Koffyfontein pipe mines. The sales quotas are as follows: South African Government, 10 percent; Diamond Corporation, 31.5 percent; De Beers, 30 percent; Consolidated Southwest Africa, 14.5 percent; Jagersfontein, 6 percent; Premier, 6 percent; and Cape Coast Exploration, 2 percent. This agreement assures two basic needs of the industry—(1) control of South African production and (2) sales of South African diamonds through one channel.

Government officials state that they desire to improve the position of an industry which supports tens of thousands of miners and diggers. As proof they cite that in 1930 Government sales totaled 97,000 carats and those of South African producers 23,000 carats, whereas in 1933 the Government sold but 23,000 carats and producers 119,000 carats.

South African production.—In 1934 South Africa produced 440,312.57 carats of diamonds with an estimated value of £1,437,591. This quantity was equivalent to about 90 percent of production in 1933 but only about 8 percent of that in 1913, the peak year. Except for a few gems from mine tailings (9,413 carats valued at £5,474) production came from alluvial diggings.

Cape Colony furnished 64.1 percent of the production; Transvaal, 32.4 percent; and Orange Free State, 3.5 percent.

Production and sales of diamonds in South Africa, 1934

	Production		Sales		
	Carats	Estimated value	Carats	Value	Value per carat
					S. *d.*
Transvaal	313,153	£648,603	507,745	£807,371	31 10
Cape Colony	120,552	778,091	655,673	1,598,514	48 9
Orange Free State	6,606	10,897	98.128	87,263	17 9
	440,311	1,437,591	1,261,546	2,493,148	39 6

Production of diamonds in South Africa in 1934, by alluvial fields

Field	Metric carats	Value	Value per carat	Field	Metric carats	Value	Value per carat
Transvaal:			*S. d.*	Cape Colony—Con.			*S. d.*
Klerksdorp	46, 859. 75	£192, 722	82 3	Vryburg	19. 25	£97	--------
Lichtenburg	240, 177. 75	359, 056	29 11	Taungs	27. 75	89	--------
Pretoria	26, 116. 25	96, 825	74 2	Gordonia	53. 75	459	--------
				Van Rhynsdorp	. 95	3	--------
	313, 153. 75	648, 603	41 5				
					115, 331. 77	774, 003	134 3
Cape Colony:							
Kimberley	5, 705. 00	32, 272	113 2	Orange Free State:			
Namaqualand	68, 754. 25	550, 010	160 0	Boshof	1, 309. 25	7, 099	108 5
Barkly West	30, 053. 22	141, 953	94 6	Winburg	979. 00	1, 823	37 3
Herbert	6, 343. 50	27, 899	88 0	Hoopstad	3. 25	15	92 4
Hay	20. 50	27	26 4	Kroonstad	6. 75	24	--------
Prieska	876. 25	5, 337	121 10	Vredefort	114. 80	550	--------
Hopetown	1, 888. 50	12, 088	128 0				
Mafeking	1, 588. 85	3, 769	47 5		2, 413. 05	9, 511	78 10

To December 31, 1934, South Africa has had a total recorded production (in addition to stolen and smuggled stones) of diamonds valued at some £311,637,600, or well over one-fourth of its gold production and almost one-fifth of its total mineral output. During the 15 years 1920–34 South Africa has produced 34,021,794 carats and sold 30,597,574, an excess production of 3,424,220 carats. The lack of balance between production and sales, first apparent in 1927, was due to the exploitation of the Lichtenburg and Namaqualand alluvial fields. Exports in 1932 were £1,955,523; in 1933, £2,131,000; and in 1934, £2,772,000.

The Namaqualand production was again small, virtually all of the valuable claims being owned either by the State or the Cape Coast Explorers, and each is working on a quota basis. Recent production has been as follows:

Year	Carats	Value	Value per carat
			£ s. d.
1929	265, 844	£1, 748, 465	6 11 6½
1930	142, 125	1, 274, 364	8 19 4
1931	137, 895	940, 946	6 16 4
1932	99, 196. 6	643, 795	6 9 10
1933	50, 687. 45	393, 221	7 15 2
1934	68, 754. 25	550, 010	8 -- --

All the pipe mines were shut down in 1934, but to give employment De Beers began on a small scale in February 1935 to wash some of its stock-piled kimberlite. The mines, however, sold diamonds from stocks on hand, and De Beers, for example, made a profit of £768,683 (£128,589 in 1933).

Sir Henry Strakosch [5] in an interesting article, after pointing out that money made in the diamond mines furnished much of the capital used in opening up the Rand (Transvaal) gold mines, adds the idea that these same Kimberley men, acquainted with the misfortunes arising from small diamond claims (31 feet by 31 feet) and lack of technical skill, determined that the gold mines would be operated as large units with the best technical ability available.

[5] Financial News, Jan. 22, 1934.

New Vaal River, a producer of fine alluvial stones, made a small profit, as did Nooitgedacht Diamonds, Ltd. Carrig Diamonds, Ltd., which in the heydey of the Lichtenburg district paid dividends of 502.5 percent in a single year, acquired several new diamond-bearing properties. Cape Coast Exploration, although not operating, continued to pay dividends from selling diamonds on hand.

Central Africa diamond field.—The northern half of the extensive Central Africa alluvial field, which next to South Africa has produced more diamonds than any other field in history, is worked by five companies operating in the Belgian Congo; and the southern half across the frontier in Portuguese West Africa is worked by Diamang.

Belgian Congo.—Belgian Congo production continued to show the effects of the curtailment program begun in the fall of 1932. For the fourth year in succession, however, it was the largest diamond producer of the world, although surpassed in value by South Africa.

The Congo diamond-mining companies employ about 150 whites and 10,500 blacks. By the use of machinery, especially larger units, and the growing efficiency of labor, the companies are reducing both their costs and the labor force necessary for their operations. Much of the overburden is removed by hydraulic giants, and many of the plants are run by hydroelectric power. The companies keep a large gravel reserve blocked out ahead of exploitation, thereby insuring a long productive life. All five companies pay dividends apparently satisfactory to their stockholders.

In June 1934 the export tax on industrial stones was reduced from 6 to 4 percent, while that on gem diamonds remained at 6 percent. The government valuation placed on gem diamonds, however, was reduced from 70 to 60 francs, and that on industrial stones remained at 8 francs.

The Forminière (Société Internationale Forestière et Minière du Congo) is the original company in Central Africa and, besides its important diamond production, its large interests cover Congo tin and gold mining as well as plantation, trading, and ranching enterprises. Like other large Congo mining companies it is an important source of revenue to the colony. Diamond production for the past 5 years has been approximately as follows: 1930, 338,000 carats; 1931, 429,000 carats; 1932, 490,000 carats; 1933, 402,600 carats; and 1934 (estimated), 472,900 carats. Fifteen mines were operated in 1934.

Beceka (Société Minière du Beceka) produces industrial diamonds mainly, less than 10 percent of its production being suitable for cutting. Approximate production was as follows: 1929, 1,400,000 carats; 1930, 1,969,500 carats; 1931, 2,885,095 carats; 1932, 3,188,000 carats; 1933, 1,487,100 carats; 1934 (estimated), slightly under 1,400,000 carats. All the mines are now operated by hydroelectric power.

Kasai-Luebo-Lueta Companies (Société Minière du Kasai, Société Minière du Luebo, Société Minière du Lueta) exploit their concessions as a unit through the Forminière. Recent production was as follows: 1932, 192,691 carats; 1933 (estimated), 115,000 carats; 1934 (estimated), 132,000 carats.

A few fine diamonds are recovered as a byproduct by the companies operating gold placers in the northeastern part of the colony. Prospectors in 1934 reported the finding of isolated diamonds of no commercial importance in several different parts of the colony.

Portuguese West Africa (Angola).—The colonial government of Angola and Portuguese, French, Belgian, American, and English investors own Diamang (Companhia de Diamantes de Angola, known as "Angolas" on the London Exchange). The diamonds are shipped through the Belgian Congo to the corporation. Operating results in recent years were as follows:

Results of diamond operations in Portuguese West Africa, 1927–34

Year	Cubic meters treated	Carats produced	Carats per cubic meter	Net profit	Dividend per £ share
					S.
1927	203,492	201,511	0.99	£108,433	1
1928	231,980	237,511	1.02	109,110	1
1929	264,323	311,933	1.18	122,032	1
1930	341,708	329,823	.97	109,480	1
1931	397,526	351,495	.88	105,949	1
1932	407,945	367,334	.90	107,908	1
1933	458,940	373,623	.81	109,386	1
1934 [1]	486,000	453,000	.93	(2)	(3)

[1] Estimated.
[2] Not yet available.
[3] Probably at least 1s.; an interim dividend of 1s. was paid on Jan. 14, 1935.

The mines (18 are now operated) are in the northeast corner of the colony. About 12 years' gravel reserves are kept blocked out ahead of production. From the formation of the company in 1917 to the end of 1934 production has totaled 3,486,543 carats. About 110 whites and 5,750 blacks are employed.

To the end of January 1935, £797,360 had been loaned to the colony and £727,020 paid to it as participations in profits. The loan is to be repaid in 25 annual installments, beginning in 1935.

Gold Coast.—The Gold Coast diamond deposits discovered in February 1919 are said to extend over an area of some 20,000 square miles. The stones are small (15 to 25 per carat) but of good quality. The largest diamond yet found weighed 9 carats and was worth £15 5s. Total exports from 1919 to 1934 have been 6,143,728 carats valued at £4,572,537. The estimated gross production in 1934 was about 1,200,000 carats.

All exploitable deposits so far known occur in the Birrim Valley, although a few stones have been found at several other places in the colony. The diamonds occur in stream gravels and drift overlying pre-Cambrian schists, basic lava beds in the schists being considered the source. Operating costs per carat of the principal producers have been reduced appreciably. The producers in 1933 were the Consolidated African Selection Trust, West African Diamond Syndicate, the Holland Syndicate, and Cayco (London), Ltd. Morkwa, Ltd., subleased its five mining leases to a continental group.

The principal producer is the Consolidated African Selection Trust, with concessions covering approximately 54 square miles in the Birrim Valley. It also owns about 32 percent of the stock of Cape Coast Exploration in Namaqualand and all the stock of the Sierra Leone Selection Trust. The latter produces relatively large stones, so that the company hereafter will present for sale a good assortment in sizes. In the Gold Coast it employs about 18 whites and 1,200 blacks. The company does not release production figures but in addition to storing some "rubbish" in Africa exports annually about 900,000 carats. The year 1934 is reported to have been satisfactory.

The West African Diamond Syndicate in 1933 produced 252,900 carats, a 15-percent increase compared with 220,000 carats produced in 1932. The company treats its concentrates in a two-stage magnetic separator and has decreased theft by concentrating all diamond picking at a single station to which concentrates are sent in locked containers.

South-West Africa.—The mandated area of South-West Africa has been hit particularly hard by the world depression, as it depended largely for its revenue upon the production of copper and diamonds, the latter usually comprising 45 to 60 percent of the exports. Production of diamonds in recent years is given in the following table:

Production and sales of diamonds in South-West Africa, 1926–34

Year	Production			Sales		
	Carats	Value	Stones per carat	Carats	Value	Value per carat
						S. d.
1926	683,801		6.7	726,808	£2,050,688	56 5
1927	723,877		5.9	577,341	1,620,862	56 2
1928	503,142		6.3	564,383	1,389,864	49 3
1929	597,187		5.3	533,101	1,617,698	60 8
1930	415,047		5.8	214,036	640,253	59 10
1931	71,532	£208,081	4.8	103,000	300,000	58 2
1932	17,944	85,503	.9	44,000	211,000	95 4
1933	2,674		.7	9,113	57,860	126 11.8
1934	(1)				331,980	

1 No mines operated, but a few carats no doubt recovered during development.

The principal producer, Consolidated Diamond Mines of South-West Africa, closed its mine in 1932, although since then it has continued successful development work north of Orange River, where it began washing diamonds on a small scale on January 1, 1935. It made a fair profit (£82,155) in 1934 from sales of stones on hand. When times become better again this company no doubt will be one of the first of those participating in the Diamond Corporation to recover, as it has large reserves of a well-varied assortment of diamonds which can be mined cheaply.

Sierra Leone.—In 1930 diamonds were discovered in Sierra Leone by members of the Colonial Geological Survey in the gravels of Kenja River and in the Kono district near the French Guinea border. Prospecting was begun in 1931 by the Consolidated African Selection Trust, Ltd., the principal producer on the Gold Coast. In April 1934 this company formed a subsidiary, Sierra Leone Selection Trust (capital £150,000 in 5s. shares), which has a monopoly of the colony's diamond mining. The Government participates in the profits. The stones produced have a good range as to quality, shape, and size, which aids in marketing them. The development work accomplished so far suggests that the field is important. Production in 1932 and early 1933 was from Shongbo, but in July 1933 the Sefadu deposit was opened, and modern treatment plants are being installed. The estimated production for 1934 was about 70,000 carats.

Miscellaneous producers.—In 1933 British Guiana produced 48,568.88 carats of diamonds valued at \$526,486.55 or \$10.84 per carat (1932, 60,185.13 carats). An average of 7.5 stones weighed 1 carat and the biggest stone weighed 8.5 carats. Ninety-nine percent of the output came from the Mazaruni district. The 1934 production was 44,818 carats. As the colony's diamond output has decreased its gold production has increased, the "pork-knockers" finding gold mining more lucrative under present economic conditions.

Diamond production in Brazil in 1934 was presumably somewhat less than in 1933. Exports from Bahia in 1933 were 9,590.79 carats of gem stones and 9,397.46 carats of carbonados. A new American-financed company, the Brazil Gold & Diamond Mines Corporation, entered the Brazilian field in 1934.

The diamond production of Tanganyika Territory continued to decline and in 1934 amounted to only 1,220 carats valued at about £1,754. The principal producer of diamonds, Tanganyika Diamonds, increased its capital to £300,000 in 1934 and became the Tanganyika Diamond & Gold Development Co., Ltd., with gold mining its chief interest. Mining was continued at Mabuki on a restricted scale, and a number of good stones were recovered, notably one of 42 carats valued at £1,470. "Yellow ground" (weathered kimberlite) nearby is stated to contain, according to recent washings, diamonds at the rate of 8.04 carats per 100 loads. The company also announced the discovery of a pipe in the Shinyanga district, but its diamond content is unreported as yet.

In 1933 India produced 2,342 carats of diamonds, a considerable increase over recent years (1931, 639 carats; and 1932, 1,254 carats). Most of these came from the Panna State, Central India. India, once the chief source of all the world's diamonds, now imports annually \$1,500,000 to over \$3,000,000 worth of diamonds.

In 1934 Venezuela produced a few carats of diamonds, perhaps 1,000, from the gravels of the Caroni River. These either were smuggled out or were exported through British Guiana.

In August 1934 it was announced officially that a diamond had been found in placer mining near Birnin Gwari in Zaria Province, and another in the Sokoto River, Sokoto Province, Nigeria. The first stone weighed 0.5 carat and the second over 10 carats. A rush was about to start when the government prohibited further prospecting.

In 1933 New South Wales produced 123 carats of diamonds, the lowest figure in recent years (1930, 677 carats; 1931, 725 carats; 1932, 251 carats). The average price received was about \$5 per carat.

Southern Rhodesia again became a diamond producer in 1934 in a modest way, as 12 carats were recovered in November. Two diamonds are reported to have been found in the Limpopo River gravels north of Messina. Its total production has been 15,793.35 carats, worth about £75,273.

W. W. Bradley, State mineralogist, states that four diamonds were recovered in 1934 in California as a byproduct of placer gold mining. The largest (2.57 carats) was found by Robert Echols in Fig Indian Creek, Amador County. The other three were smaller and were found in the Yuba River, in Yuba County, near Smartville.

Borneo, once an important diamond producer, still produces a few stones, and its cutting industry imports a fair quantity of rough from

South Africa. During the past 10 years its production has averaged about 460 carats.

Industrial diamonds.—As industrial diamonds are used widely, not only in heavy industries but also for special precision purposes, their sales are a good business barometer.

World sales were relatively large throughout 1934 probably about 50 percent above 1933. Total sales in former years of greater business activity amounted to some $10,000,000 annually. The trade receives its industrial diamonds from three principal sources: (1) From the Diamond Corporation, sold by it as industrial diamonds; (2) from cutters and brokers, representing that part of their purchases from the corporation not suitable for gem stones; and (3) from sources other than the corporation, including notably Brazilian carbonados.

Stocks of good industrial diamonds are now small, for the South African pipe mines responsible for over half the supply are closed and the Brazilian production of carbonados is far below average.

Imports of industrial diamonds into the United States during the past 8 years are given in the following table. The price per carat fell from 1929 to 1933 due to the larger imports of very small and hence cheap, off-color, gem stones for diamond drilling. Seventy-three percent of the imports come from Belgium, the United Kingdom, and the Netherlands.

Industrial diamonds imported into the United States, 1927–34 [1]

Year	Carats	Value	Value per carat	Year	Carats	Value	Value per carat
1927	34,645	$2,149,912	$62.06	1931	224,970	$2,400,879	$10.67
1928	38,342	2,756,895	71.90	1932	163,704	1,061,823	6.48
1929	46,901	4,060,577	86.58	1933	258,300	1,246,748	4.83
1930	145,958	2,756,630	18.89	1934	520,889	2,810,281	5.40

[1] Includes glaziers', engravers', and miners' diamonds.

Imports into Canada in 1934 were worth $1,395,404, more than three times those of 1933.

The year 1934 opened with a price increase of about 20 percent and with a good demand for better-grade industrial stones. Throughout the year prices tended to increase, due to the scarcity of fine industrial diamonds; those of fair size reached predepression prices, as also did fine, off-color gem borts for diamond drilling. The supply of such goods is small, and substitution of lower-grade diamonds eventually will be necessary. With this in view, some producers have carried on extensive drilling campaigns in a number of mining districts, using "common industrial goods" instead of borts with apparent success. To indicate the extent of diamond drilling it may be added that in Ontario 265 drills employing 503 men drilled 179 miles of holes in 1934 (corresponding figures for 1933, 143 drills, 251 men, and 107.7 miles of holes). In 1934 this drilling consumed 35,968.44 carats of borts, 32.23 carats of ballas, and 2,004.42 carats of carbonados.[6]

The use of diamonds for dressing emery wheels, shaped diamond tools for factory use, and diamond dies for wire-drawing expanded during 1934.

Due to the rather depressed condition of the precious stone-cutting industry, diamond dust and its source, crushing bort, was low in price

[6] Ontario Dept. of Mines, Toronto, Bull. 98, 1935, pp. 7–8.

throughout the year, although it was somewhat firmer in May and again in August. An ample supply of this grade also came on the market, much of it from the Congo and West Africa. The price was only one-tenth that of 1928, and while the low price did not increase consumption, a new use has been found for this material, and its future looks brighter. The leading abrasive companies are increasing their research as to employment of diamonds, thus in a practical way conceding the marked preeminence in hardness of diamonds over any other natural product or any artificial substitute. The General Electric Co., for example, is reported to have improved tungsten carbide as an abrasive by embedding diamond particles in it. In 1934 the Carborundum Co. exhibited its new diamond wheel at the National Metal Congress (New York, Oct. 1–5). Crushed diamonds accurately sized are embedded in a secret bond molded to the diameter desired; this is then backed by a composition wheel of the size desired. It is used for grinding and shaping hard alloy tools and should eventually find many uses, perhaps even in polishing diamonds, cutting glass, or similar purposes. The Norton Co., together with several European firms, is reported to be making similar wheels. In fact, in Europe wheels of this kind were on the market as early as 1933. This new use should increase the consumption of crushing bort greatly, for the larger wheels contain several hundred carats of diamonds.

Diamond-set tools for dressing abrasive wheels consist of a single stone or of a number of small stones in a proper binder, the latter innovation being one of the reasons for the larger imports of small stones and smaller consumption of black diamonds. The use of such tools has been increasing each year.

The demand for black diamonds or carbonados increased in 1934, particularly in small sizes. Carbonados still are essential for diamond drilling in badly fissured ground. Large-size carbonados, on the other hand, have not been cheaper for the past 40 years. The normal annual production, all from Brazil, is about 25,000 carats; in 1933 it fell to perhaps 8,000 carats but increased to about 18,000 carats in 1934.

OTHER GEM MINERALS

Amber.—Increased sales late in 1933 reduced amber stocks sharply, and mining was resumed in Prussia early in 1934, employing 375 men 40 hours per week. At Palmniken, the principal center, about 2,000,000 cubic meters of earth are reported to yield about 500 tons of amber, 20 percent of which is fit for ornamental purposes and the rest for lacquer. The sales of cheap imitation amber have been very detrimental to the trade, and in consequence a law was passed in Germany on May 3, 1934, confining the word "amber" to the natural product or to products of molten and cast amber scraps; even the use of such terms as "imitation amber" is illegal. An advertising campaign was begun stressing the superiority of the natural product, and stores displaying the products of the state amber manufactory were opened in several of the larger German cities.[7]

Emerald.—The Government emerald mines of Muzo, Colombia, were operated part of 1934; the value of production was reported as about $238,000. Early in 1934 a Colombian law was passed that required all persons engaged in cutting or selling emeralds to register

[7] Bureau of Foreign and Domestic Commerce, Foreign Trade Notes: Vol. 3, no. 8, Aug. 27, 1934, pp. 5–6.

with the Government. Emeralds found in the possession of unregistered persons are to be confiscated.

Opal.—In the fiscal year ended June 30, 1933, Australia exported unset opals valued at £15,365 (£21,254 in 1931–32), the United Kingdom taking 41 percent, Ceylon 22 percent, Germany 15 percent, and the United States 8 percent. Usually New South Wales is the largest producer, although in 1931 South Australia exceeded it; Queensland also is a minor producer. In 1933 the production of Lightning Ridge, New South Wales, was 4,231 pounds. R. S. Vincent, Minister of Mines, New South Wales, sponsored the idea that the opal be declared Australia's national gem.

Ruby.—Production of rubies in Burma in 1933 is reported to have been only 1,103 carats.

Sapphire.—The use of a fine square-cut Kashmir sapphire in Princess Marina's engagement ring has increased the popularity of sapphires in Great Britain. In 1933 Kashmir produced 1,434,285 carats of sapphire and corundum, the greater part of which must necessarily have been fit only for industrial use. In 1934 about 120 men worked the Anakie sapphire field, Queensland, particularly at Iguana Flat. One fine 886.5-carat stone was found early in the year. In 1933 sapphires sold were valued at £2,826 (1932, £1,982); 1934 sales probably were nearer those of 1932 than 1933. The Minière des Grandes Lacs Africains did not work its sapphire mines in the Eastern Belgian Congo in 1934.

Jadeite.—In 1932 Burma produced 3,026 cwt. of jadeite (2,765 cwt. in 1931), but the reported value was less than half that of 1931. Exports in 1932 were 3,654 cwt.

Madagascar produces many semiprecious stones, the reported production being 52.4 metric tons in 1932 and 131.6 in 1933.

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GEM STONES

By Sydney H. Ball

SUMMARY OUTLINE

The retail jewelry industry was one of the "hardest hit" during the depression, reaching a low point in 1933, when its sales were but 33 percent of those in 1929 ($536,000,000). Sales increased about 15 percent in 1934 (from $175,000,000 to $201,000,000), and in 1935 a further improvement of about 15 percent was noted. Christmas sales in 1935 were "spotty;" some States showed no improvement over 1934, sales in Florida doubled, and the average increase was 16 percent. A promising feature was the greater interest in fine jewels.

Although the increased sales are encouraging, the jewelry dollar is being spent more and more in the department store and, during the depression, in the pawnshop. Bankruptcy sales and distress sales by banks also cut into the jewelers' sales. Under present conditions, the jeweler must look more and more for his customers among the well-to-do, as the number of possessors of great fortunes has decreased markedly in the past 6 years. In 1935 manufacturing jewelers had the best year since 1929.

Fashions in jewels.—The tendency in 1935 to use richer fabrics in women's gowns naturally has led to a greater demand for genuine rather than imitation jewelry. Bracelets, clips, jeweled hair ornaments, and earrings have been popular, as have multiple rings, each ring being set with either diamonds, rubies, or sapphires. Late in the year, necklaces made their bid for popularity. The use of fine jewelry that may be separated into sections to be used for different purposes increased. Besides the four noble gems—diamonds, emeralds, rubies, and sapphires—aquamarines, topazes, and amethysts have been in vogue. Baguettes and other fancy shaped diamonds are losing popularity compared with brilliants. Gold in mountings gained at the expense of platinum.

Jewelry for men appears to be returning to favor, rings in the middle price range having sold particularly well.

Imports.—According to the Bureau of Foreign and Domestic Commerce, imports of precious and imitation stones into the United States in 1935 totaled $27,612,390, an increase of 54 percent from 1934. Details are shown in the following tabulation:

	Carats	Value
Diamonds:		
Rough, uncut	79, 695	$4, 261, 921
Cut, but not set	330, 617	15, 538, 902
Glaziers', engravers', and miners', not set	954, 589	4, 293, 611
Pearls and parts, not strung or set		652, 219

	Value
Other precious stones:	
Rough, uncut	$50,444
Cut, but not set	1,282,348
Imitation precious stones, except opaque	1,480,937
Imitation precious and semiprecious stones, opaque, including imitation pearls	30,032
Marcasites	21,976

Domestic production.—As in recent years, the gem production of the United States in 1935 was small and presumably did not exceed $5,000 in value. Turquoise valued at almost $2,000 was produced in Nevada from the Blue Jay claim in the Lone Mountain district, Esmeralda County and from the Snow Storm claim near Camp Royston. Rose quartz in South Dakota, kunzite in California, sapphire, ruby, amethyst, rhodolite, and aquamarine in North Carolina, moss agate in Montana, and topaz and pink beryl in the Thomas Range, Utah, were also produced on a small scale. An increasing number of mineral collectors and amateur lapidaries pay annual visits to well-known mineral localities to obtain material to further their hobbies.

DIAMOND

Recovery in the diamond industry, first noted in the summer of 1932, continued at an accelerated rate in 1935, but the industry cannot be prosperous until the United States, its best customer, enjoys good times. The trade, however, is confident of the future, and virtually every index of the industry improved, in comparison with 1934, by 15 to 75 percent.

The reorganized method of marketing by a single sales unit, the Diamond Trading Co., which first functioned early in 1934, worked smoothly and satisfactorily. The cooperation displayed by producers was excellent, and while production exceeded that of 1934, the increase was due to the operations of the larger mining companies, who are responsible for the stability of the industry. De Beers is so confident of the future that the Dutoitspan mine was reopened in March 1936, and a second pipe mine may be operated later in the year.

Stocks of rough diamonds decreased somewhat during the year, the sale of all sorts of industrial stones being especially large. Stocks in the hands of retailers are low and will have to be increased markedly if business continues to improve.

Prices of rough, firm throughout the year, were raised 7½ percent in September. The price of large cut stones advanced. Due to destructive competition between the cutting centers, however, small polished goods were less firm in price but toward the end of the year began to follow upward the price of rough.

Share dealings.—Trading in shares of diamond-mining companies was rather active, and during the year the shares of the ten principal companies gained 26 percent in price. They were at year end about 45 percent of the all-time high (1927) and over four times the all-time low (1932). Of the 17 principal companies, 11 paid dividends in 1935.

Market.—Sales of rough by the Diamond Trading Co. exceeded £6,000,000, a 55-percent increase over those of 1934. The market was broad as to the number of buyers and varieties of diamonds purchased and the sale of fine-quality stones increased markedly.

The market for cut or polished diamonds was the best since 1929, but the cutters made little money as the market was oversupplied, particularly with small sizes.

India has been, perhaps, the most important buyer of diamonds in late years and, when the price of gold was raised, converted much of its store into fine gems. The United States increased its diamond imports by about 57 percent, and Hungary and Austria increased their purchases markedly.

Fine cut stones of 1 carat or more were in demand throughout the year, indicating investment buying, in which, at one time or another in 1935, Americans, British, Hungarians, French, and Belgians participated.

Imports.—The source of diamonds imported into the United States in 1935 follows:

Diamonds imported into the United States in 1935, by countries [1]

Country	Rough, or uncut			Cut, but not set		
	Carats	Value		Carats	Value	
		Total	Per carat		Total	Per carat
Albania				33	$1,547	$46.88
Australia				3	92	30.66
Belgium	36,383	$1,926,697	$52.96	234,429	11,032,946	47.06
British Guiana	505	7,015	13.89			
Canada	1,019	29,832	29.37	58	4,019	69.29
Ecuador				7	3,500	500.00
France	1,485	465,248	313.30	1,634	110,800	67.81
Germany				147	6,545	44.52
Mexico				4	200	50.00
Netherlands	19,058	789,383	41.42	93,656	4,319,912	46.13
Switzerland				1	158	158.00
Union of South Africa	8,269	417,727	50.52	156	12,886	82.60
United Kingdom	12,976	626,019	48.24	489	46,297	94.67
	79,695	4,261,921	53.48	330,617	15,538,902	47.00

[1] Compiled from records of the Bureau of Foreign and Domestic Commerce.

Tariffs.—On April 5, 1935, Japan reduced the tariff on diamonds from 100 percent ad valorem to 5 percent ad valorem on industrial stones and 10 percent on gem stones. In February 1936, Indian duties on diamonds were reduced from 25 to 10 percent. Italy, on the other hand, on February 16, 1935, increased the duty on precious stones from 3 to 6 percent and imports are strictly controlled.

Cutting.—The struggle between Belgium, Holland, and Germany for supremacy in diamond cutting continued in 1935, but, of the three countries, only Germany improved its position. The master cutters made little profit, but there was more work in 1935 for the artisans and their wages were increased in the last half of the year. The cutting industry in the United States improved by perhaps 20 percent, but that of France suffered greatly.

Comparative hardness.—Charles E. Wooddell, research engineer of the Carborundum Co., presented a most valuable paper on the relative hardness of electric furnace products and natural abrasives before the October 1935 meeting of the Electrochemical Society. He found considerable difference in hardness between gem diamonds from different fields—carbonado softer than most diamonds and diamonds immeasurably harder than any artificial substance. As is well-known, he found the diamond much harder, compared with ruby, than the single number in Mohs' scale would indicate. His table of comparative hardnesses by the abrading method follows:

	Scale: Corundum = 9 Diamond = 10	*Scale: Quartz = 7 Corundum = 9*
South American brown bort	10. 00	42. 4
South American Ballas	9. 99	42. 0
Belgian Congo yellow (cubic crystals)	9. 96	41. 0
Belgian Congo clear white (cubic crystals)	9. 95	40. 7
Belgian Congo gray opaque (cubic crystals)	9. 89	38. 7
South American carbonados	9. 82	36. 4
Boron carbide	9. 32	19. 7
Black silicon carbide	9. 15	14. 0
Green silicon carbide	9. 13	13. 4
Tungsten carbide (13 percent cobalt)	9. 09	12. 0
Fused alumina (3.14 percent TiO_2)	9. 06	11. 0
Fused alumina "A"	9. 03	10. 0
African crystal corundum	9. 00	9. 0
Rock-crystal quartz	8. 94	7. 0

World production.—World production of diamonds in 1935 was approximately 7,300,000 carats, worth about $30,000,000. Compared to 1934 this is an increase of about 32 percent in carats and 45 percent in value. The South African pipe mines washed only a little blue ground, and in consequence the alluvial mines of the world accounted for some 96 percent of the carats and 93 percent of the value.

The following table gives, with the accuracy available statistics permit, world diamond production for the past 5 years:

Production of diamonds by countries, 1931–35, in carats

Country	1931	1932	1933	1934	1935
South Africa:					
Mines	1, 470, 376	307, 431	14, 149	9, 414	274, 316
Alluvial	647, 044	488, 096	492, 404	430, 898	402, 404
	[1] 2, 119, 155	[1] 798, 382	[1] 506, 553	[1] 440, 312	[1] 676, 720
Angola	351, 495	367, 334	373, 623	452, 963	482, 000
Brazil	80, 000	34, 000	[2] 30, 000	[2] 30, 000	50, 000
British Guiana	63, 479	61, 780	48, 569	44, 569	45, 000
Congo	3, 528, 200	3, 990, 069	1, 975, 450	3, 331, 360	[2] 3, 500, 000
Gold Coast [3]	880, 479	842, 297	863, 722	1, 142, 268	2, 172, 563
Sierra Leone	....	749	32, 017	68, 633	[2] 250, 000
South-West Africa	71, 532	17, 944	2, 674	4, 126	[2] 125, 000
Tanganyika	7, 790	1, 391	[2] 1, 432	1, 414	[2] 1, 714
Miscellaneous [4]	3, 600	3, 725	1, 825	4, 000	[2] 3, 500
Grand total	7, 105, 730	6, 117, 671	3, 835, 865	5, 519, 645	7, 306, 497

[1] Includes a small quantity of diamonds recovered from re-treatment of tailings.
[2] Estimated.
[3] Exports year ended Mar. 31.
[4] 1931–34 includes India, Borneo, New South Wales, and, in cetrain years, Rhodesia, Venezuela, French Equatorial Africa, and the United States (Arkansas and California); 1935, India, Borneo, Australia, French Equatorial Africa, and Nigeria.

The increased production over that of 1934 came largely from the pipe mines of South Africa and from the alluvial mines of Sierra Leone, Gold Coast, South-West Africa, and Congo. Of the total production, about 60 percent was bort and only 40 percent suitable for the jewelry trade, and an unusually high percentage of this was too small to cut into stones of appreciable value.

In addition to newly mined diamonds, a varying number of diamonds appears on the market annually for resale. In 1935 the quantity was relatively small, and these were sold at firm prices. In January a few Russian seconds were marketed.

Industrial diamonds.—Sales of industrial diamonds exceeded those of 1934 by about 40 percent, partly due to the increased demand for war equipment. This brought about a shortage of good industrial diamonds, especially in 1-carat sizes, as the South African pipe mines, normally responsible for much of the supply, are shut down and the Brazilian carbonado production remains small.

Imports of industrial diamonds into the United States during the past 8 years are given in the following table:

Industrial diamonds imported into the United States, 1928–35 [1]

Year	Carats	Value	Value per carat	Year	Carats	Value	Value per carat
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1929	46,901	4,060,577	86.58	1933	263,484	1,263,156	4.79
1930	145,958	2,756,630	18.89	1934	526,007	2,862,349	5.44
1931	224,970	2,400,879	10.67	1935	954,589	4,293,611	4.50

[1] Includes glaziers', engravers', and miners' diamonds; compiled from records of the Bureau of Foreign and Domestic Commerce.

The dollar value of 1935 imports was 50 percent greater than those of 1934 and over 5 percent greater than those of the boom year—1929. The price per carat fell markedly from 1929 to 1935 due to the increased use of bort for drilling and in the past 3 years to larger imports of diamond dust for abrasive wheels.

Perhaps a third more diamond drilling was done during 1935 than in 1934. Prospecting for gold, the chief use of the diamond drill for the past 5 years, was supplemented by search for deposits of base metals, due to the better market outlook for these metals. During the year further successful experiments were made in diamond drilling with "common industrial goods", a grade still cheaper than borts. In certain mines drifting is being done with light, portable diamond drills rather than with percussion drills. The use of bonded diamond wheels, described in this review last year, increased, as is indicated by the larger imports of crushing bort.

OTHER GEM STONES

The 1935 production of emerald, particularly that of good quality, was small because the Colombian mines were shut down. Cobra Emeralds, Ltd., Leydsdorp District, South Africa, apparently operated during 1935, and a Swiss company is reported to have reopened the Habachthal mine in Austria.

In 1934 the Mogok ruby district in Burma showed renewed activity and produced 21,622 carats in addition to returns by local miners.

In 1934 Kashmir produced 1,071,869 carats of sapphire, and the Anakie field in Queensland sold stones valued at £3,055. Many of the sapphires exported from Siam are produced in Cambodia; normal production is about 3,500 carats.

In 1934 New South Wales produced opal valued at £3,283, largely from Lightning Ridge. Three districts in South Australia also produced opal.

Czechoslovakia exported 110 kilos of garnet-decorated articles in 1934, valued at 710,000 crowns.

Burma's 1934 jadeite production was normal—105 tons, worth presumably, about 3,500 rupees per ton. Jordansmuhl Nephrite Gesellschaft M. B. H., formed in 1933, quarries nephrite at Jordansmuhl, Silesia, which is sent to Idar to be cut.

Government amber mines in Samland, Prussia, produce about 1,350 troy pounds yearly. As export demand has diminished since the war German chemists are seeking commercial uses for substances derived from amber. In 1934 Burma produced 414 pounds of amber. Fifty tons of labradorite were quarried from Tabori Island, Labrador, last year. Brazil and Madagascar each produce annually somewhat over 400 pounds of rock crystal. In 1934 Brazil exported 307 contos worth of declared precious stones and in 1933 Madagascar exported stones valued at 300,000 francs. About 7 tons of tiger-eye (worth about £350) were shipped from Prieska, South Africa, in 1935.

SYNTHETIC STONES

"Igmerald", produced in 1935 by Doctor Jager and Doctor Espig, chemists of the I. G. Farbenindustrie at Bitterfeld, Germany, is, without doubt, a synthetic emerald but to date, at least, the product is made only in small hexagonal crystals, the value of which does not approach the cost of production. The specimens so far produced are reported to lack transparency and can be differentiated readily from the gem. Synthetic beryl is said to have been made in France as early as 1884. The Bitterfeld plant makes a number of other synthetic gems used both as ornaments and as bearings for watches and meters.

No striking developments in the synthetic production of ruby, sapphire, and spinel were announced during the year. They are produced in a wide suite of colors. In the spring of 1935 some "sharpshooters" in London attempted to pass a synthetic spinel as a synthetic diamond.

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GEM STONES

By Sydney H. Ball

SUMMARY OUTLINE

The jewelry industry throughout the world improved markedly in 1936, but retail sales in the United States, estimated at $310,000,000, were only 58 percent of those in 1929. Prices advanced in the latter half of the year owing to the increase in prices of fine gems and platinum. Improved financial conditions stimulated sales of fine jewelry in 1936, which comprised a larger proportion of total sales than in 1935.

If the demand for fine-colored stones continues, increased production will be necessary to avoid a shortage. During the year a number of exceptionally fine jewels were exhibited in the larger cities throughout the country, thereby increasing the interest of the public in gems.

Fashions in jewels.—Women's gowns in 1936 were of fine fabrics and required real gems as well as other luxurious accessories. The fashionable world has become "jewel-minded", and even with sport clothes, jewels are considered smart. For more than a year the use of gold has been increasing at the expense of platinum. Bracelets, clips, necklaces, and earrings have been particularly popular, the last frequently being clips covering the lobe of the ear. Jeweled flowers in the form of pins are both beautiful and expensive. Diamond, emerald, sapphire, and ruby are of course the most desired of all gems; however, star sapphire and aquamarine are gaining in popularity, as are also, to a smaller extent, topaz, amethyst, and turquoise. Men continue to favor star sapphire, cat's-eye, and star ruby.

Domestic production.—The search for precious stones in the United States in 1936 was more actively pursued than in the past 5 or 6 years, and the total value of products probably approached $12,500. Lee F. Hand is reported to have produced 545 pounds of turquoise worth about $4,500 from the Snow Storm claim, Royston district, Nevada. The Mildred and Marguerite properties in the Crow Springs district and the Reik mine near Columbus, Nev., as well as properties in Mineral Park, Ariz., are also reported to have produced turquoise. Some 10 tons of moss and other agate were collected in Montana, and agate and jasper were produced in California. A considerable amount of agatized wood was recovered from private lands around the Petrified Forest National Monument, Ariz., and some 3,250 pounds of iridescent obsidian was produced in Modoc County, Calif. About 800 pounds of rose quartz of gem quality was mined in the Black Hills of South Dakota. Walter W. Bradley reports that a diamond weighing ¾ carat was recovered in Butte County, Calif. In addition, the following gem stones were produced during the year: Ruby (Tiger, Ga.); sapphire (Macon County, Ga., and Montana); aquamarine (Park County, Colo.); opal (Nevada and San Bernardino County, Calif.); topaz (Thomas Range, Juab County, Utah, and Fresno County, Calif.), and blue topaz (Teller and Park Counties, Colo.); garnet (Fresno County, Calif., Emerald Creek 12 miles southwest of Fernwood, Idaho; Thomas Range, Juab County, Utah; Montana; Colorado; Black Hills, South Dakota, and North Carolina (rhodolite)); zircon (Fresno County, Calif.); prase opal (Sonoma County, Calif.); amazonite (Florissant district, Colorado); amethyst (Lorimer County, Colo.); and rock crystal (Arkansas).

Imports.—According to the Bureau of Foreign and Domestic Commerce imports of precious and imitation stones into the United States in 1936 totaled $38,146,113, an increase of 38 percent over 1935. Details are shown in the following tabulation:

	Carats	*Value*
Diamonds:		
Rough, uncut, duty free	97, 677	$6, 230, 902
Cut, but not set, dutiable	445, 610	22, 707, 703
Glaziers', engravers', and miners', not set, free	1, 166, 094	4, 328, 603
Pearls, not strung or set, dutiable		743, 738
Other precious stones:		
Rough, uncut, free		86, 490
Cut, but not set, dutiable		2, 342, 358
Imitation, except opaque, dutiable		1, 634, 843
Imitation, opaque, including imitation pearls, dutiable		38, 708
Marcasites, dutiable		32, 768

DIAMOND

With the United States and other countries again purchasing substantial quantities of stones, the diamond industry improved beyond expectations in 1936; virtually all indicators of the industry showed gains of 25 to 45 percent over 1935. The improvement was due largely to the better world industrial outlook and to a marked increase in demand for industrial stones, as industry now absorbs many stones that 20 years ago would have been cut as jewels. Speculation and investment buying were smaller factors in the increase. Notwithstanding a small increase in production, stocks of rough diamonds decreased markedly. Stocks of polished goods were also low. Prices of both rough and cut diamonds advanced during 1936.

Share dealings.—Trading in shares of diamond-mining companies was active, especially in the second half of 1936. Six representative stocks advanced an average of 86 percent during the year. At the end of the year they were 65 percent of their high (1927) and 650 percent of their low (1932). Of the 15 more important stocks, 11 paid dividends.

Market.—The value of sales of rough diamonds by the Diamond Trading Co. was about £8,500,000 in 1936, a 36-percent gain over 1935. The market was broad; purchasers came from all parts of the world, and all types of stones were sold. Good-quality large stones were scarce at the end of the year.

The market for polished stones was animated, and in the last half of 1936 even the cutters of small diamonds were making reasonable profits. India and the United States were the principal buyers, while Japan's 1936 purchases were more than tenfold those of 1934.

Investment buying of fine stones of more than 1 carat was world-wide; the Continent was a particularly large purchaser.

Cutting.—The status of the diamond-cutting industry improved markedly in 1936, and the cutting centers of Belgium, Holland, and Germany showed a more conciliatory attitude toward one another. Better prices permitted the masters to make profits, employment increased, and the men enjoyed better wages and shorter hours. At the end of the year about 310 cutters were employed in the United States.

Imports.—Diamond imports into the United States in 1936, by countries, were as follows:

Diamonds imported into the United States in 1936, by countries [1]

Country	Rough, or uncut			Cut, but not set		
	Carats	Value		Carats	Value	
		Total	Per carat		Total	Per carat
Africa, British:						
Union of South	4,417	$310,975	$70.40	266	$30,815	$115.85
Other British	65	7,030	108.15			
Belgium	47,112	3,084,798	65.48	329,520	16,583,968	50.33
Brazil	471	11,954	25.38			
British Malaya				13	943	72.54
Canada	418	27,608	66.05	364	25,790	70.85
Czechoslovakia				165	10,990	66.61
Finland				1	60	60.00
France	79	2,398	30.35	3,619	244,769	67.63
Germany				97	5,430	55.98
Hungary				177	9,047	51.11
Japan	70	5,430	77.57			
Mexico	132	9,022	68.35			
Netherlands	23,245	1,376,986	59.24	109,349	5,627,199	51.46
Switzerland				10	3,743	374.30
United Kingdom	21,668	1,394,701	64.37	2,029	164,949	81.30
	97,677	6,230,902	63.79	445,610	22,707,703	50.96

[1] Compiled from records of the Bureau of Foreign and Domestic Commerce.

Taxes and tariffs.—On June 22, 1936, the 10-percent excise tax on sales of jewelry items valued at more than $25 was repealed. In September Italy placed a "temporary" duty of 20 percent on diamond imports.

World production.—World production of diamonds in 1936 approximated 8,296,900 carats (1.829 tons) worth about $35,600,000. Compared to 1935 this is an increase of about 9 percent in quantity and 14 percent in value. As the South African pipe mines operated only on a small scale, the alluvial mines accounted for some 96 percent of the carats and 86 percent of the value.

The following table gives, as accurately as available statistics permit, world diamond production for the past 5 years:

World production of diamonds, 1932–36, by countries, in carats

Country	1932	1933	1934	1935	1936
Africa:					
Angola	367,334	373,623	452,963	481,615	580,000
Belgian Congo	3,990,069	1,975,450	3,331,360	3,812,023	[1] 4,800,000
French Africa					[1] 13,000
Gold Coast [2]	842,297	863,722	1,142,268	2,172,563	1,489,410
Sierra Leone	749	32,017	68,633	[1] 250,000	[1] 450,000
South-West Africa	17,944	2,674	4,126	128,464	184,873
Tanganyika	1,391	1,432	1,414	1,415	[3] 2,700
Union of South Africa:					
Mines	307,431	14,149	9,414	274,317	339,718
Alluvial	488,096	492,404	430,898	402,405	284,204
	[4] 798,382	506,553	440,312	676,722	623,922
Brazil	34,000	[1] 30,000	[1] 30,000	[1] 50,000	[1] 100,000
British Guiana	61,780	48,569	44,569	46,564	[1] 47,000
Miscellaneous [5]	3,725	1,825	4,000	3,500	6,000
	6,117,671	3,835,865	5,519,645	7,622,866	8,296,905

[1] Estimated.
[2] Exports year ended Mar. 31.
[3] Exports.
[4] Includes a small quantity of diamonds recovered from re-treatment of tailings.
[5] 1932–34, includes Borneo, India, New South Wales, and, in certain years, French Equatorial Africa, Rhodesia, United States (Arkansas and California), and Venezuela; 1935, Australia, Borneo, French West Africa, India, Nigeria, and Venezuela; 1936, Borneo, India, Nigeria, Rhodesia, and Venezuela.

The increase in production in 1936 came from the pipe mines of South Africa and the alluvial mines of the Belgian Congo, Angola, and Sierra Leone, that is, from mines administered by interests closely allied to the Diamond Corporation. The Central African field (Belgian Congo-Angola), which for 6 years has been the largest producer by weight, in 1936 for the first time surpassed South Africa in value of production as well. French Africa made its initial appearance as a producer of some importance, whereas the production of the South African alluvial fields continued to decrease. Less than 40 percent of the total production was of gem quality; the increase was in industrial stones.

Industrial diamonds.—The rapid development of the use of hard alloys in industry in general and particularly in armaments programs has caused a great expansion in the use of abrasive diamonds. The United States, Great Britain, Germany, and Russia are the principal consumers. The chief use is trueing abrasive wheels, but diamond drills, diamond dies, wheels in which diamond or diamond dust are bonded in either bakelite or metal, diamond-set tools, diamond-bonded tools, and many other uses are also important. Some years ago bort largely supplanted carbonado in most drilling, but recently both types of diamonds have been set in some bits. Some bitmakers are now molding bits, the diamonds being "set" in molten metal. The use of "common goods" (cheaper than bort) in diamond drilling is increasing. Experiments continue to supplant rock drills with diamond drills in driving drifts, and diamond drills are used in stoping at the Noranda mine. On the Rand experiments are being conducted with a diamond-impregnated wheel built on the principle of a coal cutter, with which the "banket" is sliced.

It should be emphasized that 50 to 60 percent of a normal year's production of abrasive diamonds is destroyed in use in various industries.

The trade obtains industrial diamonds from three principal sources: (1) Direct from the Diamond Trading Co. or its affiliates; (2) from that part of cutters' and brokers' purchases from the company not suitable for gem stones or too "knotty" to cut easily; and (3) from "outside" sources, notably the Brazilian carbonado production. At present the Diamond Trading Co. is a more important source of industrial stones than formerly due to two factors: First, many stones once used in low-priced jewelry are now used industrially; and, second, carbonados now make up a smaller part of the total supply of industrial diamonds than a decade ago. Bahia's exports of carbonados in 1935 approximated 21,000 carats valued at $630,000 (in 1934, about 14,200 carats valued at $300,000).

Because of the greatly increased demand and the fact that most of the South African pipe mines have been shut down and that the Brazilian carbonado production has been subnormal, there has already been a shortage in supply of certain types of industrial stones. As a result of this scarcity some industrial diamonds were selling at predepression prices in 1936. Large industrial stones (over 2 carats) were, however, somewhat cheaper than in 1929, and carbonado was much cheaper. The price of crushing bort, notwithstanding increased use, remained steady.

Imports of industrial diamonds into the United States during the past 5 years are as follows:

Industrial diamonds (glaziers', engravers', and miners') imported into the United States, 1932–36 [1]

Year	Carats	Value		Year	Carats	Value	
		Total	Per carat			Total	Per carat
1932	163, 704	$1, 061, 823	$6. 49	1935	954, 589	$4, 293, 611	$4. 50
1933	263, 484	1, 263, 156	4. 79	1936	1, 165, 894	4, 328, 429	3. 71
1934	526, 007	2, 862, 349	5. 44				

[1] Compiled from records of the Bureau of Foreign and Domestic Commerce.

EMERALD, RUBY, AND SAPPHIRE

The Colombian Government abandoned the Muzo emerald mine about 5 years ago and in 1932 opened a new mine 3 miles distant. For the past 3 years the average annual production is said to have been about 400,000 carats worth 400,000 pesos. Some 300 workmen and a guard of 60 to 100 soldiers are employed. A few emeralds are recovered from the beryl pegmatites and surrounding schists near Gravelotte, northeastern Transvaal. Sales in 1935 were 148,451 carats worth £10,756.

Burma increased its ruby production considerably in 1935. The total output was 105,484 carats worth 114,063 rupees (in 1934, 21,622 carats); 2,431 carats of sapphires and 6,687 carats of spinels were produced as byproducts.

The Padar district of Kashmir, where operations at the sapphire mines were resumed in 1933, produced about 800,000 carats in 1935 compared with 1,075,000 carats in 1934. The total Indian output in 1935 was 904,571 carats. Ceylon's production of precious stones (largely sapphire) is apparently increasing; some estimates place it as high as Rs.2,000,000 in 1935. The Ratnapura, Matara, and Kandy districts were especially active. Sapphire and beryl were recently discovered in abundance in the last two districts named. For some years the American Gem Mining Syndicate has operated its mine near Philipsburg, Mont., for industrial sapphires only. Production in 1936 was 17,200 ounces worth about $25,000. Sapphire was the only gem produced in Queensland in 1935, and sales totaled £1,804 15s. compared with £3,055 in 1934. The mine is at Sapphire. The Belgian Congo sapphire mines of the Minière des Grands Lacs have not been worked for several years.

LESSER GEMS

In 1935 Prussia produced 102,489 kilos of amber and purchased 9,484 kilos from small producers (in 1934, 107,026 and 9,165 kilos, respectively); 22,900 kilos valued at 258,000 RM were exported in 1935, or the highest exports since 1931. Most of the amber output was used industrially. In 1935 Burma produced 18.57 cwt. of amber valued by the Government at $777 and 1,264.75 cwt. of jadeite valued at $71,465. Meerschaum mining at Eskischir, Asia Minor, has been encouraged by the Eti-Bank in connection with the Turkish 5-year plan. In pre-war days about 280 metric tons a year were exported, but less than 28 tons were shipped in 1935. Ninety percent of the output is exported. In 1935, 9,000 pounds of tiger-eye were exported from South Africa. The lighter-colored varieties occur in slabs 9 to 12 inches long, but the darker-colored only in smaller pieces. Brazil produces six types of quartz, of which 90 percent comes from Minas Geraes, and exports of rock crystal have averaged 5 tons yearly for the past 7 years. The United States and Japan are the principal consumers. In 1935, 230,862 kilograms valued at 998,701 paper milreis were exported. Madagascar continues to export much low-priced gem material to France, Japan, the Netherlands, Great Britain, and Czechoslovakia. In addition to 20,000 carats of precious stones about 1½ tons of garnet, amethyst, beryl, optical rock crystal, rose quartz, and chalcedony were exported in 1935. South-West Africa in 1935 exported gems other than diamonds valued at £1,818 to Germany. The mandated area is a source of aquamarine and heliodore, red and green tourmaline, topaz, and almandine garnet.

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GEM STONES

By Sydney H. Ball

SUMMARY OUTLINE

The jewelry industry throughout the world improved markedly in 1937 due to relatively large sales in the first 9 months of the year. In the United States retail sales by jewelry stores, estimated by the United States Bureau of Foreign and Domestic Commerce at about \$310,764,000, were approximately 60 percent of those in 1929. Compared with 1936, the increase was 10.2 percent. Diamonds, watches, and silverware led in the recovery. Some stores felt the recession as early as late August, and the Christmas trade was on the whole slightly less than that of 1936. The sale of more expensive items was particularly affected. A bright spot is the relatively small stock held by both wholesalers and retailers.

Fashion in jewels.—Women are again using jewelry lavishly, wearing gold, alone or set with gems, by day and platinum, set with fine stones, by night. Designs are influenced by a legion of periods, places, events, and geometric shapes; the results are usually delicate and a tribute to supercraftsmanship, although in some instances heavy and barbaric with crude, hard color effects. Heirlooms of the sixties and nineties are again being worn. Bracelets, necklaces, and hair ornaments are exceedingly popular, and the last two in many instances can be broken down into clips, bracelets, and brooches. Clips, earrings, rings, and jeweled flowers continue in favor. The jewelry of the present day is marked by variety of color due to the greater use of colored stones and by the widespread use of small diamonds set pavé. This in part explains the remarkably strong market for small cut diamonds. The finer gems—diamond, ruby, sapphire, emerald, and pearl—are of course particularly popular; but topaz is gaining favor, and occasionally aquamarine, amethyst, moonstone, turquoise, and other gem stones are used. Men continue to favor star sapphire, cat's-eye, star ruby, and crystal.

Domestic production.—Domestic production of precious stones reached a peak in 1909, when gem stones valued at \$534,280 were produced; thereafter the industry dwindled until in 1934 the value of the production was probably only about \$3,000. Since then it has gradually increased, and the 1937 output is estimated to have been worth about \$32,000; as the production is by partnerships and individuals exact figures are not available.

Turquoise represents well over half, and Nevada is the principal producer according to a letter from Mr. W. O. Vanderburg. The American Gem Co. leased the property of the Copper Canyon Mining

Co. 8 miles south of Battle Mountain and produced 424 pounds of turquoise. Lee F. Hand and the American Gem Co. produced 300 pounds of turquoise from the Lone Mountain Mine 20 miles west of Tonopah. Part of this was "spider-web matrix." Hand also produced 200 pounds from the Montezuma mine, Royston district. Joseph Norman and Rudolph Rundberg produced 50 pounds from a new prospect 17 miles north of Austin. In Colorado, the Hall mine near Villa Grove employed three to five men and produced considerable turquoise. A little turquoise was also produced in Arizona. The gem stone is cut in Gallup, Santa Fe, Taos, and Albuquerque, N. Mex., and in California cities. A number of tons of moss agate were gathered in the Yellowstone Valley, southeastern Montana, and relatively large quantities of various kinds of agates in central Oregon. Scott's Rose Quartz Co., Custer, S. Dak., produced 377 pounds of rose quartz of gem grade, besides some 35 tons of poorer material. Maine produced tourmaline, agates and jaspers, aquamarine, amethyst, and rose quartz.

Among the other gem stones produced in the United States in 1937 were emerald matrix (Mitchell County, N. C.); rhodolite (Macon County, N. C.) and other garnets (Custer, Chaffee, and Jefferson Counties, Colo.); aquamarine (North Carolina and Park County, Colo.); topaz (Teller and Park Counties, Colo.); amazonstone (Teller County, Colo.); rock crystal (Arkansas); agatized wood (Arizona); and amethyst (Larimer County, Colo.). A new deposit of fine amethyst was discovered in 1937 in Coos County, N. H.

Lapidary work is becoming a relatively popular fad, particularly in the Northwest. Beach pebbles, agates, and various other attractive minerals are eagerly sought as materials to be cut.

Alabaster (fine-grained gypsum) has been produced in some quantity by the Rocky Mountain Alabaster Co., Fort Collins, Colo., and is manufactured into lamps, vases, book ends, and other novelties.

The American Gem Mining Syndicate, Philipsburg, Mont., produced 21,469 ounces of sapphires, valued at about $35,000 which are used industrially.

Imports.—According to the Bureau of Foreign and Domestic Commerce imports of precious and imitation stones (exclusive of diamond bort and dust) into the United States in 1937 totaled $50,493,585, an increase of 32 percent over 1936. Details are shown in the following tabulation:

	Carats	*Value*
Diamonds:		
Rough, uncut, duty free	97, 219	$7, 729, 663
Cut, but not set, dutiable	517, 677	29, 860, 396
Glaziers', engravers', and miners', not set, free	1, 885, 970	6, 542, 365
Pearls, not strung or set, dutiable	--------	1, 104, 580
Other precious stones:		
Rough, uncut, free	--------	180, 433
Cut, but not set, dutiable	--------	3, 019, 713
Imitation, except opaque, dutiable	--------	1, 985, 374
Imitation, opaque, including imitation pearls, dutiable	--------	25, 400
Marcasites, dutiable	--------	45, 661

DIAMOND

Until September 1937 the diamond industry continued the improvement that had been uninterrupted since 1932, and notwithstanding the subsequent recession virtually all indices showed gains of 7 to 49 percent over those for 1936. The improvement was due to better world financial conditions early in the year, to the increasing demand for industrial stones and for small gem stones in pavé jewelry, and to investment buying. Despite a small increase in production, stocks of rough diamonds decreased, and stocks of polished goods are not high. Prices of both rough and cut diamonds advanced during 1937.

Share dealings.—The shares of diamond-mining companies had a broad and active market during 1937. They had advanced in value about 25 percent by February 24, then slumped, by August 5 reached the year's high, again fell off, and ended the year with a loss of 16 percent. At the end of the year stocks were 53¾ percent of their high (1927) and 541 percent of their low (1932). Of the 15 more important stocks, 13 paid dividends.

Market.—The Diamond Trading Co. sold rough diamonds to the value of £9,151,205, a gain of 7 percent over 1936 sales. Sales totaling £12,000,000 characterize markedly prosperous years. The demand was broad, and good-quality large stones were scarce.

The market for polished stones was broad at higher prices and from January to March was almost of boom proportions. The United States, Argentina, and India were large purchasers, and the trade improved in Great Britain, Austria, Hungary, and Canada.

Investment buying of fine stones was particularly active after September, France being one of the larger buyers.

Cutting.—The diamond-cutting industry improved in 1937, although prosperity in the first half of the year was largely offset by poor business thereafter. Wages increased, as did the yearly average of employment. The International Commission of Commerce of the Diamond Industry, an association of European brokers, cutters, and distributors formed in 1937, is rationalizing the cutting and retail branches of the industry.

Imports.—Diamond imports into the United States in 1937 by countries were as follows:

Diamonds imported into the United States in 1937, by countries [1]

[Exclusive of industrial diamonds]

Country	Rough, or uncut			Cut, but not set		
	Carats	Value		Carats	Value	
		Total	Per carat		Total	Per carat
Africa, British:						
Union of South	14,044	$966,573	$68.82	1,510	$115,992	$76.82
Other British	1,142	74,067	64.86			
Belgium	27,321	2,247,871	82.28	391,058	21,846,259	55.86
Brazil				2	75	37.50
Canada				7	985	140.71
Costa Rica				2	455	227.50
Czechoslovakia				105	14,062	133.92
France	741	43,134	58.21	3,437	305,865	88.99
Germany				38	1,715	45.13
Italy				6	370	61.67
Japan				1,143	55,009	48.13
Mexico				30	4,900	163.33
Netherlands	22,942	1,718,999	74.93	117,097	7,070,255	60.38
Switzerland				320	18,582	58.07
United Kingdom	31,029	2,679,019	86.34	2,922	425,872	145.75
	97,219	7,729,663	79.51	517,677	29,860,396	57.68

[1] Compiled from records of the Bureau of Foreign and Domestic Commerce.

Taxes and tariffs.—International tariffs, difficulties of exchange, and taxes continue to restrict the growth of the industry. Italy, British India, and Bahia reduced duties; Peru and Germany increased them, and Japan prohibited the importation of all jewelry.

World production.—World production of diamonds (gem and industrial) in 1937 approximated 9,016,250 carats (1.988 tons), worth about $43,475,000. Compared with 1936, this is an increase of almost 9 percent by weight and of over 22 percent in value. As only Dutoitspan and Bulfontein of the South African pipe mines operated, the alluvial mines produced 91 percent of the carats but only 68 percent of the value. The British Empire produced 37 percent by weight and 68 percent by value of the output. Of the total production, only about one-third was of gem quality.

The following table gives, as accurately as available statistics permit, world diamond production for the past 5 years:

World production of diamonds, 1933–37, by countries, in carats

[Including industrial diamonds]

Country	1933	1934	1935	1936	1937
Africa:					
Angola	373,624	452,963	481,615	577,531	626,000
Belgian Congo	2,256,771	1,450,203	3,758,620	4,634,266	4,904,000
French Africa	(1)		(1)	7,050	(2) 25,600
Gold Coast	803,985	2,391,609	1,145,828	1,175,399	1,170,000
Sierra Leone	32,017	68,633	295,483	616,200	(2) 913,000
South-West Africa	2,374	4,126	128,464	184,917	(2) 190,000
Tanganyika	1,432	1,155	1,446	2,704	(3) 3,230
Union of South Africa:					
Mines	14,149	9,414	274,317	339,719	820,284
Alluvial	492,404	430,899	402,405	284,204	207,359
Total, Union of South Africa	(4) 506,553	440,313	676,722	623,923	(4) 1,030,434
Brazil	34,000	42,500	39,100	136,462	(2) 100,000
British Guiana	48,569	44,821	47,785	42,478	35,038
Other countries (5)	3,500	4,000	5,500	6,000	6,000
	4,063,000	4,900,000	6,581,000	8,007,000	9,003,000

(1) Included under "Other countries."
(2) Estimate.
(3) Exports.
(4) Includes a small quantity of diamonds recovered from re-treatment of tailings.
(5) 1933: Netherland India (Borneo), India, Australia (New South Wales), French Equatorial Africa, and Venezuela; 1934: Netherland India (Borneo), India, Australia (New South Wales), Rhodesia, Nigeria, United States (California), and Venezuela; 1935: Netherland India (Borneo), India, French Equatorial Africa, Nigeria, and Venezuela; 1936: Netherland India (Borneo), India, Rhodesia, United States (California), and Venezuela; 1937: Netherland India (Borneo), India, Australia (New South Wales), Liberia, Venezuela, and Rhodesia.

The increase in production in 1937 came from the pipe mines of South Africa and the alluvial mines of Sierra Leone, offset in part by decreases in output of the alluvial mines of the Gold Coast and of South Africa. The increase was made by mines operated by interests closely allied to the Diamond Corporation. The Central African field (Belgian Congo-Angola) for the past 7 years has been the largest producer by weight but in 1937 lost first place in value to South Africa. The Sierra Leone deposits, discovered in January 1930 by the Colonial Geological Survey officers, Major Junner and J. D. Pollett, are the most important found since those of South-West Africa in 1908. The Sierra Leone production of stones of well-diversified sizes and qualities is growing rapidly. While the mother rock of these diamonds is unknown, the variety in character of the diamonds suggests more than one original source.

Industrial diamonds.—Rapid development of the use of hard alloys in general industry, particularly in the armament trade, made 1937 a record year in the use of industrial diamonds. The United States, Great Britain, Germany, Canada, and Russia are the principal consumers. Over two-thirds of the world diamond output by weight is used by industry. The chief use is truing abrasive wheels, but diamond drills, diamond dies, wheels, and tools impregnated with diamonds or diamond dust (bonded in an artificial plastic or set in powdered metal under heat and pressure), diamond-set tools, and many other uses are also important. The modern automobile factory, the airplane plant, and glass works in particular would be badly crippled were it not for industrial diamonds.

It should be emphasized that, unlike the gem stones, which last for all time, a diamond that enters industry is eventually destroyed.

In 1937, the market for industrial stones was strong and broad with an actual scarcity of the better qualities, forcing use of the poorer grades in certain trades. Prices were firm, with an upward tendency.

The importance of the diamond drill is indicated by the fact that in 1936, 402 miles of holes were drilled in Canada alone. A diamond-drill hole on the Rand has been carried to a depth of almost 2 miles (10,035 feet). Some years ago bort largely supplanted carbonado in most drilling. Experiments continue with the object of supplanting percussion drills with diamond drills in underground mining.

Bahia (Brazil) exports of carbonado or black diamonds in 1936 were 12,867.97 carats (1935, 21,033.65 carats worth about $630,000).

Imports of industrial diamonds (exclusive of bort and dust) into the United States during the past 5 years were as follows:

Industrial diamonds (glaziers', engravers', and miners') imported into the United States, 1933–37 [1]

Year	Carats	Value		Year	Carats	Value	
		Total	Per carat			Total	Per carat
1933	263,484	$1,263,156	$4.79	1936	1,166,094	$4,328,603	$3.71
1934	526,007	2,862,349	5.44	1937	1,885,970	6,542,365	3.47
1935	954,589	4,293,611	4.50				

[1] Compiled from records of the Bureau of Foreign and Domestic Commerce.

EMERALD, RUBY, AND SAPPHIRE

If fashion continues its present lavish use of colored stones in jewelry, increased production will be necessary to avoid a shortage. At present much of the supply comes from old jewelry. Barring a world financial cataclysm, prices must rise.

The Colombian Government emerald mines were closed in 1937 or at best operated on a very small scale. Leasers started operations at the Chivor Emerald Mines about November 1, 1937. The Russian emerald mines at Murzinka in the Urals were worked on a small scale. One report is that recent production has ranged from $175,000 to $300,000 per year. South Africa continues to produce beryl, some little of which is emerald of mediocre quality. Reported values were £10,756 in 1935 and £6,082 in 1936. Emeralds were discovered in

1937 on the farm, Willie No. 481, Leydsdorp district, Transvaal, near an old emerald mine. Most beryl of the pegmatite intrusive in biotite schist is pale-green, but the color is deeper near the contact. Much of the material is badly flawed. A small shipment has been made to India. Late in 1937, the Habachtal emerald mine in the Salzburg Mountains was reopened on a small scale. Emeralds are reported in gravels at Fazenda das Lages, Itaberahy district, Goyaz, Brazil.

In 1936, for the second consecutive year, Burma increased its ruby production (155,381 carats in 1936 compared to 105,484 carats in 1935). Because of restricted exports of jade to China due to the war, Burmese jade miners in the fall of 1937 petitioned the Government to be permitted to reopen the ruby mines of the Nanyaseik stone tract, first opened about 1890 but never extensively operated.

The figures for the 1936 production of sapphires in Kashmir and of sapphires and spinels in Burma is not given. The Anakiefield, Queensland, produced in 1936 corundum gems worth £2,030. The producing areas were Sapphire, Rubyvale, and Willows. Prior to the World War exports, largely to Germany, reached £60,000 to £70,000 annually.

The Ceylon gem industry is prosperous, mining in the Sabaragamuwa Province being particularly active. The Government has appointed a special committee to study the cutting and marketing of the local gems. The price of star sapphires and star rubies (the latter are rare) doubled in the first half of the year, and that of gem sapphires has improved. The demand for cat's-eye is more moderate. Burma buys from Ceylon considerable white sapphire, cat's-eye, and opal. The latter is imported from Australia, cut, and exported widely even to Australia, where cutting facilities are limited.

LESSER GEMS

In 1936, Lightning Ridge and Grawin, New South Wales, produced opals valued at some £6,000, an improvement over 1935. The Queensland opal industry is practically extinct. A little was produced at Sheep Station Creek, and some prospecting was done at Toompine and at Mount Margaret.

Report of the discovery of an important alluvial deposit of zircon at Nizhne Saldinsk comes from Russia.

Burma produced 1,671 hundredweight of jadeite in 1936 against 1,265 hundredweight in the previous year. Export of the stone to China is encountering difficulties, and jade miners are turning to ruby mining. Preparations to work the nephrite deposit near Jordansmuehl, Silesia, are completed, and regular mining has doubtless started.

The United States imported from Bahia, Brazil, 8½ tons of rock crystal in 1936: in the first 8 months of 1937 the exports to America were much less but were offset by larger exports of somewhat poorer material to Europe. Prices range from $3 a pound for fine large crystals to 4 cents a pound for small water-clear crystals for fusing. The demand for Brazilian citrine is good.

Soviet geologists report the discovery of crystal-lined caves on the upper Maidanal, South Kazakhstan Province.

Prussia produced 332 metric tons of amber in 1936 (112 tons, 1935). Much of this is used industrially. In 1934, Rumania produced 24 kilos of amber; figures for 1935 and 1936 are not yet available.

Thanks to loans by the Eti-Bank, the meerschaum industry at Eskisehir, Turkey, is reviving. Production in 1936 was 621 metric tons.

Madagascar exported 4,804 grams of fine stones in 1936, 220 kilos of amethyst, and almost 100 tons of industrial stones.

In 1936, South-West Africa sold, largely to Germany, aquamarine, tourmaline, and rose quartz valued at £3,993. Sales in 1937 were at about the 1936 rate and also included chalcedony.

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GEM STONES

By Sydney H. Ball[1]

SUMMARY OUTLINE

Retail sales of jewelry in 1938 totaled about $276,000,000, or 11.5 percent below the 1937 sales ($312,000,000) and slightly below those of 1936 ($280,000,000). Diamond rings, watches, and gold jewelry were the principal sales items. January was a fair month, February and March were poor, and May and June were better; July witnessed a slump from which a slight improvement was noted each month until the usual marked increase in December (sales in that month usually make up 25 percent of the year's sales). Although the Christmas sales of 1938 were almost as good as those of 1937, it was disappointing that no one of the later months of 1938 exceeded those of 1937 when, it will be remembered, trade was poor. The wholesalers' jewelry sales, in comparison, were 27 to 29 percent lower than those of 1937; consequently retailers' stocks at the end of 1938 were smaller than at the end of 1937. The demand for popular-price articles was better than for items in the higher price brackets, and the sales of costume jewelry were remarkably large.

Fashions in jewels.—Jewels continue to be worn in almost barbaric profusion, with large stones prominent. Gold, often in two colors, is even being worn in the evening and continues its gain at the expense of platinum. Silver jewelry also became popular in 1938. The motifs range from Hindu and Persian to French of the times of Louis XIV and of the late Directoire, as well as Victorian types and those of the nineties of the last century. Massive gold chains with pendant watches, crosses, or cameos, imposing necklaces and dog collars, and jeweled flowers and leaves are popular; jeweled hair ornaments and earrings, either long pendants or set close to the lobe of the ear, are imperative with the present coiffures. Tiaras are again worn, particularly in England. Much of the jewelry is flexible, permitting the stones to move with the wearer's movements. The ensemble is as much in vogue in jewels as in dress accessories. Costume jewelry ("junk" jewelry in the trade) is sold in quantity and may foster a love

[1] One of the consulting engineers, Bureau of Mines.

for the real article. The demand for colored stones grows, such jewelry requiring the use of countless small diamonds set pavé for contrast. The finer gems—diamonds, including "fancies," ruby, emerald, and sapphire—hold the center of the stage, but topaz and aquamarine are extremely popular, and the use of turquoise, moonstone, and amethyst and a host of other colored stones is increasing. Men are wearing more jewelry, featuring particularly star sapphire and ruby, cat's-eye, and the quartz gems.

Domestic production.—From the peak of American gem-stone production of $534,280 in 1909 the industry dwindled until 1934, when the value of the production was only about $3,000. Since then it has increased appreciably, and in 1938 the total output was perhaps $127,000; as the production is largely by individuals or partnerships and there is no canvass, exact figures are not available. The revival of the industry is due to two factors—the desire of tourists to purchase souvenirs and the increasing use of a variety of colored stones in jewelry. The demand by jewelers for American tourmaline, kunzite, and turquoise is insistent; the sales of Navajo turquoise-silver jewelry, for example, probably exceeded those of 1937 by some 15 percent.

In the Northwest and especially in Oregon, according to correspondence with H. C. Dake, are a large number of collectors of agate and other quartz minerals, many of whom are amateur lapidaries, while others send their "finds" to professional lapidaries, some 50 in number. It is estimated that in 1938 in Oregon material valued at $210,000 was collected; in Washington, $85,000; in Idaho, $35,000; and in Wyoming (largely moss agate) $8,000—a total of $338,000. Most of these agates remain in private collections, although it is believed that about one-fourth of the amount is sold to tourists. Turquoise valued at almost $30,000 was produced in 1938, and the United States is again the most important producer of this gem. Nevada produced over 80 percent of the total, Colorado 15 percent, and Arizona a small quantity. Southeastern Montana, as usual, produced a large amount of moss agate from the Yellowstone Valley which found a ready market among tourists. Scott's Rose Quartz Co., Custer, S. Dak., produced about 1,000 pounds of rose quartz. Considerable kunzite and a little tourmaline was produced by one firm in San Diego County, Calif.

William O. Vanderburg lists 39 turquoise mines in Nevada; in part he says:

> The production of turquoise and turquoise matrix in Nevada for 1938 was approximately 8,000 pounds, varying in value from $0.50 per pound for off-color and inferior grade material to $40 per pound for the finest quality. Due to the fact that the bulk of the production is made by individuals and firms who do their own cutting and polishing it is difficult to arrive at the value of the crude turquoise. Probably an average value for the crude material would be about $3.00 per pound. After the gems are cut and polished, sorted, and graded according to quality the value increases considerably.
>
> As a result of the increased demand for turquoise a number of deposits have been discovered in Nevada within the last 2 or 3 years. One of the notable features of turquoise mining in Nevada during the year was the shift in the bulk of the production from the deposits in Nye and Esmeralda Counties, centering around Tonopah, to the recently discovered deposits in Lander County with Battle Mountain and Austin as the producing centers. The principal producers of turquoise in Nevada in 1938 were the Burnham Bros., Guy Grannis, W. F. Godber (Western Gem & Jewel Co., Los Angeles), and Geo. McGinnis and associates, all of whom operated properties near Hickerson Summit, Lander County;

Lee F. Hand and C. T. Johnson, owners of turquoise properties in the Royston and Crow Springs districts, Nye and Esmeralda Counties; Ed. C. Smith, who operated the Smith mine, Cortez district, Lander County; D. J. Wilson (American Gem Co., Los Angeles), who worked a deposit in Copper Basin, northern Lander County, under a lease agreement with the Copper Canyon Mining Co.; and W. F. Godber, owner of the Reik mine in the Candelaria district, Mineral County.

The turquoise mined in Nevada varies considerably in color, ranging from green, blue-green, and various shades of blue to nearly white. The best quality is a rich blue color. Off-color material is hard to dispose of in the United States, although small lots of the inferior grades of turquoise have in recent years been sold to Germany. Turquoise matrix has an established popularity with the tourist trade, and some of its numerous varieties are characteristic of certain properties such as "black", "spider web", "gold", "brown", or "pinto matrix".

The turquoise mines in Nevada are not operated continuously; activity is restricted to the summer months, and the degree of activity is dependent on the demands of the jewelry trade. One of the most pronounced trends in Nevada turquoise mining in recent years is the tendency of the cutting establishments to acquire their own mines. Only a few years ago the principal outlets for crude turquoise were traders who made annual trips through the State, bartering articles of Indian craftsmanship for the crude turquoise, and in turn trading it to the Indians of the southwest.

The mining of turquoise is popular with miners of limited means because a minimum of equipment is necessary.

The discovery of emerald at Rye Patch, Pershing County, Nev., was widely heralded early in 1939 as the first deposit of emerald found in the United States, although deposits of the gem have long been known in North Carolina and other Eastern States. The Nevada emerald occurs as unusually deep-color marginal parts of beryl crystals in a pegmatite that intrudes limestone. The deep-color material makes up a relatively small part of the beryl, and most of it is flawed and not transparent; in consequence, the commercial importance of the find is doubtful. An abandoned emerald mine 15 miles south of Spruce Pine, N. C., was reopened early in 1938. North Carolina produced a little emerald matrix.

Near Hot Springs, Ark., there are at least seven producers of rock crystal, and these and others sell the product.

Among the other gem stones produced in the United States in 1938 were agatized wood (private lands surrounding Petrified National Monument, Ariz.); amazon stone (Teller County, Colo.); amethyst (North Carolina; and Larimer County, Colo.); aquamarine (North Carolina and Chaffee and Park Counties, Colo.); chrysoberyl (Jefferson County, Colo.); garnet (North Carolina; Custer, Chaffee, and Jefferson Counties, Colo.; and Emerald Creek, Idaho); fire opal (Owyhee County, Idaho); phenacite (Chaffee County, Colo.); ruby (North Carolina and Georgia); smoky quartz (North Carolina); and topaz (El Dorado County, Calif.; Thomas Range, Utah; and Teller and Park Counties, Colo.).

Charles H. Carpp and J. W. Kaiser operated the property of the American Gem Mining Syndicate, near Phillipsburg, Mont., in 1938. They produced 9,480 ounces of industrial sapphire valued at about $11,000. The Rocky Mountain Alabaster Co., Fort Collins, Colo., quarried about 50 tons of alabaster in 1938. Some Iceland spar of optical grade was produced in California.

Imports.—According to the Bureau of Foreign and Domestic Commerce, imports of precious and imitation stones (exclusive of industrial diamonds) into the United States in 1938 totaled $28,304,956, a decrease of 36 percent from 1937. Details are shown in the following table.

	Carats	Value
Diamonds:		
Rough, uncut, duty free	91, 515	$7, 077, 159
Cut, but not set, dutiable	330, 925	17, 016, 842
Pearls, not strung or set, dutiable		470, 304
Other precious stones:		
Rough, uncut, free		116, 924
Cut, but not set, dutiable		1, 698, 916
Imitation, except opaque, dutiable		1, 762, 458
Imitation, opaque, including imitation pearls, dutiable		18, 896
Marcasites, dutiable		143, 457

Tariffs.—There were few important changes in tariffs during the year. In the United States, under the provisions of the Czechoslovak Trade Agreement negotiated last spring, the duties on Czechoslovak imitation stones in the various brackets were reduced as much as 50 percent. Czechoslovakia was by far the chief source of such imitation stones, particularly rhinestones. The effect of the agreement was nullified when Germany occupied Czechoslovakia. Germany made barter agreements with some of the diamond-producing countries, without impressive results, however. A trade agreement with Brazil was canceled, and some of the others are stated to be inoperative.

Trade terms and judicial proceedings.—The Federal Trade Commission on March 18, 1938, issued its Trade Practice Rules for the Wholesale Jewelry Industry, a recodification of unfair methods of competition and other illegal practices in the trade. The use of the word "perfect" in describing a gem that under a 10-power loupe shows any imperfection is unfair practice; "perfectly cut" is not to be used to deceive the purchaser; the use of "diamond," "ruby," or other names is to be confined to these mineral species alone; "real," "genuine," and "natural" cannot be applied to synthetic or imitation stones; "blue white" cannot be applied to a diamond if at all off-color; articles must be as advertised; the adjective "synthetic" must be confined to synthetic stones. The Federal Trade Commission during the year issued a number of cease and desist orders against firms not living up to its trade rules.

In the fall, the Department of Commerce released texts of two commercial standards, covering gold and platinum.

The Jewelers Vigilance Committee continued its good work against shortcomings of the less ethical members of the trade; as for example, against a store that sold 0.72-carat diamonds as 1-carat solitaires. But even they are unable to do away wholly with the occasional switching of pieces of glass for diamonds, a case of this kind having occurred in Baltimore a few months ago.

Exhibits.—At the New York World's Fair jewels will be among the most attractive exhibits. In the House of Jewels, five of the leading New York jewlers will show their most beautiful jewelry, and De Beers & Associated Producing Cos. and the Diamond Corporation will exhibit rough and cut diamonds, an exhibit valued at over $5,000,000. In the Belgian pavilion, besides cut diamonds worth several millions, the art of diamond cutting will be shown. In Iraq's exhibit, goldsmiths from Baghdad will ply their ancient art. The Crown of the Andes, set with innumerable Colombian emeralds, is to be on exhibition. Boart Products, Ltd., is to have in the Hall of Mining and Metallurgy an instructive exhibit showing the industrial uses of diamonds. These exhibits should strengthen the gem consciousness of the American people and promote jewelry sales.

DIAMOND

The improvement in the diamond industry, which had continued for over 5 years, ended in September 1937; and 1938—with its wars, changes in the political map of Europe, and financial depression—was a poor year, as was to be expected with an industry that feeds on prosperity. The small demand and a large mine output increased stocks of rough diamonds for the first time in 6 years, although stocks of cut stones in the hands of cutters and retailers are not large. Prices of rough were firm, and those of cut diamonds tended to advance.

Share dealings.—The shares of diamond-mining companies listed on the London Stock Exchange had a relatively narrow market in 1938. Off to a good start, by January 15 quotations began to slip, and, except for a short rally in April, the decline continued until mid-July, after which prices strengthened for 2 months. The Czechoslovak crisis affected the market adversely, but this was followed by a sharp rise in October. For the rest of the year the market was inclined to be weak. The loss for the year was about 25 percent, the quotations of five representative stocks at the year end being 37 percent of their high (1927) and 370 percent of their low (1932). Of the more important stocks, 12 paid dividends.

Market.—The Diamond Trading Co. sold rough diamonds valued at about £4,000,000, only 44 percent of the sales of 1937. Sales in the third quarter were quite satisfactory, those of the first and fourth quarters fair, and those of the second quarter small. Good-quality large stones are still scarce.

Sales of polished stones were only about one-half those of 1937, the principal demand being for small goods and most of them of mediocre quality. June and July were the best months, as the Czechoslovak crisis interfered with the usual purchases for the Christmas trade. The United States, Argentina, India, and (early in the year) southeastern Europe were large purchasers.

As is usual in years of political crises, investment buying increased the sale of large stones, while the mode for pavé jewelry promoted the demand for small stones. Sales of industrial stones were large.

Growth of diamond-cutting industry.—Diamond cutting originated in India, where diamonds first were discovered, certainly well over a thousand years ago, and to Hindu lapidaries we owe the two basic principles of the art—the wheel and the use of diamond dust. Indeed, it was not until early in the seventeenth century that Europe wrested the cutting supremacy from India and its ally, Borneo, now for the past 2 centuries the most important of the eastern cutting countries. The Hindu cut too crudely for European taste, in part prompting the growth of the European industry. By the sixteenth century European artisans surpassed their eastern confreres in skill and were in demand at eastern courts.

The art was transmitted from India to Constantinople and later to Venice. Cut stones appeared in Europe between the eighth and thirteenth centuries. The art reached northern Europe at the turn of the fourteenth century, first at Nuremberg and Paris, and probably

Bruges only slightly later. Religious persecution drove the cutters from Bruges to Antwerp and soon thereafter to Amsterdam, later the asylum of persecuted Jews from Portugal, Spain, and Poland. Excluded from the guilds, they sought the free professions, among them diamond cutting. Diamond cutting appeared on the Western Continent in Brazil in 1802, and in the late sixties of the last century a cutting industry sprang up in the United States, small in roster but renowned for its superior product. The Government-subsidized South African industry, started in 1928, thrived for only 5 or 6 years.

The art of cutting has made steady improvement, slow at first but thereafter marked, particularly in our generation. Hindus, Venetians,

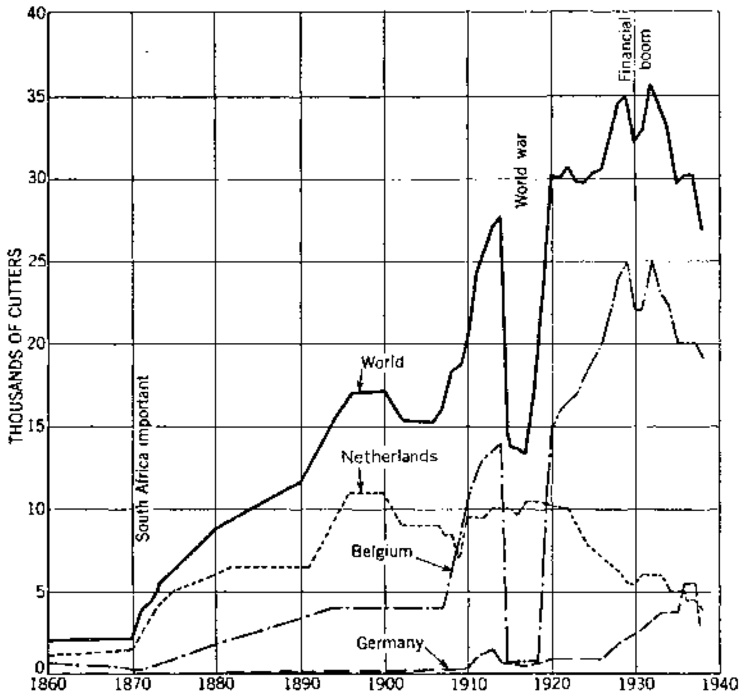

FIGURE 1.—Approximate number of diamond cutters in Belgium, Germany, Netherlands, and the world, 1860–1938.

Flemish people, both Catholic and Protestant, Netherlanders, Jews, and Americans have all made notable contributions to the craft.

An adequate supply of rough diamonds is necessary to the growth of the art. The Indian mines created the ancient industry of India and with their decline the industry died. Cutting in Borneo was fed first from the local mines, but now is supplemented by imported South African rough. Lisbon was an important cutting center while Portugal controlled the India trade, and the dominant position of the Netherlands as a cutting center was due first to her Indian trade and later to her monopoly of Brazilian rough. On the other hand, the French industry established by Cardinal Mazarin about 1650 starved to death owing to the lack of an adequate supply of rough diamonds. With the rough market centered in London, rough is now available to all cutters.

Bruges was the dominant center during most of the fifteenth century, Antwerp from 1483 to 1585, and then Amsterdam for over 3 centuries. In 1909 Antwerp regained the lead and has held it since, except for the World War period. During the past decade the growth of the craft in Germany has been phenomenal. That country, like Belgium, cuts small rough, while the Netherlands specializes in large.

During the financial boom of a decade ago, the industry became geared to prosperous times and since 1929 has been markedly overstaffed.

An ancient industry, the secrets of which were carefully guarded till 60 years ago; once a home industry, taught by father to son, it is now carried on in large factories. Started as a family trade, it has become big business. Sixty-five years ago the prince of artisans, the diamond cutter today, due to the unjustified growth of his craft, receives an indifferent and desultory wage. Unless great prosperity awaits in the near future, many a diamond cutter must seek employment in more profitable industries.

In 1500 A. D. there were some 600 cutters (India, 500; Europe, 100): 1660, 1,400 (India-Borneo, 400; Europe, 1,000): 1700, 950 (India-Borneo, 350; Europe, 600): 1770, 1,400 (India-Borneo, 300; Europe, 1,100); and in 1810 but 700, owing to the Napoleonic wars (India-Borneo, 300; Europe, 400). The growth of the industry since 1860 is shown in figure 1.

Cutting in 1938.—The diamond-cutting industry had a poor year, marked by little profit for the "masters" and increased unemployment among the men. Many of the latter were absorbed by other industries. Although the Belgian and Netherland centers lost ground, the German industry, which during the past decade has had such a phenomenal growth, suffered most severely.

Imports.—Diamond imports into the United States in 1938, by countries, were as follows:

Diamonds imported into the United States in 1938, by countries [1]

[Exclusive of industrial diamonds]

Country	Rough, or uncut			Cut, but not set		
	Carats	Value		Carats	Value	
		Total	Per carat		Total	Per carat
Austria [2]				11	$589	$53.55
Belgium	419	$23,311	$55.63	278,144	13,869,072	49.86
Egypt				1	135	135.00
France				767	67,608	88.15
India, British				87	20,456	235.13
Mexico				11	1,346	122.36
Netherlands				50,376	2,902,165	57.61
Switzerland				232	15,904	68.55
Trinidad and Tobago				8	439	54.88
Union of South Africa	91,096	7,053,848	77.43	591	65,990	111.66
U. S. S. R.				32	5,106	159.56
United Kingdom				665	68,042	102.32
	91,515	7,077,159	77.33	330,925	17,016,842	51.42

[1] Compiled from records of the Bureau of Foreign and Domestic Commerce.
[2] Figures cover period January 1 to May 5.

World production.—World production of diamonds (gem and industrial) in 1938 approximated 11,755,200 carats (2.351 tons) worth about $43,000,000. Compared with 1937 this is an increase of 22.5 percent by weight, without much variation in value, as the increase was largely in low-price industrials. As only Dutoitspan and Bulfontein of the South African pipe mines were operated, the alluvial mines produced 91.5 percent by weight and 70 percent of the value. The British Empire produced 31 percent by weight and 69 percent of the value. Of the total production, less than one-fourth by weight were gem stones.

The following table gives, as accurately as available statistics permit, world diamond production for the past 5 years:

World production of diamonds, 1934–38, by countries, in carats

[Including industrial diamonds]

Country	1934	1935	1936	1937	1938
Africa:					
Angola	452,963	481,615	577,531	626,424	[1] 651,000
Belgian Congo	3,331,360	3,812,023	4,634,266	4,925,228	[1] 7,205,300
French Equatorial Africa		138	1,550	6,197	[1] 23,000
French West Africa			6,500	52,933	59,548
Gold Coast	2,391,609	1,349,847	1,414,677	1,577,661	1,315,000
Sierra Leone	68,633	295,483	616,200	913,401	[1] 900,000
South West Africa	4,126	128,464	184,917	196,803	[1] 140,000
Tanganyika	1,155	1,446	2,704	3,234	[2] 3,590
Union of South Africa:					
Mines	9,414	274,317	339,719	820,284	979,460
Alluvial	430,899	402,405	284,204	207,359	259,145
Total Union of South Africa	440,313	676,722	623,923	[3] 1,030,434	1,238,605
Brazil	[1] 42,500	39,100	136,462	238,606	[1] 150,000
British Guiana	44,821	47,785	41,067	35,958	[1] 35,000
Other countries [4]	4,000	5,500	6,000	6,000	34,200
	6,781,500	6,838,100	8,244,800	9,012,900	11,755,200

[1] Estimated.
[2] Exports.
[3] Includes a small quantity of diamonds recovered from retreatment of tailings.
[4] 1934: Netherland India (Borneo), India, Australia (New South Wales), Rhodesia, Nigeria, United States (California), and Venezuela; 1935: Netherland India (Borneo), India, Nigeria, and Venezuela; 1936: Netherland India (Borneo), India, Rhodesia, United States (California), and Venezuela; 1937: Netherland India (Borneo), India, Australia (New South Wales), Liberia, Venezuela, and Rhodesia; 1938: U. S. S. R., India, Borneo, New South Wales, Venezuela.

The increased production in 1938 compared to that of 1937 was due largely to an unusually large production of industrial stones by the Belgian Congo. South Africa increased its production about 20 percent, and the small outputs of French Africa and of miscellaneous sources increased markedly. The production of South-West Africa decreased about 26 percent and that of Gold Coast 17 percent.

Industrial diamonds.—More diamonds were used industrially in 1938 than ever before, although, as the proportion of crushing bort used increased, the dollar sales value probably was somewhat less than in 1937. The increase was due largely to the world-wide armament race and the need of a superabrasive to cut and shape hard alloy steels, as well as to the diversified use of diamond grains bonded in plastics and powdered metals. Over two-thirds, by weight, of the world diamond output is used in industry, mainly in the United States, Great Britain, Canada, Germany, and the U. S. S. R.

The demand for industrial stones was strong throughout 1938. As the finer stones are scarce, industry was forced to use the smaller stones and those of mediocre quality more and more. Carbonado (the Brazilian "black diamond") is now selling at a price that for certain purposes renders its use attractive. Prices were firm, with an upward tendency.

Imports of industrial diamonds into the United States during the past 5 years were as follows:

Industrial diamonds (glaziers', engravers', and miners') imported into the United States, 1934–38 [1]

Year	Carats	Value		Year	Carats	Value	
		Total	Per carat			Total	Per carat
1934	526,007	$2,862,349	$5.44	1937	1,885,970	$6,542,365	$3.47
1935	954,589	4,293,611	4.50	1938	1,396,247	4,213,412	3.02
1936	1,166,094	4,328,603	3.71				

[1] Compiled from records of the Bureau of Foreign and Domestic Commerce.

EMERALD, RUBY, AND SAPPHIRE

For the third successive year the lavish use of colored stones in jewelry depleted the store obtainable from old jewelry and brought nearer the time when the colored-gem mines will have to increase their scale of operation or a shortage will result. Barring a world war or a financial cataclysm prices must rise.

The Government-owned Muzo emerald mine, Colombia, was closed at least most of the year and early in 1939 was to be leased to private parties. The Government gives, rather naively, the theft of the better stones by the miners as the reason for the proposed change in management. The Chivor Emerald Mines, Colombia, operated on a restricted scale in 1938. The Bank of the Republic is said to have 24,000 carats of uncut emeralds stored in its vaults. The Cobra Emerald Mine, South Africa, in 1937 was operated by the African & European Investment Co. at a small profit. The official figures of the value of emerald produced in South Africa were £6,082 in 1936 and £10,838 in 1937. Victor Leinz and O. H. Leonardos report the occurrence of emeralds in detrital deposits in the State of Goyaz, Brazil, 20 miles southeast of the city of Goyaz. The stones are of good color but are badly flawed and lack transparency. The geological occurrence suggests affiliation with occurrences in the U. S. S. R., Egypt, and North Carolina—mica schists cut by pegmatites. The emerald mine at Habachtal (former Austria) is now in German territory.

In 1937 Burma produced 157,308 carats of rubies valued at £6,841 (20 cents a carat). Its rubies and byproduct sapphires were valued at £7,069 as opposed to £7,319 in 1936. Burmese miners in Cambodia produced a few rubies, sapphires, and zircons at the alluvial mines at Païlin and at Bo-Keo. The 1936 value was 1,880 piasters, three-fourths from the first locality and one-fourth from the second. Production, in carats, has been as follows: 1934, 450; 1935, 312; and 1936, 104.

India in 1937 produced 22,736 carats of sapphire, largely from Kashmir. The value as officially given is £1,682 in 1936 and £41 in

1937. The larger part of the Kashmir production is understood to be only usable industrially.

Sapphires valued at £1,410 were sold in the Anakie (Queensland) field in 1937 (£2,030 in 1936). Twenty-five men were engaged in mining, largely around Ruby and Sapphire, although some of them were attempting to locate new leads in the surrounding country. First blues, only a small percentage of the production, were in demand, but yellows and greens were difficult to sell. The Miners' Association sold largely in France, although a few fine stones were disposed of in America. Queensland produced gems, largely sapphires, from 1860 to 1937, inclusive, worth £643,156, the years of important production being 1907 to 1925.

The special committee appointed by the Government of Ceylon to investigate the gem-mining industry at first decided to establish a Government cutting works and a sales room at Colombo but finally recommended that the miners bring their stones to small depots where they could obtain the best current prices. The committee recommended further that an up-to-date map of the gemmiferous area be made, as it believes much illicit mining is being carried on and that there are several unexplored areas in Ceylon where gems may be found. Whether the central depots will be advantageous to the trade, time alone can tell. The Government could perhaps spend its efforts more advantageously in preventing unscrupulous merchants from selling synthetics and imitations as genuine stones.

LESSER GEMS

The all-time opal production of New South Wales is valued at £1,622,795, although for the 10 years, 1928–37, the average yearly production has been but £4,803. The 1936 production was valued at £6,110 and that of 1937 at £3,357. In the latter year over 97 percent came from Lightning Ridge, Grawin and White Cliffs supplying the remainder. The total opal production of Queensland from 1860 to 1937 is valued at £187,745, the big production being in the last 8 years of the nineties. In 1936 the production was only worth £150 and in 1937 had shrunk to £16. This came from Sheep Station Creek in the Quilpie district, where four men prospected part of the year. South Australia had sold opal to the value of £160,158 from 1916 to 1937. In 1937, £11,887 worth of opal was marketed, the most satisfactory year since 1920. The demand was better than usual, and hence mining was more active. Coober Pedy was the principal source; but two smaller fields, Mintabie and Andamooka, also produced. Opal artifacts and jade and crystal beads were found in a cave near Nakuru, Kenya, by Dr. L. S. B. Leakey, the distinguished archaeologist. The objects are believed to date from about 4,000 B. C. Dr. Leakey believes there were important opal mines in the vicinity.

In 1937 about 40 men gophered turquoise stringers at Nishapur, Iran. The owners, an Iranian mining company in Meshed, plan to drive a large tunnel 200 to 300 feet beneath the deepest old workings, which in turn are several hundred feet beneath the surface. The company cuts and mounts the turquoise in a small shop at Meshed. The same company also mines and sells salt; according to a letter from Lester S. Thompson, to increase the sale of the latter, a cheap turquoise ring is concealed in every five-hundredth 1-kilo package of table salt sold. A little turquoise (20 oz. worth £8 in 1936, none in 1937) is produced from time to time in the Brisbane district, Queensland.

The Afghanistan lapis lazuli contact-metamorphic deposits are worked by long tunnels whose sides are badly smoked, the rock having been broken by fire setting. It is believed there has been no mining for 10 years, the lapis lazuli sold coming from stocks on hand. Ernest F. Fox states that the best goes to Kabul, where it is cut.

In 1937, 2,952 cwt. of jadeite were produced in Burma, nearly double the previous year's production, although the value (£13,030) was lower (£13,412).

Burma also produced amber valued at £668 (£409 in 1936). Recent production of amber in Germany was, 1935, 112 metric tons; 1936, 332 metric tons; and 1937, 328 metric tons.

Vesuvianite of fine gem quality is produced to a limited extent at Laurel, Quebec.

Considerable amounts of jet are produced in the Province of Kompong-Thom, Cambodia (1934, 13,000 kilos; 1935, 24,000 kilos; and 1936, 24,270 kilos).

The United States annually imports from Brazil 5 to 6 tons of unusually fine quartz crystals absolutely essential in radios and in telephonic, telegraphic, and optical apparatus. Even if the finest crystals are used, the finished plates represent but a twentieth of the original. Minas Geraes exports its rock crystal to the United States, Germany, and Japan. Mining is primitive and rarely is carried to any considerable depth. Recently a fine rock crystal from Minas Geraes, Brazil, was sent to this country. It weighed 63 pounds and was sold for over $1,100, or about $18 per pound.

Amethysts occur in seams in trap rock near Scott's Bay, Nova Scotia, on the Bay of Fundy. The winter's frost each year forms new outcrops. Some of the amethysts are cut in Europe, returned to Nova Scotia, set in lockets or rings, and, together with rough crystals, sold to tourists. The trade has increased greatly in the last 6 or 7 years.

Several tons of rose quartz from pegmatic dikes in Minas Geraes, Brazil, are sold annually. Japan, China, and Germany are the principal markets, the best grades bringing $500 to $600 per metric ton. The State of Hyderabad, India, has widely distributed deposits of agate, plasma, and bloodstone.

The Iceland spar deposit at Hegustader, Iceland, is still operated as a Government monopoly.

As a result of 1938 political changes, the well-known Bohemian garnet localities and the Czerwenitza opal locality became German territory. It is understood that further working of the Jordansmühl (Silesia) nephrite deposits is to be regulated by the German Government.

In 1936, 13 companies were mining precious stones in Madagascar, although the production only was worth some $21,000. In 1936, 6.6 kilos of beryl, tourmaline, and kunzite were exported (4.5 kilos in 1935 and 9 kilos in 1934) and 31 kilos of feldspar and quartz gems, garnets, and similar stones (16 kilos in 1935, 23 in 1934). In addition much greater weights of industrial stones were exported. The demand is, however, so irregular that exports for a single year mean little.

The mines are small units, and the use of explosives is avoided lest the gems be ruined.

South-West Africa in 1937 produced 46.765 kilos of precious stones, largely tourmaline. Sales, largely to Germany, were, however, 688.987 kilos. In the first 9 months of 1938, 110.563 kilos were sold for £1,182. The stones included aquamarine, tourmaline, topaz, rose quartz, and chalcedony.

Brazil is the most important producer of the lesser gems, but figures on its 1938 production are not at hand.

SYNTHETICS

The Gemmological Institute of America in a study of synthetic emeralds finds the best method of distinguishing synthetics from real is the presence of irregular cracklike or wisplike markings in the synthetics, imperfections markedly different from the blemishes of emeralds.[2]

The Russian Precious Stone Trust is now making synthetics in its Leningrad laboratory, several of which, a sapphire of 292 carats and a ruby of 250 carats, are sizable.

The I. G. Farben-Industrie has a large synthetic-gem plant at Bitterfeld, Germany, which produces several thousand carats of synthetics a day. Some are sent to Oberstein for cutting, and others are used as jewels for watches and bearings for precision instruments.

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GEM STONES

By Sydney H. Ball[1]

SUMMARY OUTLINE

Retail sales of jewelry in 1939 totaled about $307,000,000, or 10 percent above sales in 1938 ($279,000,000) and only slightly less than those in 1937 ($312,000,000). Diamond rings, watches, and gold jewelry were the principal items. After February sales were better each month than in 1938, and after September monthly sales showed increases over those of 1937. Improvement was progressive in 1939, and the Christmas trade in jewelry was markedly better than that for either of the past 2 years (16 percent over 1938 and 13 percent over 1937); moreover, there was some demand for higher-price articles. Sales in Oregon and Washington and, to a smaller extent, Georgia and South Carolina, made marked progress over 1938. Installment selling is increasing in the trade and is likely to show further gains.

Manufacturers' sales and those of wholesalers were respectively 25 and 20 percent greater than in 1938, and it is evident that both wholesalers and retailers increased their stocks somewhat in 1939 (retailers about 2 percent). Wholesale trade was relatively good, particularly during the last 5 months of the year, and sales of costume jewelry continued to increase.

Fashions in jewels.—Large jewels, flamboyant in color and daring in design, were the mode in 1939. Use of gold (often in two or three colors) and silver, to a smaller extent, gained at the expense of platinum. It is the opinion of many, however, that platinum sets off fine diamonds much more advantageously than gold. The motifs include geometric, classical, Victorian, Georgian, Hindoo, and ancient Egyptian. Jewelry ensembles, each piece set with similar stones, gained in popularity, as did large jewels divisible into several ornaments. Long pendant earrings, rings with large stones, clips, lapel ornaments, and necklaces were much worn. Jeweled flowers increased in popularity.

Colored gems set pavé with countless diamonds are used to a larger extent yearly. The finer gems—diamond (including an unusual number of colored diamonds), ruby, sapphire, and emerald—are most popular; however, aquamarine, moonstone, and topaz are used fre-

[1] One of the consulting engineers, Bureau of Mines. Figures on imports compiled by M. B. Price, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

quently and many other colored stones from time to time. For men's wear, star sapphires, cat's-eye, and quartz gems predominate.

As a result of the war "mourning jewelry" is likely to be in demand (jet or black-stained onyx alone or with white stones, such as moonstone).

Domestic production.—From the 1909 peak production of gem stones valued at $534,280, the domestic industry dwindled until in 1934 the value decreased to about $3,000. Since then production has increased markedly and in 1939 was valued at $235,000 to $470,000; the first figure is a rough estimate of the amount used in jewelry and the second an estimate of the total, including that treasured by collectors or sold to tourists, mineral collectors, and rock gardeners. Almost 85 percent of the amount used in jewelry comprises stones of the agate family. Gems are produced largely by individuals or small partnerships, and as there are no official production returns exact figures are not available. The revival of the industry is due to three factors: (1) The purchase by automobile and other tourists of souvenirs, (2) the extraordinary increase in gem cutting as a hobby (particularly in Oregon and Washington), and (3) the use of an increasing variety of colored stones in jewelry.

The war has shut off, at least partly, the country's normal sources of supply of colored gems and has engendered nationalistic sentiments; consequently, gems of American origin, notably turquoise, tourmaline, kunzite, benitoite, and hiddenite, should increase in popularity. An important gem-stone industry cannot, however, arise in this country owing to the lack of gem deposits of the first order and the high cost of cutting in the United States. Unfortunately, some unscrupulous dealers sell to tourists and even to their fellow townsmen "American" gems which actually originated in foreign countries and were cut in Germany.

In the Northwest, especially in Oregon, according to correspondence with H. C. Dake, the number of mineral collectors and lapidaries, both professional and amateur, most of whom collect and cut quartz gems, continues to increase markedly. He estimates the value of the material cut in 1939 as follows: Oregon, $300,000; Washington, $90,000; Idaho, $35,000; Montana, $10,000; and Wyoming, $8,000—a total of $443,000. Much of the material remains in private mineral collections. In Oregon the centers of the industry are Portland and Newport. Some 14 lapidary shops in Newport employ from 2 to 10 persons each. For about 75 miles up and down the beach from Newport agate hunters (both amateur and professional) search for the rough material, particularly from February to the beginning of summer after winter storms have uncovered new sources of supply. The mineralogical societies of Lincoln County have protested against the use of local agate-bearing gravels as road material by the State highway commission. Oregon ships some uncut agates to cutters outside the State. In Washington the largest cutting centers are Seattle and Spokane; the principal stone cut is opalized wood from Miocene lake beds. In Wyoming local gem stones, mostly moss agate, are cut at Rawlins and Cheyenne. In Idaho the production was largely opalized wood from the southwestern part of the State and star garnets from Ruby Creek, Latah County.

Numerous collectors are slowly depleting the supplies of moss agate along the Yellowstone River in southeastern Montana from Huntley to northeast of Glendive, a distance of over 200 miles; however, the supply is partly replenished by the spring floods which rework the gravels. The most satisfactory collecting periods are during low water. Billings is the chief cutting center. The better moss agates are valued at $3 to $5 a pound in the rough.

Nevada yielded turquoise valued at about $17,000 in 1939. The principal producers were the Smith mine, Cortez district, Lander County, the Blue Matrix mine near Tenabo, and the "Royal Blue" mine at Royston. The output of the Smith mine was 7,512 pounds in 1939. Considerable turquoise was also produced at Villagrove Colo., and a little in Mineral Park near Kingman, Ariz. Mines in Utah, some about 5 miles west of Fairfield and others about 10 miles south of Grantsville, yielded 1,000 pounds or more of variscite.

A substantial quantity of sapphire was produced in Montana (perhaps 1,000 pounds), but very little of this was gem material, most of it being of industrial grade.

In 1939 it was reported that nephrite was found in place in California and that some had been cut and was on the market. Considerable prospecting for gems was done in North Carolina in 1939, and the local lapidary trade is increasing, thanks largely to tourist demand. Kunzite crystals were discovered in Mitchell County a few years ago.

Other gem stones produced in the United States in 1939 included agatized wood (private lands surrounding Petrified National Monument, Ariz.); amethyst (Townes County, Ga.; Larimer County, Colo.; and New Hampshire); aquamarine (Black Hills, S. Dak., and Maine); kyanite (Upson County, Ga.); garnet (Washington); oligoclase moonstone (North Carolina); rock crystal (Arkansas and North Carolina); rose quartz (Black Hills, S. Dak., and Albany, Maine); ruby (Macon County, N. C.); rutilated quartz (North Carolina); satin spar (Niagara Falls, N. Y.); topaz (Thomas Ridge, Utah; San Diego, Calif.; and New Hampshire); and tourmaline (green—San Diego, Calif., and Maine; red (rubellite)—Black Hills, S. Dak.).

For 60 years the Potter family has cut satin-spar (gypsum) beads and other souvenirs at Niagara Falls. Some of the material is of local and Canadian origin, but most of it is imported from England.

Marble similar to Mexican onyx was produced near Pelican Point on Utah Lake, Utah, by the Onyx Corporation of America and by the Jay Em Onyx & Gem Co., near Hartville, Wyo.

According to information furnished by A. H. Cornelison, the Hawaiian Islands produce a few gems and several decorative stones. Their output of olivines in 1939 was very small, as information regarding the locality of the best prospect was lost with the death of E. Mott Smith. Some clear plagioclase feldspar, locally known as "Hawaiian golden-yellow topaz," was mined, also an interestingly marked jasper and some common opal. The known deposits of "Hawaiian diamonds" (rock crystal) are almost exhausted. Possibly $1,000 worth of local stones were sold in 1939.

Imports.—According to the Bureau of Foreign and Domestic Commerce, imports of precious and imitation stones (exclusive of industrial diamonds) into the United States in 1939 totaled $40,487,877, an increase of 43 percent over 1938. Details are shown as follows:

	Carats	Value
Diamonds:		
Rough or uncut (suitable for cutting into gem stones), duty free	153, 982	$7, 956, 397
Cut but unset, suitable for jewelry, dutiable:		
Less than 10 stones per carat	60, 332	5, 107, 173
10 or more stones per carat	427, 822	22, 310, 100
Emeralds:		
Rough or uncut, free	36, 946	17, 531
Cut but unset, dutiable	17, 624	361, 345
Pearls and parts, not strung or set, dutiable:		
Natural		249, 415
Cultured or cultivated		328, 250
Other precious stones:		
Rough or uncut, free		111, 830
Cut but unset, dutiable		1, 937, 479
Imitation, except opaque, dutiable		2, 018, 134
Imitation, opaque, including imitation pearls, dutiable		30, 969
Marcasites, dutiable:		
Real		38, 860
Imitation		20, 394
		40, 487, 877

Tariff regulations.—Wars in Europe and the East brought about many changes in tariffs.

As soon as war was declared France decreed that licenses are required for the importation of gems and jewelry, and to conserve the country's gold, licenses doubtless will be difficult to procure. Supplies of gold for use in jewelry are controlled, and to prevent hoarding, jewelry containing an abnormal quantity of gold can no longer be manufactured.

At the outbreak of war the British Government placed an embargo on the export of diamonds to prevent industrial stones from reaching its enemies. Committees were set up in Antwerp, Amsterdam, Paris, and possibly also in New York to assist the British Board of Trade in issuing export licenses. The early delays caused by the embargo are now less exaggerated, but the embargo accounts partly for the fall in American diamond imports of uncut and industrial stones after September 1939.

Germany requires that official approval be obtained before precious and rare metals can be fabricated, and jewelers can only sell gold jewelry made of gold furnished by their clients. When Germany absorbed Czechoslovakia the duty on imitation precious stones immediately was increased 30 to 45 percent, as Czechoslovakia had a favored-nation trade agreement. France is supplying part of the shortage.

In Belgium special authorization from the Department of Economic Affairs is necessary to import or export rough diamonds for the duration of the war. In January 1940, Hungary replaced free imports by a regime of permits, and by May permits were virtually unobtainable.

In May 1939 Japan required all residents to report to the Government all gold held and after June 1 no gold articles could be displayed in shop windows. China nationalized all gold (coins, bars, and jewelry) in August, the owners being compensated at official rates.

Ceylon reduced the import duty on diamonds from 15 to 5 percent, or to that of India and Burma. Precious stones can be exported from

Brazil only by registered buyers or dealers after official appraisal. During the year Palestine removed duties on diamonds and unset precious stones.

Effect of war on jewelry trade.—When war was declared certain panicky dealers feverishly replenished their stocks; this buying, with a certain speculation by those outside the trade, raised the price of small cut diamonds 20 or 30 percent and that of large stones less. In reality the supply of diamonds is adequate, and prices should only have been raised enough to cover increased shipping and insurance costs. The price of colored stones also rose some 20 percent. Later higher cutting costs may have to be taken into consideration. Rather large stocks of costume jewelry were purchased, as the war automatically cut off some important sources of imitation and synthetic precious stones. Platinum prices rose (January 1, 1939, \$34.44; December 30, 1939, \$40 an ounce).

Hereafter jewelry probably will be more expensive, but there is no reason to fear a shortage of supply, even if the war becomes a long-drawn-out affair. Obviously the warring nations need dollar exchange.

The American diamond-cutting industry may be stimulated somewhat by the war, but even under war conditions small diamonds doubtless will continue to be cut in Europe, as American cutting costs on such goods are prohibitive.

War and destruction are synonymous, therefore war must hurt industry. Today the Russian and German markets for gem stones are almost nonexistent; France and England are throttled by high taxation; hence the industry must live on the trade of the United States, India, and South America and on such investment buying of fine gems as the citizens of belligerent countries can accomplish.

Gem publicity.—At the New York World's Fair, jewels will again be attractively exhibited in 1940. The House of Jewels will show the beautiful jewelry of five leading Fifth Avenue jewelers and gorgeous diamonds, uncut and cut, of De Beers & Associated Producing Cos. During 1939 De Beers, in a selected group of periodicals, conducted a campaign advertising the beauty, value, and rarity of the diamond.

DIAMOND

The year 1939 was surprisingly satisfactory in the diamond industry in view of the grave political crises and the two major wars. Trade was far better than in 1938, and in some respects was almost as good as in 1937, admittedly a good year. Production of rough stones, which was virtually equivalent to that in 1938, exceeded sales, and for the second successive year stocks increased. All grades of diamonds increased in price. In Europe increases were as follows: Large rough, slight, and small rough, 25 to 45 percent; large cut, 15 to 20 percent; and small cut, almost 100 percent. In America increases were less. Many stones were bought for investment, notwithstanding attempts by various governments to curtail the practice.

Share dealings.—The shares of diamond-mining companies listed on the London Stock Exchange had a restricted market in 1939. Prices were weak during most of the year, although there were sharp recoveries in the last half of July, owing to activity in Wall Street, and after October, owing to news of good sales by the Diamond Trading Co., and smaller recoveries from mid-February to mid-March, early May to mid-June, and late December. During the year five representative stocks lost 17 percent of their value and at the end of the year were 31 percent of their high (1927) and 307 percent of their low (1932). Of the 12 principal mining shares, 7 paid dividends in 1939.

Market.—In 1939 the Diamond Trading Co., which sells about 95 percent of the world output of diamonds, inaugurated a new sales policy. "Sights" are now held fortnightly; buyers, large and small, are urged to attend, and goods are sorted into standard types that will not vary from "sight" to "sight." Sales in 1939 were about £5,865,000—159 percent of those in 1938 but only 64 percent of those in 1937. First- and fourth-quarter sales were particularly satisfactory. Good-quality stones continue to be scarce.

Sales of polished diamonds, while not satisfactory, showed an appreciable gain over 1938. Small sizes were particularly in demand, fine goods being bought when available and mediocre grades at other times. Fine large stones were in demand as investments. Sales of industrial stones were excellent. The market was quiet until May, after which the improvement was progressive, and by August the market was animated. When war was declared, frantic buyers, fearing that their sources of supply would be cut off, purchased in quantity, but in October the market became normal.

Cutting in 1939.—The cutting trade was even worse in 1939 than in 1938; "masters" made little money, and the men were frequently unemployed. During the year the number of artisans decreased from approximately 27,000 to 23,000, owing largely to the shutting down of German shops at the outbreak of war. Both Antwerp and Amsterdam suffered, the first somewhat more than the second. Cutters' wages were raised 15 percent in October.

Imports.—Diamond imports into the United States in 1939, by countries, were as follows:

Diamonds imported into the United States in 1939, by countries

[Exclusive of industrial diamonds]

Country	Rough, or uncut			Cut, but not set		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
Africa:						
British East Africa	34	$3,091	$90.91			
Union of South Africa	148,001	7,656,408	51.73	1,488	$187,107	$125.74
Belgium				399,806	21,733,478	54.36
Brazil	5,846	292,854	50.09			
France				4,719	699,239	148.18
Germany				7	419	59.86
Guiana, British	101	4,044	40.04			
Netherlands				77,422	4,454,205	57.53
Palestine				36	2,299	63.86
Switzerland				1,392	69,926	50.23
United Kingdom				3,284	270,600	82.40
	153,982	7,956,397	51.67	488,154	27,417,273	56.17

World production.—World production of diamonds (gem and industrial) in 1939 approximated 11,330,000 carats (2.266 metric tons) worth about $39,270,000. Compared to 1938 this is a decrease of 2 percent (readjusted figure, 11,620,000 carats worth $40,750,000) by weight and 4 percent by value. Of the South African pipe mines only Dutoitspan and Bulfontein operated; world alluvial mines yielded 91 percent of the output by weight and 77 percent by value. The British Empire produced 26 percent by weight and 60 percent by value of the total production; less than one-fifth by weight were gem stones.

The following table gives, as accurately as available statistics permit, world production for the past 5 years.

World production of diamonds, 1935–39, by countries, in metric carats

[Including industrial diamonds]

Country	1935	1936	1937	1938	1939
Africa:					
Angola	481,615	577,531	626,424	651,265	[1] 682,000
Belgian Congo	3,812,023	4,634,266	4,925,228	7,205,620	[1] 7,201,000
French Equatorial Africa	138	1,550	5,588	16,013	[1] 16,000
French West Africa		18,897	57,687	61,928	56,314
Gold Coast (exports)	1,349,847	1,414,677	1,577,661	1,296,763	1,087,652
Sierra Leone	295,483	616,200	913,401	689,621	[1] 600,000
South West Africa	128,464	184,917	196,803	154,856	35,470
Tanganyika	1,446	2,704	3,234	3,576	[2] 3,445
Union of South Africa:					
Mines	274,317	339,719	820,284	979,460	[1] 1,062,670
Alluvial	402,405	284,204	207,359	259,148	[1] 184,000
Total Union of South Africa	676,722	623,923	[3] 1,030,434	1,238,608	[1] 1,246,670
Brazil	39,100	136,462	238,606	[1] 235,000	[1] 350,000
British Guiana	47,785	41,067	35,958	32,522	32,491
Other countries [4]	5,800	6,000	6,000	34,200	19,000
	6,838,400	8,258,200	9,617,000	11,620,000	11,330,000

[1] Estimated.
[2] Exports.
[3] Includes 2,791 metric carats recovered from re-treatment of tailings.
[4] 1935: Borneo, India, Nigeria, and Venezuela; 1936: Borneo, India, New South Wales, Rhodesia, United States (California), and Venezuela; 1937: Borneo, India, Liberia, New South Wales, Rhodesia, and Venezuela; 1938–39: Borneo, India, New South Wales, U. S. S. R., and Venezuela.

In South Africa the output of pipe mines increased, whereas that of alluvial mines continued its decline. Production in Brazil and the new fields of the French African colonies increased, but in Southwest Africa and the Gold Coast it was drastically curtailed. As usual, the Belgian Congo contributed 64 percent, by weight, of the world output, largely industrial stones. New discoveries are reported in the U. S. S. R., Kenya, and Uganda.

Tropical hygiene and diamond production.—Diamond output, more than that of any other mineral product, comes from tropical countries—in the past from India, Borneo, and Brazil; today from Central Africa and to a smaller extent Brazil and British Guiana. The richness of the tropics in gems is a matter of chance, but the scientists of the Middle Ages believed that the hot tropical sun ripened the gems. A century ago 100 percent of the production came from the tropics; in those days tropical diseases decimated the workmen, and jewel buyers felt they were risking their lives in visiting the diamond fields. Of the present world output, approximately 88 percent by weight and 51 percent by value are produced in tropical countries, but today the personnel of the larger companies enjoys a health record comparable to that of mining companies operating in temperate climates. The different records of the two centuries "spotlights" the advance of tropical hygiene.

Malaria no longer saps the vitality of the staff and workmen; the dreaded sleeping sickness is being conquered, and dysentery has become rare. Turn-over in the staff is no longer a detriment to efficient operation. The staff lives in modern camps with proper water supply, sewerage systems, electric lights, and golf courses. Many bring their families, and schools are provided for the children. The villages of native laborers serve as models to be imitated by the bush natives. The Forminière Co., operating in the Belgian Congo, realizing that its future labor supply was menaced by the sleeping-sickness plague for some years, has had a large, mobile medical staff examining the natives of the countryside and giving treatment to infected natives. In 1938 the medical staff examined 129,348 natives for the disease. The scourge is now under control. Throughout the Belgian Congo the number of cases of the dread disease has decreased from 11 per 1,000 in 1908–10 to 2.9 per 1,000.

It may be stated safely that if it were not for tropical medical research and present-day knowledge of sanitation, the diamond production of the world would be at least one-third less than it is.

Industrial diamonds.—In 1939 more industrial diamonds were employed than ever before; larger factory use in the United States and munition-plant use in Europe more than offset decreased use of the diamond drill in Canadian prospecting. Striking features of the 1939 advance were the rapid expansion in use of diamond-impregnated wheels and other abrasive tools (particularly those with a powdered-metal bond), the increased use of very small bort in drilling, and the gain of mechanically set over hand-set diamond-drill bits. Diamond drills are now employed extensively, particularly in Canada, for blast-hole work.

The demand for industrial stones was strong throughout 1939. As it has been for 3 years, the scarcity of fine stones required the use of mediocre grades. Prices of all grades registered marked advances.

Imports of industrial diamonds into the United States during the past 5 years were as follows.

Industrial diamonds (glaziers', engravers', and miners') imported into the United States, 1935–39

Year	Carats	Value		Year	Carats	Value	
		Total	Average			Total	Average
1935	954,539	$4,293,611	$4.50	1938	1,396,247	$4,213,412	$3.02
1936	1,166,094	4,328,603	3.71	1939	3,568,730	9,725,683	2.73
1937	1,885,970	6,542,365	3.47				

The 1939 imports are somewhat misleading, as some shipments were sent here for safekeeping by the countries at war; in addition a number of dealers, forced to leave their homelands, brought with them their stocks of industrial diamonds.

EMERALD, RUBY, AND SAPPHIRE

The increased use of colored stones in jewelry during the past 4 years has caused concern over the source from which supplies are to be obtained in the future. With the State-owned Colombian emerald mines closed, the Burma ruby mines worked only by the natives, and the production of world sapphire mines small, little new rough stone is coming on the market. The jewelers are using largely stones recovered from old jewelry, Spain having furnished many fine-colored stones in the past 2 years. Such a situation, however, cannot last, and eventually old mines must be reopened or new mines found.

The Muzo emerald mine in Colombia has been shut down several years, but the property of the Chivor Emerald Mines, Inc., has been operated under lease from September 15, 1937, to date by the Compañía de Esmeraldas de Colombia. From September 15, 1937, to September 1, 1939, 28,841.22 carats of emeralds of all grades and 73,633.4 carats of moralla were produced. About 100 miners were employed. Since September 1, 1939, the output has been unimportant. The property is to be sold to the leasing company on a royalty basis and a cash payment of $10,000.

The emerald deposits of the Murchison Range, Transvaal (*see* bibliography, Kent, L. E., Emeralds, Murchison Range, Transvaal) were discovered in 1927; altogether there have been 15 producers, most of which are now moribund. Production to the end of 1937 was 664,612 carats, worth £84,294, or 2s. 6½d. per carat. Some of the stones are of fine color, but like most emeralds they usually are flawed (owing to movement after deposition) and often include biotite inclusions. Color zoning is common. Cobra Emeralds, Ltd., has been by far the largest producer. Emeralds occur as well-shaped crystals, distributed sporadically in shoots and pockets in biotite schist near pegmatitic intrusions. The pegmatite contains no emerald but does contain beryl. Near later basic intrusions the emerald has been "baked" to a brownish green. The emerald deposits resemble those of Egypt, the Urals, the Salzburg Alps, and North Carolina. The emeralds were deposited during the "hydrothermal phase" following the intrusion of the pegmatite.

Open-cut methods of mining are used, and the emeralds are separated largely by hand methods. The yearly emerald content has ranged from 2.75 to 3.16 carats per load (approximately a cubic yard). The product is sold directly to London gem buyers. In 1938–39 the Cobra Emerald Mines, Ltd., was shut down, owing partly to the depressed state of the precious-stone market and partly to decreased quality of the stones. N. M. Uspensky believes that although some of the emeralds at the Ural emerald mines near Sverdlovsk, crystallized at 500° C., most of them crystallized below 400° C. and some as low as 200° C.

In 1938 the Mogok or Katha workings, Burma, produced 202,483 carats of rubies, a 29-percent increase over 1937 (157,308 carats).

The subcommittee appointed by the Government of Ceylon to report on marketing and cutting gems in Ceylon, recommended (1) that a Government institute to instruct the natives in gem cutting be set up as part of the Department of Mineralogy, and (2) that a Government salesroom be attached thereto. The Singhalese cutter certainly has much to learn from an up-to-date gem cutter. The report of the committee is an interesting document, describing the three trades concerned (the miner, the cutter, and the dealer), the laws relating to gemming, mining methods, marketing, and other phases of the industry. It is understood that the recommendations of the committee will be acted on favorably.

The sapphire production of the Mogok ruby workings, Burma, has been as follows in the past 3 years: 1936, 172 carats; 1937, 4,392 carats; and 1938, 1,344 carats. Judging from the statistics of the Indian Government, the output of the Kashmir sapphire mines was probably less than 10,000 carats in 1938.

In 1938 gems valued at £2,166 were sold from the Anakie (Queensland) sapphire field (£1,410 in 1937). First blues comprised three-fourths of the sales; other sapphires (green and yellow) and zircons were not in demand. Production came from Rubyvale, Reid's Water Hole, and Mt. Laura. In 1939 a new field is said to have been discovered about 6 miles west of Rubyvale, central Queensland. A 412-carat emerald-green sapphire is reported among the finds. No gem sapphires were produced in New South Wales in 1938, but 132 ounces of industrial stones were produced at Sapphire.

At Mtito Andei, Kenya, patches of fine blue sapphire are found in crystalline corundum, encountered in working asbestos. Several small parcels of sapphires have been shipped.

LESSER GEMS

The Smithsonian Institution put on exhibition a huge topaz weighing 153 pounds, or about 350,000 carats, in 1939. It is pale blue, with a sherry-color interior. The Harvard University Mineralogical Museum also added to its collection a large white topaz weighing 225 pounds. Late in the year the American Museum of Natural History, New York, obtained an even larger topaz weighing 596 pounds. All three crystals came from Minas Geraes, Brazil.

In 1937 the output of aquamarine at Daso, Kashmir, was 6,260 carats (no output in 1935 and 1936).

The total value of the opal production of New South Wales to December 31, 1938, has been £1,627,021. The 1938 output was valued at £4,226 (1937, £3,357); Lightning Ridge produced stones valued at £4,132, Grawin £50, and White Cliff £44. No production was reported from Queensland in 1938.

In 1930 a deposit of lapis lazuli was discovered by G. L. Judin at Ovalle, Pamir Mountains, Badakhshan. Like similar occurrences, it is a contact-metamorphic deposit in marble.

The Katanga copper deposits are the most important present-day producers of malachite. The material is used in cheap jewelry and objets d'art. Recent sales are as follows: 1937, 3½ tons; 1938, 2½ tons; and 1939, 1½ tons.

A little turquoise is produced in northern Baja California, Mexico, not far from Ensenada.

The amber mines at Palmnicken, Samland, Prussia, produced 400 metric tons of amber in 1938 (1937, 328 metric tons). Amber is used as an ornament, and considerable amber oil and amber acid are distilled, as they are employed in the German dye and varnish industries. In 1938 Germany exported 16,400 kilos of amber valued at 229,000 reichsmarks. Most of the amber goes to Danzig for processing and reexport, the major trade being with the Balkan States and the Orient. In Germany the use of amber "German gold" has been increased by nationalistic propaganda and the difficulty of buying other types of jewelry. Laws forbid the sale of imitation amber and synthetic resins resembling it in Germany.

Some gem prospecting is being done in the Grenville limestone near Laurel, Quebec. Clear pale-lilac diopside and honey-yellow vesuvianite occurences may have some gem value. Previously minute blue sapphires were found at Kilmar. As Frank D. Adams has pointed out, the geology of the Laurentian rocks is similar to that of the gem-bearing rocks of Ceylon, but owing to recent glaciations there is no concentration of the gems in stream gravels.

The mining and cutting of jet at Whitby, England, was an important industry 75 years ago. Today, only a few score of people are engaged in it. The present war may revive the trade.

In 1938 Brazil exported 746,872 kilos of rock crystal, 2½ times the average for the preceding 14 years (*see* bibliography, Winslow, Rollin R., Quartz Crystal (Brazil)). Japan in particular, Great Britain, Germany, and to a smaller extent the United States are the principal purchasers. The best-quality crystals are sent to the United States for use in scientific instruments. Bahia is the principal producer, followed by Minas Geraes and Goyaz. The crystal occurs in pegmatite dikes or in detrital or placer deposits derived from them. Mining methods are primitive and usually are carried on by "garimpuros," locally called "crystalleiros"; the open pits are rarely more than 5 meters deep. Most of the exporting firms have their own buyers in Brazil. Rough crystal is worth \$0.15 to \$18.50 per kilo, according to quality. Reserves of crystal are reported to be large. Optical quartz has been discovered recently in the Mtito Andei district, Kenya.

No other gem except the diamond has a wider variety of industrial uses than rock crystal. It is employed for oscillators in radio transmitters; for quartz-plate resonators at cable and long-distance telephone terminals; and for quartz plates in sound-detecting and sound-locating devices of various sorts and in detonator measurers. Quartz is also the basis of fused quartz employed as tubes, flasks, and fibers for precision instruments. It is used widely in the optical trade, in moderate-priced jewelry and objcts d'art, in quartz lamps, and as an abrasive. A glass developed in 1939 by the Corning Glass Works may decrease the use of fused quartz. In December the United States Treasury Department bought 14,800 pounds of Brazilian crystals under its strategic-materials buying program. The price was \$98,875, or \$6.68 per pound.

San Luis and Mendoza Provinces, Argentina, produced, respectively, 325 and 270 metric tons of greenish yellow translucent marble ("onyx") suitable for decorative purposes in 1937. The United States is the principal purchaser; the rough material is worth \$140 to \$230 per ton. To obviate flaws, the blocks are cut by hand with chisels, no percussion drills or powder being used. The "onyx" deposits at El Marmol, Baja California, Mexico, produce from 3,000 to 25,000 cubic feet a year. The product is trucked to Santa Catarina, whence it is shipped to the United States.

In 1938 Madagascar exported 453,638.037 kilos of gems and industrial stones. Beryl, tourmaline, colored topaz, opal, sapphire, ruby, garnet, and spodumene totaled 6.81 kilos; feldspar, scapolite, amethyst, and other lesser gems, 263.544 kilos; opaque beryl and garnet, 328,979.208 kilos; rock crystal, 4,693.625 kilos; rose quartz, amazonstone, etc., 6,249 kilos; and industrial rock crystal, 111.763 kilos. France was the principal purchaser, although Germany purchased the finer rock crystal and Switzerland and England certain grades of stones.

There were four producers of precious stones in South-West Africa in 1938. The following table gives productions and exports for 1937, 1938, and the first quarter of 1939.

Production and exports of precious stones in South-West Africa, 1937–38 and first quarter of 1939

	Production			Exports		
	1937	1938	1939 (first quarter)	1937	1938	1939 (first quarter)
Semiprecious stones:						
Aquamarine............grams..	4,970	270	2,000	4,350	200	....
Chalcedony............do....	....	....	....	119,000	70,000	....
Rose quartz............do....	....	....	6,720	54,786	9,720	....
Topaz............do....	4,000	500	....	3,000	1,000	70
Tourmaline............do....	37,795	26,248	4,300	507,851	59,508	10,666
Iceland spar............pounds..	873	3,630	250	309	24	....

Germany buys virtually the entire output of aquamarine.

With the possible exception of Ceylon, Brazil is the most important producer of the lesser gems, but figures on its 1939 production are not at hand.

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GEM STONES

By Sidney H. Ball[1]

SUMMARY OUTLINE

The jewelry industry in 1940.—Retail sales of jewelry in 1940 totaled about $416,000,000—a 15-percent increase over sales of $361,564,000 in 1939, as reported by the Bureau of the Census. They were the most satisfactory since 1929, but the quantity sold exceeded that in 1929, as jewelry prices today are below those of that year. In 1939, 14,558 retail jewelry stores were operating in the United States. The Retail Business Census shows that in 1929, $1.11 out of the consumer's $100.00 was spent for jewelry, contrasted with only $0.86 in 1939. As compared to 1939, Michigan, Washington, Oregon, and Texas showed notable advance in retail sales in 1940. The gains were due largely to the increased sale of relatively inexpensive items, and although some high-priced articles were sold a colorless stock market exercised a restricting influence, particularly in New York. The volume of Christmas trade was at least 25 percent above that in 1939. Diamonds and watches were the leading items; sales of the former were augmented by the large number of engagement and wedding rings bought, especially after the passage of the Selective Service Act.

Jewelry manufacturers were unusually busy from May on, and overtime was common. The industry experienced some labor difficulties in 1940, the principal issue being the closed shop.

Retailers evidently believe wholeheartedly in the future of their trade. Tiffany's moved, for the fifth time in the 103 years of the corporation's life, to commodious quarters at 5th Avenue and 57th Street, New York City; two other important Fifth Avenue retailers thoroughly remodeled their stores; and, late in the year, at least two internationally known French jewelry houses opened shops on Fifth Avenue.

Fashions in jewels.—Colorful jewelry in large units characterized the 1940 mode. Gold, often in two or three colors, was more popular than platinum, although the latter was used in the finer diamond mountings. Patriotic, geometric, conventionalized floral, astronomic,

[1] Figures on imports compiled by M. B. Price, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

animalic (some few attractive), Egyptian, and East Indian motifs were seen. Styles were striking and individual. Jewelry ensembles set with similar stones continued to gain popularity, as did large pieces divisible into several ornaments. An abundance of bracelets and necklaces, hair ornaments (including tiaras), clips, rings, and earrings were worn. Wealthy refugee women wear their jewels, and American women are not to be outdone.

Large diamonds and colored gems set pavé with small diamonds were popular; but in the fall, the high price of small cut (owing to destruction of the cutting industry in the Low Countries) forced new styles requiring fewer melee. The finer gems—including the diamond (including fine yellow and some coffee-colored stones), ruby, and sapphire (not only blue but yellow)—were particularly popular, while the emerald was less so. The less-valuable colored stones—star sapphires, moonstone, and topaz, and, to a smaller extent, aquamarine and amethyst—were likewise much used. The appreciation of and demand for colored stones almost unknown to the earlier generation is evidence of the increasing knowledge of precious stones among the American people. Because of the insistent demand for diamonds, colorless stones were most popular; red, blue, green, and yellow stones followed in order.

Costume jewelry.—No costume is now considered complete without real or imitation jewelry, which is being used more and more. The black gowns so prevalent today form an excellent background for "gold" pins, clips, necklaces, and bracelets. The sales of costume jewelry in 1940 increased substantially, probably to a greater extent than sales of real jewelry. Designs are improving and either follow the lead of jewelry designers or in some instances precede them. Many foreign sources of supply were cut off by the war, but American industry has successfully made up the deficit. Plastics are effectively used, and lucite beads are a fair substitute for satin spar. The manufacture of costume jewelry centers in New York. The value at the factory of costume jewelry produced in 1939 was $33,921,990 (1937, $29,928,567), and over 12,000 people were employed in the industry.

Domestic production.—From the 1909 peak output of gem stones valued at $534,280, the domestic industry dwindled to only $3,000 in 1934. Since then production has increased markedly and in 1940 was valued at $340,000 to $750,000; the first figure is a rough estimate of the amount used in jewelry and the second an estimate of the total, including that treasured by collectors or sold to tourists, collectors, and rock gardeners. The rise is due largely to the growth of lapidary work as a hobby (particularly in the Pacific Northwest and notably in Oregon and Washington). Stones of the agate family comprise about 87 percent of the amount used in jewelry. Gems are produced largely by individuals or partnerships, and as there are no official returns exact figures are not available.

The war has shut off, at least in part, the country's normal sources of supply of colored gems; their place, to some extent, has been taken by gems of American origin.

In the Northwest, especially in Oregon (according to correspondence with H. C. Dake) mineral collectors and lapidaries, both professional and amateur, continue to increase. He estimates the value of the material (largely quartz minerals) collected and cut in 1940 as follows: Oregon (professional lapidaries—$150,000, amateurs—$225,000);

Washington, \$140,000; and Idaho, \$47,000—a total of \$562,000. A new agate-producing district in Harney County, Oreg., an opalized-wood locality in central Washington, nephrite in place in an aplite dike near Split Rock, Fremont County, Wyo., and nephrite boulders about 48 miles southeast of Lander, Wyo., are reported. Miss M. Barrie Berryman states that there are some 50 professional and amateur lapidaries in Utah; she estimates the total value of the rough and cut gems and mineral specimens produced in the State as \$25,000 in 1940 compared with \$8,000 in 1939.

With the exception of quartz gemstones, turquoise leads in total value—about \$20,000; Nevada ranks first in output and Colorado second. The Fox turquoise mine near Cortez, Lander County, Nev., produced 7,928 pounds of rough turquoise; of this the more desirable material was sold for \$11,405. The Tonopah district and mines at Austin, Nev., also produced some turquoise, as did the turquoise mine in the San Luis Valley near Villagrove, Colo. A little is reported to have been produced in New Mexico, and some Arizona turquoise was sold, although little or no mining was done in 1940. Sales of turquoise jewelry in the southwestern curio shops were large.

Arthur L. Crawford reported that three localities in Utah (5 miles west of Fairfield, Utah County; 9½ miles south of Grantsville, Tooele County; and 25 miles north of Lucin, Box Elder County) produced variscite in 1940, and the mineral was also discovered near Promontory Point, Box Elder County.

In 1940 Montana produced about 12,350 troy ounces of sapphires (1,029 pounds) valued at about \$17,000. The principal producers were the American Gem Mines at Philipsburg, owned by Charles H. Carp and J. W. Kaiser, and the Perry-Schroeder Mining Co. of Helena, dredge operators. The stones are used industrially, as few are suitable for jewelry. As difficulty is likely to arise in obtaining synthetic sapphires and rubies from Europe, Montana sapphire mining may well become an important cog in our national defense program, because jewels are essential in many instruments necessary for military purposes.

Austin F. Rogers [2] describes nephrite recently found in the western part of the Santa Lucia Range, southern Monterey County, Calif. It occurs not only in large and small boulders but also in place in serpentine in a region of Franciscan rocks. The nephrite ranges from light greenish gray to black in color, and some of it is suitable for cutting. According to reports, californite (a compact vesuvianite used as a substitute for jade) is being mined by the Curly Jack Mining Corporation on the South Fork of Indian Creek near Happy Camp, Siskiyou County, Calif.

Three operators produced tourmaline, kunzite, beryl, and rock crystal valued at about \$2,400 from the well-known gem-stone deposits of San Diego County, Calif.

In 1940 a number of mineral collectors visited Topaz Mountain in the Thomas Range, Juab County, Utah, according to Miss Berryman. By blasting they collected a quantity of sherry-color topaz, which had been bleached water-white at the surface. When cut this material forms attractive gems readily sold locally.

A considerable amount of moss agate was recovered from the gravels of the Yellowstone River in southeastern Montana. This

[2] Rogers, Austin F., Nephrite Jade from Monterey County, Calif.: Bull. Geol. Soc. America, vol. 51, No. 12, pt. 2, December 1940, p. 1941.

source has long furnished beautiful moss agate for jewelry, but fine material is becoming scarce. The deposit in the Granite Hills near Split Rock, Wyo., also supplied considerable moss agate, and some was produced in other Mountain States.

A few Sioux still dig pipestone at Pipestone, Minn., and cut it into pipes or ornaments for their own use or for sale.

In the fall of 1939 Carl M. Anderson found a deposit of lapis lazuli, some of rather fine quality, at an elevation of 12,500 feet on the slope of Italian Mountain, Gunnison County, Colo. The lapis occurs as three stringers in Paleozoic metamorphic limestone intruded by diorite, which reach a maximum width of 7 or 8 inches and are traceable for about 300 feet. Harold I. Rosencrans, a Longmont jeweler, controls the deposit, cuts the lapis, and sold some in the East and set the remainder in Indian-style silver jewelry for distribution in the West.

Some gem stones were produced as a byproduct of North Carolina feldspar and mica mining; C. C. West operated a ruby property near West Mills, Macon County, and sold the product to the tourist trade. A number of lapidaries also cut for sale to tourists.

A small amount of rose quartz was produced at Scott's mine near Custer, S. Dak. The total recorded production of rose quartz in the Black Hills from 1879 to date has been valued at about $55,000. A small amount was also produced at Albany, Maine, and asteriated rose quartz in North Carolina.

Other gem stones produced in the United States in 1940 included agate (Utah, South Dakota, New Mexico); agatized wood (private lands surrounding Petrified National Monument, Ariz., New Mexico, Utah); alabaster (New Mexico, Utah, Wyoming); amazonstone (Colorado); amethyst (Red Feather Lakes, Larimer County, Colo., Georgia, Maine, North Carolina); aquamarine (Colorado, Maine, North Carolina); azurite (Bingham, Utah); chalcedony (Utah); emerald matrix (North Carolina); garnet (Colorado, New Mexico, North Carolina); golden beryl (North Carolina); jasper (California, New Mexico, North Carolina, Utah); lazulite (Clubbs Mountain, N. C.); malachite (Bingham, Utah); moonstone (North Carolina); rock crystal (Arkansas); iridescent obsidian (California); rhodonite (Utah); rutilated quartz (North Carolina); topaz (Colorado, Maine, North Carolina); pink sapphire (Georgia); and tourmaline (Maine).

Imports.—Imports of precious and imitation stones (exclusive of industrial diamonds) into the United States in 1940 totaled $37,767,705—a 6.7-percent decrease as compared with 1939. Details are shown as follows:

	Carats	Value
Diamonds:		
Rough or uncut (suitable for cutting into gem stones), duty free	227,886	$11,595,703
Cut but unset, suitable for jewelry, dutiable:		
Less than 10 stones per carat	54,005	5,457,151
10 or more stones per carat	267,466	16,544,568
Emeralds:		
Rough or uncut, free	14,364	6,915
Cut but unset, dutiable	16,093	394,104
Pearls and parts, not strung or set, dutiable:		
Natural		224,101
Cultured or cultivated		355,595

	Value
Other precious and semiprecious stones:	
Rough or uncut, free	$153, 858
Cut but unset, dutiable	2, 191, 513
Imitation, except opaque, dutiable:	
Not cut or faceted	4, 127
Cut or faceted:	
Synthetic	359, 672
Other	423, 344
Imitation, opaque, including imitation pearls, dutiable	32, 193
Marcasites, dutiable:	
Real	6, 790
Imitation	18, 071
	37, 767, 705

As compared with 1939 imports of rough diamonds, other precious and semiprecious stones, cultured and imitation pearls, and synthetic gems increased whereas imports of cut diamonds, uncut emeralds, natural pearls, and marcasites decreased. The number of watch jewels imported in 1940 totaled 98,771,042 valued at $1,831,007 compared with 43,712,840 valued at $913,245 in 1939.

Government regulations.—Owing to the war, Government regulations affecting the jewelry trade were legion in 1940. By Presidential proclamation, effective July 5, 1940, as a result of the Sheppard-May Bill, a license was required to export industrial diamonds and quartz crystals, and on December 20, 1940, the order was amplified to include all products that contain them.

The British embargo on the export of diamonds (to prevent industrial diamonds from reaching the enemy) promulgated at the beginning of the war is effective, except for a major leak of Brazilian stones to Germany. In 1940 the order was amended several times to increase the control of industrial diamonds. As of July 1, 1940, diamonds, precious stones, and jewelry were permitted to be carried out of Great Britain by license only to prevent the export of capital. Customs officials at British ports require the presentation of a license for all jewelry worn by travelers, even wedding rings if they appear to be new. The budget of July 1940 increased the British tax on jewelry to 33⅓ percent of the wholesale value.

Canada has classified industrial diamonds and piezoelectric quartz crystals as of indirect strategic value. To keep cash within the Dominion, in December 1940 Canada prohibited the importation of jewelry and uncut diamonds from the United States and placed a 25-percent excise tax on the sale of luxury articles. Canada was formerly this country's most important foreign market for jewelry. Severe regulations exist regarding the sale of military emblems that might be mistaken for official insignia.

In May the Union of South Africa decreed that all shipments of rough diamonds can thereafter be addressed and delivered only to parties in London.

For the period July-December 1940 New Zealand cut imports of precious stones from the United Kingdom and its Crown colonies by 75 percent. The export of precious stones, unset or in jewelry, from Australia is prohibited, except by consent of the Minister for Trade and Customs.

On June 3, 1940, France decreed that cut precious stones and jewelry could not be exported from the country; previous decrees had covered the export of rough stones.

In May 1940 Germany prohibited the sale in the Reich of gold objects weighing more than 50 grams (1.6 ounces) or of more than 14 carats gold content. Early in 1940 Hebrews in Bohemia and Moravia were required to register with the Government all precious stones and articles made of precious metals. In Occupied France the German military authorities required inspection of all private safety deposit boxes and official listing before January 10, 1941, of the gold and precious stones they contained.

Early in 1940 Japan appealed to its citizens to sell or give their gold jewelry to the Government. In June the sale of watches costing more than $12 and the manufacture and sale of rings and necklaces were prohibited. Stocks of such articles in stores were to be liquidated within 3 months. The export of gold, even that in one's teeth, is reported to be dutiable upon leaving Japan.

On March 24, 1940, French Indochina required all shipments of imitation precious stones imported into the colony to show clearly the country of origin. Many of the zircons cut in Bangkok, Siam, originate in Indochina and are smuggled across the border. To control the trade, the Indochinese Government on June 12, 1940, decreed (1) that only the Kha people could dig the gems; (2) that only licensed buyers could purchase them; and, (3) that buyers and lapidaries must keep an accurate and detailed account of the stones bought and sold.

On July 22, 1940, Switzerland placed the control of industrial diamonds under its War Industries and Labor Office, to regulate sales and insure more equitable distribution of the supply on hand.

On February 8, 1941, President Getulio Vargas of Brazil issued a decree prohibiting the export of 35 minerals (including industrial diamonds and rock crystal) without an export permit, except to American nations. Exports to Japan, either for Japanese consumption or for reexport, were relatively large in 1940.

Industrial gem stones and national defense.—Certain gem stones are essential to the United States armament program. Industrial diamonds are one of the critical [3] minerals being stocked by the Government to insure rapid and efficient motor- and airplane-engine production. Lapidaries should be trained to produce the smaller-gage diamond dies. As of June 30, 1940, the Procurement Division of the United States Treasury had purchased 11,800 pounds of rock crystal for $98,875, and early in 1941 it bought Brazilian industrial diamonds valued at $100,000. Piezoelectric quartz from Brazil is necessary in the manufacture of certain types of radios, telephones, telegraph instruments, and cables. Rock crystal is also essential for the lenses and prisms widely used in optical instruments and when fused is employed in the chemical and electrical trades. Limited quantities of fine fluorspar, also utilized in optical instruments, can be obtained in the Illinois-Kentucky fluorspar district, and a synthetic substitute is said to be satisfactory. Iceland spar is essential for Nicol prisms. A deposit found recently in the Copper Mountain mining district 30 miles southwest of Taos, N. Mex., promises to replace in the American optical industry the spar formerly imported from Helgustadir, Iceland. Tourmaline is used in the tourmaline tongs (a simple form of polariscope) and might have other value in military instruments. Watch

[3] Considered "critical" by the Army and Navy Munitions Board for purposes of procurement under the Reconstruction Finance Corporation.

and instrument jewels, essential for airplane instruments and time bombs, are normally cut in Switzerland from European-made synthetic sapphire. An adequate domestic supply of raw material is available in the Montana sapphire mines, but lapidaries should be trained in this country to cut the jewels.

Effect of war on jewelry trade.—The jewelry industry continues to feel the effects of war. Destruction of the cutting industry in the Low Countries doubled or even quadrupled the price of small-cut diamonds. The price of fine large stones, however, only increased about 20 percent, inasmuch as such goods can be profitably cut in this country, England, and South Africa. For the present prices should be firm, with possible increases in large-cut stones later. The limited supply of small-cut stones in this country will result in fashion changes, and pavé settings will be replaced by "sec" mountings (large stones set with a minimum of small stones).

The British embargo on the export of uncut gem and industrial diamonds has been administered broadly; in consequence, imports into the United States have been unusually large. New York has increased in importance as a diamond center but can scarcely, as some claim, become the locale of the world cutting industry.

The fine-precious-stone industry, with its center—Paris—in the hands of the Germans, has been in chaos; imports into the United States have been more or less normal, and although prices are firm no great increase is expected, as stocks in the United States are adequate. For the duration of the war India will be a more important—and Paris a much less important—center of fine-gem trading.

Most of the less-valuable stones were cut in Germany, Czechoslovakia, and France, and before the war the United States imported synthetic stones from Germany, France, and Switzerland. The stocks of the less-valuable stones were normal when war broke, but since then they have been replenished but meagerly; in consequence, shortages of certain stones already have occurred. Stocks of synthetic stones suitable for jewelry are not large.

An alleged shortage of iridium (used as an alloy in jewelry platinum) caused a marked increase in price in 1940 (from $175 to $275 an ounce), although the price of platinum itself was stable. The war can only increase the cost of most jewelry items.

DIAMOND

Notwithstanding world conditions the diamond industry in 1940 had a relatively satisfactory year. Production increased in total weight but decreased in total value. Total sales of rough stones by the Diamond Trading Co. were about the same as in 1939, but the war has largely limited retail purchases (with the exception of clandestine investment buying) to the American continents, India, and the East Indies. The invasion of the Low Countries disrupted the cutting industry. The Germans have the men, equipment, and plants but little rough stock; Great Britain has the stocks; and Great Britain and powers friendly to it have a few cutters of large stones.

Share dealings.—The shares of diamond-mining companies, virtually all of which are listed on the London Stock Exchange, had a limited and at times a nominal market in 1940. After a short spurt quotations declined until the French debacle in June, by which time they had been reduced almost 50 percent; prices then seesawed for 3 months and afterward rose rather sharply. During the year five representative stocks lost about 8 percent—better performance than that of most British and American stocks. At the end of the year quotations were 29 percent of their high (1927) and 285 percent of their low. Of the 11 leading diamond-mining companies, 8 paid dividends.

Market.—In 1940 the Diamond Trading Co., which controls the sale of about 95 percent of the world output of diamonds, sold rough stones valued at about £6,000,000. For the first 4 months of the year sales were large and reminiscent of the prosperous twenties. But with invasion of the Low Countries trade fell off markedly, and America remained the chief customer. Industrial diamonds were, however, sold in quantity throughout the year.

Sales of polished diamonds were also large until May, and during January and February small cut stones were in marked demand. After May, the United States was practically the only buyer of importance and since then has been building up its stock of small cut stones. Retail sales in the United States increased compared with those in 1939.

Stocks of rough stones held by the Diamond Corporation are large, although they include few fine, large gems. Stocks of rough gem-grade diamonds in the United States are believed to be adequate, but stocks of industrial grades are less so. Stocks of large cut stones are adequate; those of small cut stones are inadequate, and unless the latter can be replenished, jewelry styles must change.

Imports.—Diamond imports into the United States in 1940 by countries were as follows:

Diamonds imported into the United States in 1940, by countries

[Exclusive of industrial diamonds]

Country	Rough or uncut			Cut but not set		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
Belgium				242,326	$15,137,583	$62.47
Brazil	3,436	$322,773	$93.94	1,612	140,058	86.88
Cuba				131	10,884	83.08
France				6,487	582,519	89.80
Mexico				40	3,465	86.63
Netherlands				34,309	2,306,740	67.23
Netherlands Indies	1,789	45,423	25.39	501	18,593	37.11
Palestine				1,123	92,318	82.21
Peru				18	933	51.83
Switzerland				995	87,894	88.34
Union of South Africa	222,615	11,222,372	50.41	24,571	2,827,942	115.09
U. S. S. R.				1,017	39,986	39.32
United Kingdom				8,341	752,804	90.25
Venezuela	46	5,135	111.63			
	227,886	11,595,703	50.88	321,471	22,001,719	68.44

Cutting.—The cutting industry was normal for the first 4 months of the year, but when the Germans invaded the Low Countries in May the centers of 90 percent of the industry became wholly disorganized. America, the principal market, must now depend on the 450 cutters in the United States, 300 in South Africa, and 200 in England to supply its needs, as Brazil, Borneo, India, and Palestine cater largely to local and Eastern markets. The cutters in the first three countries are paid such high wages that small stones cannot be cut profitably. Recent increases in America (the minimum weekly wage rose from $75 to $120) must increase prices; however, some observers claim that if the industry is mechanized further the United States can profitably cut small diamonds.

World production.—Owing to the war, actual production figures are not available but the estimates in the following table are believed to be fairly accurate. World production (gem and industrial) in 1940 is estimated to have been 14,140,200 carats (2.828 metric tons) valued at about $31,000,000—an all-time record as to quantity. Compared with 1939 total weight increased 13 percent; value decreased 24 percent. In other words, the production of bort increased markedly and that of gem stones decreased by about 22 percent. Belgian Congo was the leading world producer both in weight (77 percent) and in total value (24 percent). As only one pipe mine was operated—and that for but 8 months—the alluvial mines produced 96 percent of the world total by weight and 91 percent by value. Of the world total the British Empire produced 14 percent by weight and 37 percent by value. Industrials comprised 85 percent by weight of the world total.

The following table shows, as accurately as available statistics permit, world production for the past 5 years:

World production of diamonds, 1936–40, by countries, in metric carats

[Including industrial diamonds]

Country	1936	1937	1938	1939	1940
Africa:					
Angola	577,531	626,424	651,265	690,447	[1] 785,000
Belgian Congo	4,634,266	4,925,228	7,205,620	8,344,765	[1] 10,900,000
French Equatorial Africa	1,550	5,588	19,644	[1] 16,000	[1] 16,000
French West Africa	18,897	57,687	61,928	56,314	[1] 75,000
Gold Coast (exports)	1,414,677	1,577,661	1,296,763	1,087,652	[1] 825,000
Sierra Leone	616,200	913,401	689,621	[1] 600,000	[1] 600,000
South-West Africa	184,917	196,803	154,856	36,010	30,017
Tanganyika	2,704	3,234	3,576	3,445	[1] 2,250
Union of South Africa:					
Mines	339,719	820,284	979,460	[3] 1,089,144	[1] 351,400
Alluvial	284,204	207,859	259,148	160,684	[1] 172,000
Total Union of South Africa	623,923	[3] 1,030,434	1,238,608	[2] 1,249,828	[1] 523,400
Brazil	136,462	192,000	111,257	[1] 350,000	[1] 325,000
British Guiana	41,067	35,958	32,522	32,491	26,764
Other countries [4]	6,000	6,000	34,200	19,000	[1] 31,750
	8,258,200	9,570,400	11,499,900	12,486,000	14,140,200

[1] Estimated.
[2] Includes 1,009 metric carats recovered by debris washers.
[3] Includes 2,791 metric carats recovered from re-treatment of tailings.
[4] 1935: Borneo, India, Nigeria, and Venezuela; 1936: Borneo, India, New South Wales, Rhodesia, United States (California), and Venezuela; 1937: Borneo, India, Liberia, New South Wales, Rhodesia, and Venezuela; 1938–40: Borneo, India, New South Wales, U. S. S. R., and Venezuela.

The Belgian Congo increased its output, particularly from the Beceka mines, which produce mainly bort. Angola also increased its yield about 14 percent. The Gold Coast curtailed production drastically, and the pipe-mine output was about 37 percent of that in 1939. Venezuela—a minor producer— is increasing its output.

Age of African diamond deposits.—The more famous of the African diamond fields (South African kimberlite pipes) are of Cretaceous age. South African alluvial deposits and those of South-West Africa are derived from the break-down of such pipes. The Tanganyika pipes are contemporaneous, as are the noncommercial Belgian Congo pipes; strangely enough, the Arkansas kimberlite intrusives are approximately of the same age.

The Belgian Congo-Angola diamonds are known to be older than the Jura-Triassic and are presumably of pre-Cambrian age. Junner [3] believes that the Gold Coast deposits are also of pre-Cambrian age, and diamonds have been recovered from the clean-up of the Ashanti-Adowsena gold mine, whose ore bodies occur in the Banket series (Tarkwaian quartzites of pre-Cambrian age). An occasional diamond is found in the gold mines on the Witwatersrand, where the gold deposits also occur in pre-Cambrian rocks. The important Sierra Leone deposits and those of the French African colonies are likewise presumably of pre-Cambrian age.

In normal years the value of the production from the Cretaceous and pre-Cambrian deposits is more or less comparable; in 1940, owing to the small amount of activity in pipe mining, the older deposits represented 96 percent by weight and 72 percent by value of that part of the world production that can be allocated to deposits of these two types.

Industrial diamonds.—In 1940 American industries, working under the stress of the defense program, consumed more diamonds than ever, probably in excess of 2,000,000 carats, and in European munition plants the increased use was equally great. In the past 30 years the use of industrial diamonds has increased eightfold, and a decade hence the diamond mines of the world may have difficulty in satisfying the world demand. Industrial diamonds are one of the critical war materials to be stocked by the Procurement Division of the Treasury. During the last 2 years the American trade has accumulated a stock of industrial stones that may be adequate for 1 year's consumption. Naturally such a small stock is wholly inadequate for a highly industrialized country lacking local sources of supply. Features of the trade in 1940 were (1) the further expansion of the use of diamond-impregnated wheels and tools with a powdered-metal bond, (2) the increased use of mechanically set drill bits studded with small stones, and (3) the tendency to replace cleavages by fine crystals in diamond dies.

Throughout 1940 the demand for industrial diamonds was strong because of the high rate of industrial activity in the United States and in Great Britain. Prices were firm, with an upward trend.

Imports of industrial diamonds into the United States during the past 5 years were as follows:

Industrial diamonds (glaziers', engravers', and miners') imported into the United States, 1936–40

Year	Carats	Value		Year	Carats	Value	
		Total	Average			Total	Average
1936	1,166,094	$4,328,603	$3.71	1939	3,568,730	$9,725,683	$2.73
1937	1,885,970	6,542,365	3.47	1940	3,809,071	11,026,563	2.89
1938	1,396,247	4,213,412	3.02				

Imports from Brazil increased markedly and caused an advance of 16 cents a carat in the average value.

[3] Junner, N. R., Origin of Gold Coast Diamonds: Gold Coast Colony Report of Geol. Survey Dept. for financial year 1937–38, p. 6.

RUBY, SAPPHIRE, AND EMERALD

Sales of rubies, sapphires, and emeralds and of less-expensive colored gems were large in 1940. Particolored sapphires were popular, and one New York jeweler combined Montana sapphires and yellow gold attractively.

After the Burma Ruby Mines, Ltd., abandoned operations in 1931 local Burmese miners continued them. The production rose markedly from 1934 to 1937 (21,622 carats of rubies valued at £2,708 and 153 carats of sapphires valued at £25 in 1934 to 157,308 carats £6,841, and 4,392 carats, £228, in 1937, respectively). There was a further increase in 1938. A few spinels are a byproduct.

In 1939 the Anakie (Queensland) industry sold sapphires valued at £326; production was somewhat greater, as appreciable quantities of fancy stones and industrial corundum were exported but not sold.

The Kashmir sapphire output was nominally 18,344 carats valued at £41 in 1937 and 4,892 carats, £11 in 1938. Owing to its high altitude this deposit (at Soomjam in the Pedar district) can be worked only when the weather is favorable.

After 25 years of Indochinese sovereignty the sapphire deposits of Pailin were reincorporated into Thailand (Siam) toward the close of 1940.

In 1940 the United States imported 16,093 carats of cut emeralds valued at $394,104 (United Kingdom 58 percent, Russia 20 percent, Colombia 13 percent, France 2 percent, and Belgium 1 percent) and 14,364 carats of rough emeralds valued at $6,915. The Chivor Emerald Mines, Ltd., Colombia, was operated under lease in 1940, and some good material is reported to have been found. Dr. Thomas Clements (see following bibliography) considers that the Muzo (Colombia) emeralds were deposited by magmatic waters at relatively low temperatures. Although the mine has been closed since January 1, 1939, Dr. Clements states that the deposit is not exhausted, and he believes that there may be other deposits in the vicinity. Government reports indicate that emerald stocks valued at about $400,000 are in the Banco de la República. Brazil exports a few light-color emeralds obtained in the States of Minas Gerais and Bahia.

LESSER GEMS

A little opal was produced at Sheep Creek Station, Queensland, in 1939, but operations at Duck Creek were at a standstill.

Burma produced 1,303 hundredweight of jadeite valued at £4,320 in 1938 and 2,952 hundredweight valued at £13,030 in 1937; the cause of the decrease was attributed to the war in China.

Production of amber in Palmnicken, Prussia, increased consistently from 1936 to 1939 (estimated exports for 1939 were 26,860 kilograms valued at 138,000 reichsmarks); most of this output was shipped to Danzig for processing and re-export. The Myitkynia district produced 38.7 hundredweight of amber valued at £668 in 1937, but no production was recorded in 1938.

A rock crystal weighing 4,400 pounds and valued at $25,000 was found at Itamarandiba, Brazil, in 1940. The Swedish Geological Survey reports the discovery of rock crystal in the Province of Jamtland, northern Sweden. Preliminary tests suggest that this find may supply Sweden's small demand for piezoelectric rock crystal formerly obtained from Brazil.

Kornerupine of gem quality is reported to have been identified in concentrate from gem pits at Ratnapura, Ceylon.

Dr. A. L. Parsons reports that a little iolite was produced from the Great Slave Lake region, Canada. Some attractive gems have been cut from the material.

Agalmatolite is exploited on a small scale at the large deposit near Para de Minas, Minas Gerais, Brazil; it is used for church construction, ornamental purposes, and sculpture.

In 1939 Turkey produced less meerschaum than in 1938 (335 cases compared with 385 in 1938).

In the first half of 1940 Brazil exported 1,754,745 carats of gem stones—virtually all to the United States. Bahia and Rio de Janeiro were the principal shipping points.

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GEM STONES

By Sydney H. Ball

SUMMARY OUTLINE

JEWELRY INDUSTRY IN 1941

Retail sales by jewelry stores in the United States totaled about $526,000,000 in 1941, a 30-percent increase over 1940 (when sales totaled about $405,000,000) and within 2 percent of those in 1929. An additional 18 to 24 percent was sold by department stores.

Arkansas, Connecticut, and Indiana showed notable advances over 1940 in retail sales. Again, as in 1940, gains were due mainly to larger turn-over of relatively inexpensive items, and sales of high-priced articles were the exception. This can be explained, in New York at least, by the colorless stock market.

The jewelry trade had two "Christmases"—the first late in September, when taxwise buyers bought heavily to avoid the 10-percent excise tax, and the real Christmas. During both periods the buying rate was higher than at any corresponding time since 1929. Some expensive articles were sold during both buying seasons, and certain of these, strangely enough, were purchased by European refugees. In 1941 the gain in sales may have been in part a hedge against inflation, that is, investment buying; but furthermore, compared with 1940 the Nation's income had risen from about $72,000,000,000 to about $92,000,000,000. Sales were also increased by an all-time record number of marriages (1,565,000), over 16 percent above those in 1940, which had been the banner year.

From year to year in the larger cities, a few of the better department stores are cutting into sales of retail jewelers, and it may be added that, on the average, they are handling stock of finer grade year after year.

Wholesale jewelry sales in 1941 were somewhat greater even than those of the retailers, and stocks in retail jewelry shops increased 14 percent. Manufacturers' personnel was employed full time. During the year, exports to South America, which normally obtains its jewelry supplies from Germany, were large.

The national income of Canada is also rising ($5,180,000,000 in 1940—$6,200,000,000 in 1941), and retail jewelry sales in 1941 topped those of 1940. Canadian prices have as their ceiling those of the basic period September 15–October 11, 1941. Luckily, the more important shops had fairly extensive stocks when the price order went into effect; but as the war progresses, the transfer of machinery and artisans to war work and the lack of certain materials may cause a shortage of articles, resulting in smaller retail sales.

FASHIONS IN JEWELS

Large, flamboyant jewelry characterized the mode in 1941, a year in which it was used even with sport clothes. Gold continued to be worn more than platinum, although the latter was used in the finer diamond mountings. For the first time, however, industrial consumption of platinum exceeded that of the jewelry trade. Regimental and other military insignia and the "V for Victory" pins and clips were popular, but floral decorations, grotesque animals, geometric designs, and Victorian and South American motifs were also seen. Ensembles set with similar stones and large jewelry pieces divisible into several ornaments continued in favor. Clips and lapel pins were especially popular; watches, bracelets, earrings, and necklaces were less so. Double wedding rings are gaining popularity.

The shortage of melee is decreasing the use of pavé mountings, and more and more fine gems are being set "sec." Stones, such as citrine and aquamarine, weighing up to 400 carats (over 2 ounces), were used in bracelets and pins. Diamond (including some brown stones for men), sapphire (largely blue, but also yellow and pink), and ruby were the most popular gems, followed by topaz, moonstone, emerald, aquamarine, and amethyst. Due to the insistent demand for diamonds, colorless stones were dominant, followed by blue, red, yellow, and green. For the first time in many years, yellow stones were more popular than green and were used almost as commonly as blue and red stones. Owing to wider knowledge of gem stones in the United States, some 40 varieties were used in jewelry in 1941, in contrast to the few kinds once worn.

DOMESTIC PRODUCTION

From the 1909 peak output of gem stones valued at $534,280, domestic production dwindled to only $3,000 in 1934; but since that year productior has increased progressively and markedly and in 1941 was valued at $240,000 to $770,000. The first figure is a rough estimate of the value of uncut stones used in jewelry and the second an estimate of the total value after cutting, including stones added to mineralogists' collections or sold to tourists, collectors, and rock gardeners. Of the total value, 70 percent represents members of the quartz family, 18 percent sapphires (largely used industrially), and 12 percent turquoise. The principal producing States (in approximate order of output) were Oregon, Montana, Washington, Nevada, Wyoming, and Colorado.

The interest in beautiful minerals continues to grow; the number of professional and amateur lapidaries is increasing, particularly in Oregon (largely Portland and Newport) and Washington. Dr. H. C. Dake says that in those States the shops are operating at capacity and there is a shortage of skilled labor; cabochon-cut gems are being sold to American makers of costume jewelry; and agate balance knives and mortars and pestles are being produced. Local machine shops manufacture cutting equipment, including diamond saws.

Professional gem cutters operate also in New York, Rhode Island (Providence), Maine, North Carolina, Montana, and South Dakota. Gem cutting is carried on as a hobby in many States, notably in Idaho, Wyoming, Utah, and North Carolina. Owners of precious-stone claims complain that amateur mineralogists "high-grade" the deposits in the absence of a resident watchman.

Agate and jasper are collected in quantity in Oregon and Washington, particularly on the beaches of Lincoln County, Oreg. Most of this is cut by local lapidaries, although some rough is shipped to other States. Montana continues to produce a considerable quantity of fine moss agate from the gravels of Yellowstone River in the southeastern part of the State. Wyoming also furnishes good material. Alfred M. Buranek states that Utah produced about $10,000 worth of agate in 1941. Arthur L. Crawford describes the principal varieties as jasper from the east bank of the Colorado River in Grand County; agate from 6 miles east of Cisco, Grand County; and red jasper geodes from Tidwell, Emery County. Arkansas produces considerable rock crystal from the vicinity of Hot Springs. Farmers dig most of it in the winter, but mineral dealers also mine some. Most of it is sold to tourists as curios, but some is used in jewelry. Scott's Rose Quartz Co. produced considerable rose quartz from its mine near Custer, S. Dak., and sold some for jewelry use.

In 1941, Montana produced about 3,720 troy pounds of sapphire (of which perhaps 50 percent was first-grade material), valued at some $43,000. The principal producers are American Gem Mines at Philipsburg, owned by Charles H. Carp and J. S. and R. M. Kaiser, and the Perry-Schroeder Mining Co., dredge operator of Helena. The former company operates on the West Fork of Rock Creek in Granite County, and the latter obtains its stones as a byproduct of gold-dredging Missouri River bars in Lewis and Clark County. Most of the stones are sold for industrial use; if for any reason the supply of synthetic sapphire should be inadequate to satisfy war demands for instrument jewels, Montana sapphire would have prime importance. Carl J. Trauerman (Butte Daily Post, June 3, 1941) believes that, if necessary, Montana could produce 150,000 to 200,000 ounces yearly. Besides the two localities mentioned above, production could be obtained from Brown's Gulch in Silver Bow County, Dry Cottonwood Creek in Powell County, and lode mines of Yogo Gulch.

Turquoise ranks after the quartz family and sapphire in value of production, with a total of about $28,000. Nevada ranks first in output and Colorado second. The principal producer in Nevada was the Smith mine at Cortez, operated by A. Guisti, which produced over 7,550 pounds; the material is shipped to E. C. Smith, Santa Barbara, Calif. The King mine at Manassa, Colo., had an unusually successful year, as one "pocket" alone produced almost 700 pounds of good material. Richard M. Pearl reports that W. S. Kettering of Pueblo opened up a deposit in Pueblo County, Colo., in 1941, some of the product being good gem material. Imitation turquoise is cutting somewhat into western turquoise sales.

Further data furnished by B. F. Couch, Reno, Nev., suggests that Nevada alone produced turquoise worth at least $20,000 in 1940, so that the author's estimate of $20,000 as the country's production in

1940 (Gem Stones, p. 1401, Minerals Yearbook, Review of 1940) is probably somewhat low. The chief production centers are Royston and southern Death Valley (Nye County), Battle Mountain, Cortez, and Austin (Lander County), and one deposit in Mineral County. Couch says also that in 1941 Nevada produced over 2,175 pounds of good material worth $13,775, with two producers not reporting. The Smith mine in the Bullion district, Lander County, was the chief producer, followed by mines in northern Lander County and the Royston and Beatty districts, both in Nye County.

Richard M. Pearl (see Bibliography) states that Colorado has for several years ranked second among the States as a turquoise producer, the gem stone occurring at four localities in the southwestern part of the State. The principal mines are the Hall near Villagrove and the King near Manassa; both of these deposits occur in felsite porphyry. The deposit near Leadville occurs in Silver Plume (Algonkian) granite, and turquoise near Creede occurs as stream pebbles. The turquoise of the lode deposits is believed to have been deposited by cold meteoric waters in fractures and shear zones.

Alfred M. Buranek states that about $2,000 worth of variscite was produced from the Clay Canyon deposit near Fairview, Utah. Jewelers, museums, and mineral collectors were the purchasers.

Vergil E. Barnes (North American Tektites, University of Texas Publication 3945, Austin, June 1940, pp. 477–582) describes the only tektites yet found in North America. The first of these, which have been dubbed "bediastites," was found in Grimes County in 1936, and in all 482 have been recovered. To the local residents they are known as "black diamonds," and some have been cut for jewelry. They are found in an area 10 miles long and 5 miles wide. The tektites are black and have an average specific gravity of 2.37; the largest weighed 59.4 grams. Most of them are ellipsoidal, and a few are spherical or tabular with their exterior deeply furrowed. The tektites consist dominantly of silica (73.52 to 77.76 percent) and alumina (13.3 to 15.88 percent), with low lime. Barnes considers them fulgurites.

Several hundred carats of colorless and yellowish topaz was obtained from the Tarryall Mountains, Park County, Colo. Gems up to 5 carats in weight have been cut from this material (according to a letter from R. M. Pearl). Topaz Mountain in the Thomas Range, Juab County, Utah, also produced a little topaz. Dr. H. C. Dake reports that some nephrite of gem quality was obtained from the two Wyoming localities (Fremont County and 48 miles southwest of Lander); at the first locality the material is mined from a dike, and at the second it occurs as boulders. One mass weighed 119 pounds. He states that in 1941 about 1 ton of this variety of jade was produced, the best rough material selling for $5 a pound. Alfred M. Buranek states that a little fine pyrope garnet was mined near Mexican Hat in southeastern Utah. Some was sold to prominent jewelers. Only three or four Indians worked the catlinite deposit at Pipestone, Minn., in 1941.

Other gem stones produced in the United States in 1941 included agate (Arizona, Colorado, Georgia, Montana, Oregon, South Dakota, and Utah); agatized wood (Arizona (private lands surrounding Petrified Forest National Monument) and Wyoming); alabaster (South Dakota); amazonstone (central Colorado); amethyst (Colorado, Georgia, South Carolina, LaSal Mountains and San Rafael Swell in

Utah, and near Liberty, Wash.); apatite (South Dakota); aquamarine (Colorado, Georgia, North Carolina, South Dakota, and Wyoming); azurite (northern Colorado); carnelian (Bastrop and Colorado Counties, Tex.); chalcedony (Colorado); chrysoprase (North Carolina); emerald matrix (North Carolina); epidote (Milford, Utah); garnet (Georgia; rhodolite from Mason County, N. C.; and a variety from the Oregon coast known locally as "Oregon jade"); hematite (Platte County, Wyo.); jasper (Socorro County, N. Mex.); jet (Mesa County, Colo.); lapis lazuli (Gunnison County, Colo.); opal (Georgia and Wyoming); moonstone (North Carolina); opalized wood (central Washington); rhodonite (North Carolina); rock crystal (Colorado, Georgia, and Idaho); rose quartz (Maine and North Carolina); rutilated quartz (North Carolina); smoky quartz (Colorado, North Carolina, and Utah); sapphire and pink sapphire (Macon County, N. C.); and tourmaline (Milford, Utah).

A little pale emerald occurs in the beryl-bearing pegmatites northeast of Winnipeg, Manitoba, Canada.

IMPORTS

On January 2, 1942, the United States Department of Commerce announced that "in the interest of national and hemisphere war effort, no further detailed statistics concerning the foreign trade of the United States" would be published. Imports of precious and imitation stones (exclusive of industrial diamonds) into the United States for the first 9 months of 1941 totaled $22,802,940, a 19-percent decrease compared with the corresponding period of 1940. Details for 1941 are shown in the following table.

Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States in 1941 (January–September, inclusive) [1]

	Carats	Value
Diamonds:		
Rough or uncut (suitable for cutting into gem stones), duty free	124, 202	$5, 967, 938
Cut but unset, suitable for jewelry, dutiable	182, 652	13, 570, 481
Emeralds:		
Rough or uncut, free		----------
Cut but not set, dutiable	18, 497	247, 730
Pearls and parts, not strung or set, dutiable:		
Natural		145, 897
Cultured or cultivated		423, 918
Other precious and semiprecious stones:		
Rough or uncut, free		75, 111
Cut but not set, dutiable		2, 074, 363
Imitation, except opaque, dutiable:		
Not cut or faceted		9, 703
Cut or faceted:		
Synthetic		217, 988
Other		18, 806
Imitation, opaque, including imitation pearls, dutiable		26, 957
Marcasites, dutiable:		
Real [1]		22, 208
Imitation		1, 840
		22, 802, 940

[1] Figures for 1940 in Minerals Yearbook, Review of 1940, p. 1403, should read—Marcasites, real, $8,220; grand total, $37,769,135.

Imports of pearls and cut precious stones and imitation stones increased notably, while all other subdivisions decreased. Imports of uncut diamonds decreased sharply, suggesting that American cutters overbought in 1940. The decrease in cut imported was somewhat less drastic. The number of watch jewels imported in the first 9 months of 1941 totaled 79,875,751 valued at $1,769,689, compared with 98,771,042 valued at $1,831,007 in the 12 months of 1940.

Synthetic rubies and sapphires imported in the first 9 months of 1941 totaled 440,491 pieces worth $217,988, or 71.8 percent of the quantity and 75.3 percent of the value imported in the corresponding period of 1940. Imports of synthetics were small in the third quarter of 1941 and are believed to have been negligible in the fourth quarter.

GOVERNMENT REGULATIONS

Again, due to the war, Government regulations covering the jewelry trade were legion in 1941. Great Britain, Germany, Italy, and France made strong efforts to divert funds normally spent on jewelry to Government securities.

EFFECT OF WAR ON SOURCES OF GEMS

The prices of colored stones, like those for diamonds, have increased since the Second World War started. For instance, fine rubies and emeralds are 15 to 20 percent higher and some of the less noble gems and all synthetics even more.

War in the Pacific has removed Thailand and Indochina from the list of countries from which the United States obtains precious stones. The principal sources of zircons (rough, Indochina; cut in Thailand) therefore can no longer trade with us. Thailand also supplied a few sapphires and rubies. Japan provided most of our cultured pearls. Furthermore, as a result of the war, imports of gems from India will have to be rerouted, and receipt of precious stones from Burma may be temporarily interrupted.

With the declaration of war imports from Germany (largely imitation stones) and Italy ceased, and the difficulty of importing watches and watch parts—notably jewels—from Switzerland increased.

Bombay (Bureau of Mines Mineral Trade Notes, August 20, 1941, pp. 27–30) has long been one of the more important precious stone markets of the world. However, before the war started, Bombay had virtually no direct trade with the United States; its stones were exported to London or Paris—then the center of the trade in colored stones—where American gem merchants purchased their requirements. Bombay does not control the output of any important gem-stone deposits but has always been only a junction point in the world circulation of precious stones. However, conditions have changed since the war. In 1938 Bombay exported $35,169 worth of gem stones and pearls; in 1940, $443,020. The increase of its exports to the United States has been even more remarkable, because American importers now look to Bombay instead of Paris for their colored stones. The quantity of stones exported is controlled by the Reserve Bank of India. Rubies from Mogak, Burma, are the principal exports. Although star rubies are cut in Burma, other Burmese rubies are cut largely in Cambay, India, and a few in Bombay itself. The price of rough rubies has increased 15 to 20 percent since the war began, although the price of cut stones has changed little. Star rubies and sapphires sell for four or five times their pre-war price. Sapphires are imported from Burma, Ceylon, and Kashmir and emeralds from Ceylon and U. S. S. R.; diamonds, formerly imported from Europe, usually are sold locally. Since March 1940, an export certificate, obtained at an accredited bank, is required before gems can be exported to the "hard-currency" countries. Precious stones cannot be imported from "hard-currency" countries. An ad valorem duty of 5 percent is paid on most stones imported, although gems from Burma are exempt from duty.

China is sending us tiger-eye and quartz cameos, which formerly were purchased in Germany.

Although there seems to be no deficiency in the supply of fine rubies, sapphires, and emeralds, there is a distinct shortage of the less expensive grades of these gems, of some of the lesser gems, and of synthetics. Brazil, however, is supplying the United States with sufficient aquamarine, topaz, citrine, amethyst, and tourmaline, and our imports (both cut and rough) from that country are increasing. In view of the unusually good demand for colored stones, the lack of adequate cutting facilities in the United States is unfortunate. American lapidaries are working overtime cutting South American rough and recutting into modern shapes stones recovered from old jewelry. Some South American chalcedony is being stained into black onyx.

DIAMOND

A layman would have expected the diamond industry, which produces a luxury, to be one of the first adversely affected by the war. In reality, in 1941 it enjoyed relative prosperity, notwithstanding the fact that its processing branch—the cutting of gem stones—is about one-eighth as large as normally since the invasion of the Low Countries.

Production was appreciably smaller than in 1940 and, indeed, less than in any year since 1937. Sales of rough, on the other hand, were large, due partly to a slight increase in sales of gem stones in America but largely to huge sales of industrials. Prices of rough and fine large cut advanced; prices of small cut held at two to four times those of early 1940. "Investment" buying increased in 1941—in Europe in "black markets," in the United States in a free market.

Share dealings.—The shares of diamond-mining companies, virtually all of which are listed on the London Stock Exchange, gained over 75 percent during the year and in the fall were market leaders. Until Russia showed its strength, the market was uninteresting, but by mid-September a gain of 50 percent had been made. Prices sagged in October, rose sharply in November, weakened on the entrance of the United States (the chief market for cut) into the war, and at the year end strengthened on good dividend declarations. The market rise was in contradistinction to a 14-percent rise in English industrials and a loss of 18 percent during 1941 on the New York Stock Exchange. At the year end, diamond-mining stocks were 39 percent of their high (1927) and 445 percent of their low (1932). Of the 12 leading diamond-mining companies, 11 paid dividends; the twelfth, Cape Coast Exploration, is soon to make a handsome liquidation payment.

Market.—In 1941, the Diamond Trading Co., which in normal times controls the sale of about 95 percent of world production, sold rough valued at about £7,500,000 (£6,144,314 in 1940). The United States bought such "American qualities" (fine, relatively large stones) as were available and some fine small rough, but the increase in sales was due principally to large purchases of industrial diamonds by the Governments of the United States and Russia and by American brokers. In addition to its London and Kimberley offices, the Diamond Trading Co. in the fall opened an office at Hamilton, Bermuda, to deal with cutters and brokers residing in the United States.

In 1941 the American market for cut was featured by an increasing demand, a reasonable supply of large cut, and a wholly inadequate supply of small cut. There was a fair turn-over in polished stones in Great Britain, notwithstanding Government attempts to restrict it. The finer stones were sold for "investment" purposes in a thriving "black market." South America, Canada, and India were relatively large buyers of cut. Citizens of Nazi-occupied Europe desired to "invest" in diamonds, but opportunities were few.

Prices of rough diamonds advanced 10 to 15 percent, and a further rise is likely early in 1942. Prices of fine, large cut are 10 to 20 percent higher than in pre-war days, and prices of small cut have doubled or quadrupled. In America, a fine 1-carat stone costs what it did before the 1929 crash; in Nazi-occupied lands and in the British "black market," prices are much higher.

Stocks of rough increased somewhat in 1941 but will decrease in 1942. Those in the hands of American cutters are adequate, as are those of fine, large cut; however, the supply of small cut is pitifully low.

Imports.—On September 30, 1941, the Department of Commerce ceased to publish import figures. Imports from January 1 to September 30, 1941, were as follows:

Diamonds imported into the United States in 1941 (January–September, inclusive), by countries

[Exclusive of industrial diamonds]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
Argentina				146	$8,607	$58.95
Belgium				123,052	6,722,113	54.63
Brazil	35,825	$1,261,715	$35.22	2,470	276,702	112.03
British Malaya				73	6,872	94.14
Cuba				191	16,947	88.73
France				3,867	474,752	122.77
Germany				539	42,337	78.55
Mexico				432	35,314	81.75
Netherlands				1,123	42,384	37.74
Netherlands Indies				104	5,339	51.34
Palestine				3,409	398,123	116.79
Switzerland				630	108,796	172.69
Union of South Africa	88,377	4,706,223	53.25	31,043	3,776,182	121.64
U. S. S. R.				30	2,250	75.00
United Kingdom				15,543	1,653,763	106.40
	124,202	5,967,938	48.05	182,652	13,570,481	74.30

Cutting.—In May 1940 the world cutting industry was completely disorganized, having lost 90 percent of its operatives as a result of German invasion of the Low Countries. A few cutters escaped and reestablished their trade in far corners of the earth, others were marooned in France, but most were caught in the Low Countries. The United States and South Africa and, to a smaller extent, Great Britain and Palestine furnish an adequate supply of "American qualities" (fine, large cut), but there is a woeful shortage of small cut. Germany has attempted without success to reestablish the industry in Belgium and the Netherlands.

By a fluke, New York is now the leading diamond-cutting center of the world, with some 650 cutters and a large number of apprentices. Several firms are attempting to cut melee. Some of the more experienced cutters make over $235 a week. South Africa has 300 to 400 cutters, Great Britain 200 to 250, Palestine perhaps 200, Puerto Rico 75, and Java a few. Borneo and Brazil cut some diamonds for the local trade, but their product is not cut well enough for the American market.

World production.—For the second year, due to the war, actual diamond-production figures are not available, but the estimates in the following table are believed to be fairly accurate. World production (gems and industrials) in 1941 is estimated to have been 9,088,000 carats (1.817 metric tons) valued at about $27,000,000. Compared with 1940, the total weight decreased 36 percent and the value 19 percent. The average quality of the stones produced was better than in 1940, bort representing perhaps 78 percent of the caratage and gem stones 22 percent. Belgian Congo was the leading world producer, both in weight (over 67 percent of the total) and in value (27 percent). The British Empire produced 19 percent of the total by weight and 31 percent by value. The South African pipe mines were not operated; consequently, all production was from alluvial mines.

The following table shows, as accurately as available statistics permit, world production for the past 5 years.

World production of diamonds, 1937–41, by countries, in metric carats

[Including industrial diamonds]

Country	1937	1938	1939	1940	1941
Africa:					
Angola	626,424	651,265	690,353	784,270	787,000
Belgian Congo	4,925,228	7,205,620	8,344,765	[1] 10,900,000	6,106,000
French Equatorial Africa	5,588	16,013	[1] 16,000	[1] 16,000	20,000
French West Africa	54,687	61,928	56,314	[1] 75,000	35,000
Gold Coast (exports)	1,577,661	1,296,763	1,087,652	[1] 825,000	742,000
Sierra Leone	913,401	689,621	[1] 600,000	750,000	850,000
South-West Africa	196,803	154,856	35,470	30,017	46,614
Tanganyika (exports)	3,234	3,576	3,445	2,250	[1] 1,750
Union of South Africa:					
Mines	820,284	979,460	1,089,144	[1] 351,447	
Alluvial	207,359	259,147	160,684	[1] 172,027	112,300
Total Union of South Africa	[2] 1,030,434	1,238,607	1,249,828	[1] 523,474	112,300
Brazil	238,606	235,000	[1] 350,000	[1] 325,000	325,000
British Guiana	35,958	32,522	32,491	[1] 26,764	27,000
Other countries [3]	6,000	34,200	19,000	31,750	34,350
Grand total	9,614,024	11,619,971	12,485,318	[1] 14,289,525	9,088,014

[1] Estimated.

[2] Includes small quantity of diamonds derived from re-treatment of tailings.

[3] 1937: Includes Netherlands Indies (Borneo), India, Australia (New South Wales), Liberia, Venezuela, and Rhodesia; 1938: U. S. S. R., India, Borneo, New South Wales, and Venezuela; 1939: Venezuela, India, Borneo, New South Wales, and U. S. S. R.; 1940 and 1941: Borneo, India, New South Wales, U. S. S. R., and Venezuela.

Most countries showed decreased production as compared with 1940, although Sierra Leone and South-West Africa made minor increases.

During the year, DeBeers Consolidated Mines, Ltd., absorbed Cape Coast Exploration, Ltd., and now owns or controls all important diamond mines in the Union of South Africa and South-West Africa except the State mines of Namaqualand.

In 1942 some of the companies are to attempt to increase production of the industrial stones so necessary today and may succeed. If the war continues, however, the long-term outlook is for a drying up of production as certain essential supplies will be lacking owing to the isolated position of the mines now producing.

Industrial diamonds.—The use of industrial diamonds continues to increase amazingly. The expansion, of course, is due largely to the national defense and war programs, but even without a war the increase would have been marked. World consumption in 1942 is expected to approach 7,500,000 carats, or more than the world production of industrial grades. For several years, stocks of certain types of fine industrial diamonds have been small; however, users will find that the grades substituted are satisfactory.

With signing of the United States-Brazil Trade Agreement (May 15, 1941), the Axis Powers lost their last primary source of industrial diamonds. It is reported that Germany is now using gem stones industrially.

On March 18, 1941, industrial diamonds were classified among the critical war materials, and after April 15 they could not be exported from the United States without an affidavit, except to the British Empire. Since October 31, 1941, American dealers and users have had to report quarterly stocks on hand and transactions completed. The United States Government began to stock-pile diamonds in June 1940.

The percentages, by value, of the chief uses for industrial diamonds follow:

	Percent
Diamond drilling	45–40
Diamond-set tools	30–35
Diamond dies	10– 7
Crushing bort (bonded wheels and tools)	10– 7
Miscellaneous	5–11

In 1940, for the first time in 3 years, diamond drilling in Canada by contractors increased (1939: 391 miles; 1940: 459 miles). The use of diamond drills in stope blast-hole drilling also increased in Canada, and it is reported in the copper mines of Rhodesia and Belgian Congo. The use of diamond-impregnated bits in drilling is increasing.

The demand for diamond dies is large. Formerly the specialty of France, they are now being produced in America, and mechanical methods successfully replace meticulous hand methods.

The Diamond Trading Co. announced that it would not raise the price of industrial stones during the war Indeed, the price of Congo (Beceka) crushing bort was reduced in the summer of 1941. Whether the price differential between this grade and those of South Africa and Gold Coast is warranted seems questionable.

Imports of industrial diamonds into the United States during the past 5 years were as follows:

Industrial diamonds (glaziers', engravers', and miners') imported into the United States, 1937–41

Year	Carats	Value		Year	Carats	Value	
		Total	Average			Total	Average
1937	1,885,970	$6,542,365	$3.47	1940	3,809,071	$11,026,563	$2.89
1938	1,396,247	4,213,412	3.02	1941 (Jan.–Sept.)	2,911,117	7,415,133	2.55
1939	3,568,730	9,725,683	2.73				

RUBY, SAPPHIRE, AND EMERALD

Production of precious stones in Burma seems fairly well stabilized. The 1939 production was 211,570 carats of rubies and 10,532 carats of sapphires. A few spinels and other gem stones are byproducts.

Sapphires continued to be produced in 1941 in the Anakie field, Central Queensland. Prices reached perhaps an all-time peak; £85 an ounce was refused for high-quality gems, blue stones brought £45 an ounce, and second-grade stones realized 15 to 30s. an ounce.

Ceylon is changing its mining laws. The Revenue Office now determines gem-mining royalties, the land (both Crown land and that alienated by the Crown) to be exploited, and the location of the workings. Natives are to be trained, after the European method, to cut gems for beauty and not for weight. As Ceylon is a tourist center from which every globetrotter desires to bring a precious stone, prices are higher on the average than they are in Europe. A fine star ruby weighing 310 carats was found in Ceylon by Dr. D. P. E. de Silva late in 1941. Some 15 years ago one weighing 215 carats was found and sold for Rs. 85,000.

LESSER GEMS

Australia is the world's principal source of opals, and its output from 1936 to 1939 ranged in value from $40,000 to $75,000 a year. Since 1936 South Australia (1938, £4,750; 1939, £6,020) has been the principal producer, followed by New South Wales. Queensland's production is small (1938, £80; 1939, £50). In 1941 the fields were reported to be doing well and the diggers busy. The market for opals was said to be good.

The ancient turquoise mines of Madan are about 30 miles west of Nishapur, Iran (Bureau of Mines Mineral Trade Notes, January 20, 1942, pp. 26–28). The Iranian Government farms out the mines to operators for about $2,000 a year. When India, the principal market, is buying in quantity 150 men are employed; at present the demand is poor, and only 20 men are employed. As for most gem mines other than those producing diamonds, profits are small. Turquoise occurs as seams and nodules in brecciated trachyte porphyry. Mining consists of open pits, shafts, and tunnels. To minimize shattering, powder is used instead of dynamite. If the color of the gem does not change within 2 weeks of mining, it is likely to be relatively stable.

The stones are cut at Meshed, 75 miles from the mines. The Iranian market absorbs 10 percent of the product; of the remainder, the best goes to India, and the poorer qualities go to Mecca for the pilgrim

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trade. From June 21, 1936, to March 20, 1940, yearly exports have averaged about 822 kilos of cut and 825 kilos of uncut, worth, respectively, 884 rials and 19 rials per kilo (at 50 rials to the dollar, \$17.68 and \$0.38, respectively.)

Brazil produces a number of gem stones, notably aquamarine, pale emerald, tourmaline, amethyst, yellow and blue topaz, and citrine. The value of aquamarine exported is normally 10 times that of tourmaline. Exports are considerably larger than the declared value, recently estimated as \$10,000. Minas Gerais is the principal producer. The war apparently reduced 1941 exports somewhat.

Chile exports considerable tonnages of green "onyx" to the United States through the port of Antofagasta.

Despite Government restrictions, zircon continued for a time to pass the Indochinese border into Thailand for cutting at Bangkok. As already stated, upon the outbreak of the war in the Pacific, Thailand ceased to be a source of zircon for the United States.

South-West Africa, normally a large producer of aquamarine, tourmaline, and other lesser gems, produced 4,075.031 kilos of gems in 1939. As Germany had been the chief buyer, trade languished after the war started.

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GEM STONES

By Sydney H. Ball

SUMMARY OUTLINE

JEWELRY INDUSTRY IN 1942

Retail sales by jewelry stores in the United States totaled $699,000,000 in 1942—an all-time record and a 32.9 percent increase over 1941. Gains were particularly large in Washington and Oregon and in other areas where there are big war plants. As in the past 2 years, the increase was due to a large turn-over of relatively inexpensive items, although a few high-priced items were sold. Even the New York Fifth Avenue shops are showing more reasonably priced articles. The Christmas trade reached an all-time record, many believing it to be the last Christmas until the war is over when one could buy what one liked.

Increased sales were due to the marked rise in income of a large number of Americans (national income: 1939, 70 billion dollars; 1942, 119.8 billion dollars—thanks, unfortunately, to the war), to some investment buying, and to an all-time high in number of weddings (about 1,800,000 marriages, an 11-percent increase over 1941). Women war workers form a new class of jewelry-store customers, and some new fortunes are being made which will mean new purchasers of gems.

National income in 1943 will be even greater than that in 1942; and, notwithstanding the markedly higher taxes, the public will be ready to buy jewelry, particularly that moderately priced. Retailers will have difficulty in keeping their showcases filled, even though their business, as is likely, may average less than that of 1942. However, they can get diamond-set palladium jewelry and other gem stones, probably set in gold, and will find dealing in old jewelry profitable. As retailers face a shortage in help and higher operating costs and taxes, as well as ceiling prices on their wares, their 1943 profits are not likely to be as large as those of 1942.

Sales by wholesalers showed smaller gains (9 percent), and yet their stocks decreased (10 percent). Retailers' stocks decreased during the year, and certain lines (watches, alarm clocks, etc.) were sold out during the Christmas season; they are begging wholesalers for goods, and of course, owing to Government regulations, the situation will become more acute. Late in 1942 the War Production Board limited the size of inventories that might be carried by the large and financially more stable companies in the hope that stocks might be distributed more evenly among retailers. Inventories in 1942 shrank only slightly.

As far as selective service is concerned, the jewelry trade is to receive few favors; jewelry artisans, lapidaries, and salesmen (both retail and wholesale) are nondeferrable.

Canadian retail sales were excellent before the new 25-percent excise tax was effective, June 23, 1942.

FASHIONS IN JEWELS

The rather severe modern gown requires the gaiety of jewels. Utilitarian, though smart, jewelry characterized the mode in 1942, and hence multiple-use clips and other double-duty jewelry were popular. The vogue for gold continued to grow at the expense of platinum, which cannot be used hereafter for jewelry. Regimental jewelry, "V for Victory," and floral designs were popular, although geometric, Hindu, and Latin American motifs also were used. Ensembles set with similar stones were much worn. Clips and brooches were especially popular; bracelets (identification and charm bracelets largely), earrings, and rings were also in demand.

Owing to the shortage of melee, pavé mountings are becoming rare. Topaz, amber, and aquamarine barbaric in size were used in bracelets and rings. Diamond (including some yellow stones), ruby, and sapphire (largely blue, but also yellow and pink) were the most popular gems, followed by topaz, aquamarine, amethyst, and amber. The insistent demand for diamonds and the patriotic motif in jewelry caused colorless stones to be dominant, followed by blue and red stones, then yellow and brown, and then green, purple, and black. The wide knowledge of gem stones, because of lectures by jewelers and courses in some colleges, is causing the American public to use a wider range of gem stones than ever before. Fine examples of certain of these stones are not too expensive, and some of them may be as beautiful as some of the noble gems.

DOMESTIC PRODUCTION

The production of gem stones in the United States in 1942 did not escape the blight of war, because producers sought minerals of greater strategic importance. Further, gas rationing in 1942 reduced not only collecting by amateurs but cut down the number of tourist customers who passed the lapidary's door. On the other hand, the shortage of foreign-cut stones improved the market for stones of American origin and cut. Intensified mining of pegmatitic ore bodies for block mica, beryl, and tantalite should have increased the production of aquamarine and other pegmatitic gem stones; but, if so, the miners appear to have high-graded the gem byproduct. Government-aided crystal mining (for radio plates) in Arkansas and California also probably increased the production of crystal suitable only for objets d'art. Makers of meerschaum pipes were short of the Turkish raw material, and satin spar was not available to the cutters of beads at Niagara

Falls. Restrictions on the use of silver in jewelry are said to have reduced the manufacture of turquoise-set jewelry by the Navajos.

It is believed that the net result of these various factors was a markedly smaller production of gem stones in 1942. A rough estimate of the value of uncut stones used in jewelry and related industries is $150,000 with a total value after cutting of $400,000; corresponding estimates in 1941 were, respectively, $240,000 and $770,000. Of the total value in 1942, sapphires (largely used industrially) represented 31 percent, turquoise 21 percent, and the quartz minerals 20 percent. The chief producing States in approximate order of output were Montana, Nevada, Oregon, and Wyoming.

Two corporations in Montana in 1942 produced sapphires weighing about 50,000 ounces (1.71 short tons) worth $47,000; most of these stones were stock-piled for possible use as instrument jewels, although a few were cut for gems. American Gem Mines (Charles H. Carpp, manager) at Philipsburg was the principal producer; this company sold its product to the Government. The Perry-Schroeder Mining Co., a gold-dredging company operating near Helena, was permitted, after the orders closing gold mines were issued, to continue dredging because of its sapphire byproduct. The New Mine Sapphire Co. at Utica and the Simon property near Butte did not operate.

The Smith mine near Beowawe, Nev. (product sold in California), was the principal turquoise producer; it yielded 13,033 pounds valued at $32,000. B. F. Couch reports that other Nevada turquoise miners produced about 350 pounds worth $4,000. The King property, at Manassa, Colo., also produced considerable turquoise, and a small quantity is said to have been mined near Kingman, Ariz. The Los Cerrillos mine, near Santa Fe, N. Mex., was not operated.

Dr. H. C. Dake reports that in 1942 gem mining in the Pacific Northwest (Washington, Oregon, Idaho, Montana, and Wyoming) was only about half as active as in 1941, although cutting of agate cabochons increased. Part of the lapidary industry was converted to the cutting of radio quartz plates. Fine moss agate was discovered about 8 miles southeast of Willowdale, central Oregon; the agate is reported to occur as a thick vein in rhyolite, and about 4,000 pounds worth $4,000 is said to have been mined.

Fine moss agates continue to be recovered from the gravels of Yellowstone River in southeastern Montana, but in diminishing quantities. R. L. Harris, of Miles City, Mont., a jeweler and moss-agate enthusiast, found on the banks of the Yellowstone a moss agate with a natural "V" for Victory on it. He had it cut and mounted in a ring of Montana silver and requested a national news weekly to present it to Winston Churchill; this was done, and the last leg of the journey was made in a ferry bomber. The Prime Minister was pleased to accept it. A little agatized wood, "rainbow" agate, and other forms of quartz are produced in Wyoming.

New occurrences of both green and black jade (nephrite) have been discovered in the general vicinity of Lander, Wyo. (personal communications of Fred Abernathy, Lloyd B. Curtis, H. C. Dake, and O. W. Plaga). Some of the green is of fine quality and worth $5 a pound. Boulders of jade, one of which is said to weigh almost 2,000 pounds, occur in an area 20 miles long and 3 miles wide paralleling Sweetwater River. Black nephrite is reported to occur in place in granite, but the lighter green is known only as boulders. It is by no means impossible that after the war American jade will be exported to China.

A. M. Buranek reports that several hundred pounds of variscite were mined from the Clay Canyôn deposit near Fairfield, Utah, and collectors obtained some variscite from Grantsville (Toocle County) and Lucin (Box Elder County). Fine agates and jaspers were obtained in eastern Utah. Considerable jet was collected from the Henry Mountains in southeastern Utah. Black obsidian with white christobalite inclusions, attractive when polished, has been found in Millard County, and some has been sold. Good topaz crystals were collected on Topaz Mountain, and pyrope garnet was obtained near Mexican Hat, San Juan County.

P. C. Leggett reports that several hundred carats of fine amethyst were produced in 1942 from two New Hampshire localities—Stark and Milan. The Stark locality, on Lone Mountain, is almost exhausted, but smoky quartz crystals occur rather abundantly in other "pockets" on the mountain. After heat treatment, the gem turns pale yellow. The Milan amethyst from Greens Ledge is not as fine as that from Stark, but the crystals are larger and less flawed. Gems of almost 30 carats have been obtained. Yellow, wine, blue, and colorless topazes also are found on Greens Ledge. Several good aquamarine crystals were found during the year in two mines in North Groton. Deeply colored, asteriated rose quartz was produced near the French mine in Gilsum.

Hugh D. Miser (see Bibliography) considers the veins from which the Hot Springs (Ark.) quartz crystals are obtained to be hydrothermal deposits of probable magmatic origin of mid-Pennsylvanian age. Although some of the finer crystals are sold for jewelry under the trade name "Hot Springs diamonds," most are sold to collectors or to constructors of water fountains and religious and memorial shrines. He estimates the value of crystals sold in 1941 at $12,000. Some are cut into radio oscillators. Crystals weigh from a small fraction of an ounce to 330 pounds. Certain localities furnish beautiful crystals of smoky quartz.

Other gems produced in the United States in 1942 included alabaster (South Dakota); albite (Maine); amazonstone (near Bar Harbor, Maine); amethyst (Maine); aquamarine (Amelia, Va.; Avon, Idaho); asteriated quartz (Wyoming); caesium beryl (Maine); lepidolite (Maine); moss agate (Siskiyou and San Bernardino Counties, Calif.); pipestone (Minnesota); rock crystal (Arkansas); rose quartz (Maine and South Dakota); greenish spodumene (Maine); topaz (Maine); tourmaline (Maine); and californite, a variety of vesuvianite, (Siskiyou County, Calif.).

CANADA GEM STONES

Dr. A. L. Parsons reports that a little rock crystal was discovered in 1942 in Leeds County, Ontario; otherwise, the industry, never important, was dead.

The Royal Ontario Museum at Toronto has a fine collection of Canadian gem and decorative stones, notably agate (Bay of Fundy and Thunder Bay district, Ontario); amethyst (Nova Scotia and Thunder Bay district, Ontario); and rose quartz (Lyndock Township, Ontario, and Manitoba). The rose quartz is deep in color and has been used commercially to some extent. Included, also, are peristerite, an iridescent feldspar (Monteagle Township, Ontario); sodalite (Bancroft, Ontario, and Ice River, British Columbia); aquamarine (rare, Lyndock Township, Ontario, and southeastern Manitoba); golden beryl (rare, Manitoba); yellow scapolite (Grenville Township, Quebec); and amber (Cedar Lake, Manitoba).

IMPORTS[1]

Imports of precious and semiprecious (real and imitation) stones (exclusive of industrial diamonds) totaled $28,449,422 in 1942, a 16-percent decrease from 1941. Details are as follows:

Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1941–42

Commodity	1941		1942	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty-free	215,026	$10,301,371	277,826	$11,518,085
Cut but unset, suitable for jewelry, dutiable	229,582	18,346,415	125,806	14,599,770
Emeralds:				
Rough or uncut, free	10,295	25,739	6,506	676
Cut but not set, dutiable	22,160	313,185	21,209	205,717
Pearls and parts, not strung or set, dutiable:				
Natural		387,053		179,169
Cultured or cultivated		469,676		
Other precious and semiprecious stones:				
Rough or uncut, free		107,610		72,387
Cut but not set, dutiable		2,968,129		1,580,705
Imitation, except opaque, dutiable:				
Not cut or faceted		10,962		195
Cut or faceted:				
Synthetic		244,264		86,829
Other		534,070		97,573
Imitation, opaque, including imitation pearls, dutiable		33,377		2,622
Marcasites, dutiable:				
Real		28,228		104,150
Imitation		7,136		1,544
		33,777,215		28,449,422

METAL SHORTAGES IN AMERICAN JEWELRY TRADE

Most of the common metals normally utilized in costume jewelry were diverted to national defense in 1941; and in 1942 use of most of the other metals in jewelry was prohibited. Limited amounts of domestic silver are still available, as, of course, is gold. Small amounts of the copper necessary to harden these metals can be used until June 30, 1943. The use of platinum, iridium, and rhodium in jewelry is forbidden. However, palladium alloyed with ruthenium is an acceptable substitute for platinum. Incidentally, should the need for it arise, the diamond-set platinum jewelry of United States citizens constitutes a considerable reserve of two critical materials for war purposes—platinum and diamonds. The Canadian manufacturer of jewelry is restricted even further, because the use of palladium is forbidden.

PRICE CEILINGS

Jewelry prices were frozen in June 1942 to the level effective during March 1942, although this did not affect "precious stones" as defined

[1] Figures on imports compiled by M. B. Price, of the Bureau of Mines, from records of the Department of Commerce.

by the Office of Price Administration. A precious stone, according to the OPA, is "any ruby, sapphire, emerald, natural pearl or any diamond weighing more than 1 carat or any semiprecious stone, after sale by the cutter, when the cutter has received more than $100 for sale of the stone." In addition, when "two or more diamonds with an aggregate weight of 1.5 carats are set in one mounting," the diamonds shall be deemed precious. According to this definition a faded ruby, a watery sapphire, or a badly flawed emerald weighing a carat is precious, but a half-carat, flawless, well-cut diamond is not.

CONVERSION OF THE JEWELRY INDUSTRY

The jewelry industry—as it produces in part articles of no value to the war effort and as it has been shorn of many of its raw materials—has been converted to war work to the greatest possible extent. Some of the larger units are wholly converted, the smaller less completely so, although some of the smaller shops, by pooling, have obtained valuable subcontracts. Silverware plants are making munitions; a firm formerly manufacturing expensive jewelry is now cutting quartz plates for radio work; and watch factories are turning out instrument jewels.

GOVERNMENT REGULATIONS

Every government, from the smallest to the largest, since the war began has had to formulate a host of regulations for the jewelry trade. The principal objects were to divert funds normally spent on jewelry to government securities, to discourage exportation of easily converted wealth, and to prevent critical material and needed skilled labor from being used to produce unessential merchandise.

EFFECT OF WAR ON THE GEM-STONE TRADE

In 1942, the United Nations lost Burma and thereby an important source of ruby, sapphire, spinel, jade, and tourmaline. On the other hand, when Dakar sided with the Fighting French, the Axis Powers lost the most important source of industrial diamonds remaining to them.

There is no shortage of gem diamond, ruby, emerald, and sapphire in America, nor of most of the less expensive precious stones, with the possible exception of zircon. The "good-neighbor policy" is making Americans more familiar with the lovely tourmaline, aquamarine, and topaz of South America. The lapidaries of the Northwestern States are cutting many agate and jasper cabochons for mountings of inexpensive jewelry. Supplies of synthetic stones and imitations are inadequate.

Owing to the war, Indian and Ceylonese stones (especially sapphire and star sapphire) arrive in New York direct instead of via Paris and London, as formerly. By air mail, elapsed time is 3 or 4 weeks.

Nazi puppets in the Netherlands, Croatia, and other dependencies continue to rob Jews of their jewelry, in instances having the effrontery to pretend that the funds which the jewels represent will be administered in favor of the victims.

Americans in India are buying jewels for souvenirs on an extensive scale. Jaipur, the principal Indian cutting center, has never been busier. As the business ethics of the average Hindu jeweler are low, some American soldiers will find themselves possessing fine bits of glass; others will acquire jewels that will serve as heirlooms for generations to come. Algerian goldsmiths look upon the arrival of Americans as a reasonable excuse to quadruple prices.

DIAMOND

The diamond industry had its most prosperous year in over a decade, owing to unprecedented sales of industrial diamonds. Rough, suitable for gem cutting, also was sold in considerable quantity.

Production continued in 1942 at about the 1941 rate, although it was only 69 percent of that in 1940. A large part of the product of the mines of central and northwest central Africa—only African mines now operating—is of industrial grades, but the gem stones recovered are sufficiently valuable to keep industrial prices reasonable. Prices of rough and fine large cut continued to advance; those of small cut declined somewhat. In fear of inflation, "investment" buying increased in the black markets of Europe and the free market here.

Share dealings.—The shares of diamond-mining companies, virtually all of which are listed on the London Stock Exchange, gained over one-third in value in 1942. Their record was much better than that of the British industrials or American stocks in general. Frequently they were market leaders.

Stocks were hesitant for the first quarter, then advanced sharply; fell, owing to the British set-back in Libya, but from mid-July to the year end gained markedly. At the close of the year stocks stood at 560 percent of the all-time low (1932) and at 52 percent of the all-time high (1927). Nearly all the companies paid dividends in 1942, several at increased rates.

Market.—In 1942, the Diamond Trading Co., which in normal times controls the sale of about 95 percent of the world output, sold rough to the value of well over £10,500,000. "American qualities" (large fine rough) and fine small goods enjoyed a satisfactory market, but probably over 40 percent of the sales were of industrials. In mid 1942 the British Government appointed C. H. Rodwell diamond controller. The Trading Co. branch office at Hamilton, Bermuda, is said to have been closed recently, all stocks on hand having been sold.

In 1942 America bought large quantities of medium-size cut, particularly in the second half of the year. The other warring nations bought what they could, usually in "black" markets at fantastic prices. In time of war diamonds are natural "investments" to the enslaved people of a conquered country and to citizens of a belligerent country whose war future is dismal.

Prices of rough diamonds early in the year advanced 5 to 20 percent, according to qualities. Fine cut advanced 10 to 15 percent; melee slumped 30 percent in the first half of the year but rallied and was off but 10 percent at the year end.

Stocks of rough decreased markedly in 1942, as consumption exceeded production. Stocks in the hands of American cutters are probably adequate, as are those of fine large cut; the supply of small cut is abnormally low.

Imports.—As the following table shows, 1942 imports of gem diamonds were 91 percent of those of 1941, a small gain in rough imported being offset by a larger loss in cut. The quality of cut imported was excellent; that of rough was mediocre.

Diamonds imported into the United States, 1941–42, by countries

[Exclusive of industrial diamonds]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1941						
Argentina				146	$8,607	$58.95
Belgium				145,504	8,298,551	57.03
Brazil	63,710	$2,280,628	$35.80	7,434	678,099	91.22
British Malaya				286	19,878	69.50
Cuba				205	17,806	86.87
France				4,950	726,665	146.80
Germany				539	42,337	78.55
Hong Kong				9	596	66.22
Mexico				443	35,930	81.11
Netherlands				1,521	76,565	50.34
Netherlands Indies				104	5,339	51.34
Palestine				5,523	703,293	127.34
Switzerland				630	108,796	172.69
Union of South Africa	150,324	7,986,039	53.13	42,326	5,450,923	128.78
U. S. S. R				30	2,250	75.00
United Kingdom				19,932	2,170,778	108.91
Venezuela	992	34,704	34.98			
	215,026	10,301,371	47.91	229,582	18,346,415	79.91
1942						
Argentina				36	32,013	889.25
Belgian Congo	205	4,573	22.31			
Belgium and Luxembourg				26,755	2,042,757	76.35
Brazil	6,320	477,812	75.60	23,842	2,686,071	112.66
British Guiana	591	19,775	33.46	55	5,810	105.64
British Malaya				278	19,628	70.60
Canada				1	395	395.00
Colombia				18	2,666	148.11
Cuba				2,746	321,863	117.21
France				1,327	184,250	138.85
Germany				162	7,520	46.42
India and Dependencies (British India)				1	50	50.00
Mexico				365	41,211	112.91
Netherlands				960	83,341	86.81
Netherlands Indies				117	13,579	116.06
Palestine and Trans-Jordan (Palestine)				20,502	2,989,910	145.84
Switzerland				175	19,346	110.55
Union of South Africa	252,580	10,524,425	41.67	35,153	4,738,062	134.78
United Kingdom [1]	1,683	102,154	60.70	13,307	1,410,598	106.00
Venezuela	16,447	389,346	23.67	6	700	116.67
	277,826	11,518,085	41.46	125,806	14,599,770	116.05

[1] United Kingdom of Great Britain and Northern Ireland.

Cutting.—In 1942 diamond cutting ceased its recent rapid growth, due partly to a slightly smaller demand for large cut but mostly to the diversion of artisans from gem to industrial cutting.

Now that the Low Countries are no longer factors in the cutting industry, the United States (750 cutters and 750 apprentices) and Palestine (reported as 2,500 cutters) are the largest cutting centers, followed by South Africa (400 cutters), Great Britain (300), Puerto Rico (75), and Cuba (66). Java, Borneo, and Brazil cut some diamonds for their local trade, but the cutting is not done well enough to satisfy the American trade.

Several of the belligerents propose to train their wounded as cutters, notwithstanding the unfortunate outcome of similar experiments after the First World War.

World production.—For the third year, due to the war, accurate diamond-production statistics are not available, but the estimates in the following table are believed to be fairly accurate. World production (gems and industrials) in 1942 is estimated to have been 9,254,200 carats (1.851 metric tons) valued at $28,000,000. Compared with 1941, the weight increased somewhat more than 1 percent, and the value did not change. The quality was similar to that of 1941, bort representing about 79 percent of the total and gem stones 21 percent. Belgian Congo was the leading producing country, both in weight (65 percent of the total) and in value (29 percent). The British Empire produced 22 percent of the total by weight and 33 percent by value. As the South African pipe mines were not operated, all production was from alluvial mines.

The following table shows, as accurately as available statistics permit, world production for the past 5 years.

World production of diamonds, 1938–42, by countries, in metric carats

[Including industrial diamonds]

Country	1938	1939	1940	1941	1942
Africa:					
Angola	651,265	690,353	784,270	787,000	[1] 791,850
Belgian Congo	7,205,620	8,360,000	9,603,000	5,866,000	6,018,000
French Equatorial Africa	16,013	[1] 16,000	[1] 16,000	20,000	20,000
French West Africa	61,928	56,314	[1] 75,000	35,000	36,000
Gold Coast [2]	1,296,763	1,087,652	[1] 825,000	1,000,000	[1] 1,000,000
Sierra Leone	689,621	[1] 600,000	750,000	850,000	[1] 850,000
South-West Africa	154,856	35,470	30,017	46,578	60,000
Tanganyika (exports)	3,576	3,445	2,250	[1] 1,750	1,000
Union of South Africa:					
Mines	979,460	1,089,144	[1] 371,447		
Alluvial	259,147	160,684	[1] 172,027	112,300	[3] 106,000
Total Union of South Africa	1,238,607	1,249,828	[1] 543,474	112,300	[3] 106,000
Brazil	235,000	[1] 350,000	[1] 325,000	325,000	300,000
British Guiana	32,522	32,491	[1] 26,764	27,000	27,000
Other countries [4]	34,200	19,000	31,750	34,350	44,350
Grand total	11,619,971	12,500,553	13,012,525	9,104,978	9,254,200

[1] Estimated.
[2] 1938–40: Exports; 1941–42: Production.
[3] South African production without Namaqualand was about 76,505 carats.
[4] 1938: U. S. S. R., India, Borneo, New South Wales, and Venezuela; 1939: Venezuela, India, Borneo, New South Wales, and U. S. S. R.; 1940 and 1941: Borneo, India, New South Wales, U. S. S. R., and Venezuela (Venezuela produced 29,399 carats); 1942: Borneo, India, New South Wales, Rhodesia, U. S. S. R., and Venezuela (Venezuela produced 34,084 carats).

Both Angola and Belgian Congo showed slightly greater production; but the decrease in South Africa was rather marked, indicating near exhaustion of its alluvial diggings.

In 1942 some of the companies attempted to increase production of the industrial stones so necessary today and succeeded in a small way. If the war continues, however, the long-term outlook is for a drying up of production, as certain essential supplies will be lacking owing to the isolation of the mines now producing.

Industrial diamonds.—In these days industrial diamonds steal the limelight from the gem variety, not only as to sales but as to romance. Concerning the latter, we may cite the recovery of several shipments snatched by the Allies from under the eyes of the Axis Powers.

The use of industrial diamonds, particularly of crushing bort, continues to increase beyond the expectations of anyone in the industry. Part of this expansion, of course, is due to the war program; but after the war is over, industrial diamonds will retain much of their gain in use. Consumption greatly exceeds production. The finer grades continue to be scarce, but users are schooling themselves to utilize advantageously the grades that are available.

Germany and Italy are already feeling a shortage of industrial diamonds. Germany's shortage is dramatically indicated by the fantastic prices charged in the Swiss "black" market. Japan is in an even less enviable position, as it has not a store of gem stones to which it can resort.

Wholesale prices of industrials in 1942 remained firm; retail prices strengthened. During the year the War Production Board tightened its regulations as to transactions in industrial diamonds.

In pre-war days the percentages, by value, of the chief uses for industrial diamonds were as follows:

	Percent
Diamond drilling	45–40
Diamond-set tools	30–35
Diamond dies	10– 7
Crushing bort (bonded wheels and tools)	10– 7
Miscellaneous	5–11

Today the use of crushing bort is much greater, and the use of diamond-set tools and of dies is relatively greater, largely at the expense of diamond consumption in drilling.

Imports of industrial diamonds into the United States during the past 5 years were as follows:

Industrial diamonds (glaziers', engravers', and miners') imported into the United States, 1938–42

Year	Carats	Value		Year	Carats	Value	
		Total	Average			Total	Average
1938	1,396,247	$4,213,412	$3.02	1941	6,882,248	$14,908,809	$2.17
1939	3,568,730	9,725,683	2.73	1942	11,203,704	22,154,076	1.98
1940	3,809,071	11,026,563	2.89				

RUBY, SAPPHIRE, EMERALD

In Indian Precious Stones, by L. A. N. Iyer (Bull. 6, Records of the Geological Survey of India, Calcutta, New Delhi, 1942, pp. 17–23), the Indian sapphire localities of Afghanistan, Burma, and Ceylon are described. In its 40-year life (1885–1925), the average annual gross of the Burma Ruby Mines Co. was only about $300,000, sufficient reason why the company expired some years ago. The local natives carry on mining in a crude way, either by shallow shafts from which the "byon" is removed and robbed laterally as far as safety permits; by terracing the sides of a hill, somewhat after the Colombian mining practice; or by collecting gravels from limestone caves. The gravels are treated in an open, slightly sloping pond, in which the valuable gems sink and the valueless sands are washed away.

Edward Gübelin (see Bibliography) described the rather distinctly differing microscopic and other characteristics of sapphires from the major fields (Kashmir, Burma, Thailand, and Ceylon).

LESSER GEMS

Jade (nephrite) occurs in Burma in place in a dike, in a Tertiary conglomerate derived from it, and in modern stream gravels (Indian Precious Stones, by L. A. N. Iyer, pp. 38–41). Mining is confined to the dry months, March to May. Although the finer cutting is done in China (75 percent of the product is exported to that country), some stones are cut in Mandalay. The market depends on the prosperity of China; hence, at present it is depressed.

In 1940, Madagascar produced 4,400 pounds of agate, 1,004 pounds of rock crystal, and 28,508 troy ounces of precious stones of various classes. Its beryl, amethyst, and particularly its amber are fine.

Brazil is rich in precious stones. Its diamond and quartz crystal are mentioned elsewhere; one report states that in the first 9 months of 1941 Brazil exported the following additional gem stones to the United States:

Kind		*Quantity*	*Value, milreis*
Aquamarine	grams	26, 080	1, 912, 092
Amethyst	do	45, 286	666, 336
Tourmaline	do	3, 412	238, 027
Topaz	do	16, 561	175, 821
Agate	kilos	5, 410	83, 076
Other gem stones	grams	371, 129	1, 431, 107

About 63 percent of these exports reached the United States. Total exports of aquamarine in 1940 were reported to have been 1,169,034 grams, worth about $667,000, and in 1941, 524,651 grams, worth about $550,000. Brazil's cutting industry employs about 2,500 artisans.

An aquamarine weighing 109 kilos was found early in the summer of 1942 at Ariranho in the State of Minas Gerais. The owners were at once offered 800 contos for the stone, or about $40,000. A short time before, a fine block of rock crystal weighing 480 kilos had been found in the same region.

South-West Africa formerly sold its precious stones to the Germans; in consequence, since the war began very little if any mining has been done. In 1939, however, 4,075,031 grams of precious stones were produced, and 9,226,269 grams, worth £1,132, were exported to Germany. The principal stones were aquamarine, heliodor (golden yellow beryl), tourmaline (blue, through green, to a pale yellow-green), rose quartz, and chalcedony. A few colorless or light-blue topazes are also produced around Leideritz Bay in the diamondiferous gravels, and some agate. Apparently, so far as aquamarine, tourmaline, and topaz are concerned, the pegmatite druses at the surface are more or less exhausted. The unweathered rock is hard, requiring the use of dynamite in mining, and any gem stones recovered from such rock are likely to be flawed.

INSTRUMENT AND CHRONOMETER JEWELS

Before the war, the United States imported virtually all its instrument and watch jewels from Europe, particularly from Switzerland. Without such jewel bearings, high-grade instruments and chronometers to guide our aviators and to assist our bombardiers and Navy officers cannot be made. When war came, plants were created in this country to produce synthetic sapphire, and stocks of Montana sapphire were set aside as a reserve. Simultaneously, mechanical means of fabrication were introduced. The program is apparently approaching successful completion. In addition, certain hard-glass bearings are being made, which will alleviate the situation. Imports for consumption of jewels for any movement, mechanism, device, or instrument or for any meter or compass numbered 92,547,236, valued at $2,007,012, in 1941 and 36,649,359, valued at $1,015,788, in 1942. In November 1942 the use of instrument jewels was confined to essential war work (WPB. M-50, amended Nov. 2, effective Nov. 2, 1942).

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GEM STONES

By Sydney H. Ball

SUMMARY OUTLINE

JEWELRY INDUSTRY IN 1943

Retail jewelers have never had a year like 1943. Sales of taxable jewelry totaled $998,094,416, or 26 percent above those in 1942 ($792,000,000). Gains over 1942 reached their peak in the second quarter of the year, then tapered off. The causes were an all-time high national income ($142,000,000,000, compared with $115,500,000,000 in 1942); a large number of weddings (1,725,000—only exceeded by the 1,800,000 in 1942); reduced competition from other luxuries and semiluxuries; and much money in the hands of free-spending warworkers. The increased sales were without Government stimulation. All men of draft age in the industry were nondeferable under the Selective Service System, and the 10-percent excise tax on jewelry sales was effective throughout the year.

Christmas sales were 20 percent larger than in the previous year and began as early as late September, so that our boys (and girls) overseas would get their gifts by Christmas. Gold jewelry, diamonds, costume jewelry, and Swiss watches were in particular demand.

Sales were largely of medium-price articles, although both retailers and art galleries disposed of a number of items running into five figures.

Manufacturing jewelers, with their supplies of metal markedly restricted by Government regulations, continued to make what jewelry they could, although the industry was converted, where possible, to war work. Their sales early in the year were large, although less than those of retailers. By August, however, sales slipped below those of 1942, and stocks decreased. Wholesalers began to sell from stocks accumulated in a happier day.

Luckily, now that the Office of Price Administration has removed price control from all diamonds, the black market in these gems has evaporated. The recently increased excise tax on all jewelry (from

10 to 20 percent, effective April 1, 1944) will scarcely increase the tax collected, as it is likely to cut down on gross sales and may create a black market, for certain of the smaller refugee "merchants" will sell without charging the tax. L-45 (Karat-Gold Limitation Order) has created a black market in carat-gold goods, particularly in wedding rings. It centers in New York. Some of the skilled workmen of the industry have left their former employers and work for fly-by-night shops or work overtime in them. Such shops have no difficulty in getting, at a price, the gold and the medieum of copper required. Low-carat gold rings and some electroplated silver rings are being sold surreptitiously as 14-carat rings.

On January 15, 1944, the War Production Board announced that approximately 50 percent more gold and palladium could be used by jewelers in 1944 than in the latter half of 1943. This liberalization of L-45 will retard the growth of the black market but is not sufficient to crush it.

A year or two hence—unless in the meantime peace is declared—the position of most retailers is not likely to be enviable. In 1943 most jewelers sold their accumulated stock, and adequate replacement is difficult or impossible; further, competent help is hard to find. Perhaps the less-aggressive sales attitude which the British retailers have adopted—namely, sell only that which can be replaced—is to be preferred. Present profits subject to current high tax rates are less desirable than having a going concern when the war ends. More retailers should specialize in diamonds, and they should replenish their stocks from heirloom jewelry. Some few retailers have shut up shop; others are shortening store hours appreciably.

POST-WAR PROSPECTS

As to the post-war outlook, competition within the retail trade will be keen, but reconversion of the jewelry trade should require less time than that of most other industries, and jewelers should be in an advantageous position compared with most of their competitors in being able early to extract from ex-warworkers some of their accumulated savings. Within the industry there will presumably be more competition from department stores, upstairs distributors, and door-to-door solicitors, because medium-price articles are likely to make up a larger percentage of the gross than formerly.

FASHIONS IN JEWELS

Jewelry was never more popular than in 1943 among American women who realize that beautiful jewelry, appropriately worn, may increase the charm of a smart gown. The vogue for gold, often in two or three tints, continued to grow, and more silver was used than ever. Diamonds still show to best advantage when set in white metal. Palladium, the substitute now used for platinum, is so light that it is ideal for earrings, and palladium pins do not "pull down" flimsy textiles. Floral designs and patriotic motifs were particularly popular, followed by geometric, leaf, and Latin-American and Chinese designs. Bizarre insects, animals, and dwarfs were common, particularly in cheaper jewelry. Multiple-use clips and other double-duty jewelry and ensembles, all mounted with the same gem, were widely used. Earrings and clips were much worn, bracelets and necklaces to a less extent.

Owing to a shortage of small cut, fewer melee were used in mountings. Huge topaz and aquamarine were mounted in bracelets and bridge rings. Diamond, ruby, and sapphire (the vogue for varied-colored sapphires is expanding) led in popularity, followed by natural and cultured pearl, emerald, topaz and topaz quartz, aquamarine, and moonstone. The insistent demand for diamonds, together with the patriotic motif in jewelry, caused colorless, then red and blue stones to be dominant, followed by green and yellow, and then purple and black stones.

American knowledge of precious stones continues to expand, and American women today use effectively three or four times as many varieties as did their mothers. High school and college girls love their jewelry, and turquoise and pearl are particularly popular with them.

DOMESTIC PRODUCTION

The production of gem stones throughout the world was blighted in 1943 by war, but nowhere more than on the North American Continent, which has no gem field of prime importance. In 1942 a rough estimate of the value of uncut stones used in jewelry and related industries was $150,000; in 1943, it was not over $67,000. The decrease was due to three principal factors: Professional gem miners turned to the mining of one or more of the strategic minerals; amateur collectors did not have enough gasoline (or tires) to rush out over the week-end to well-known mineral deposits; and the best customers of the trade, touring automobilists, were, for the same reason, a tradition. The increased mining of pegmatite bodies for mica and other strategic minerals apparently did not increase the production of beryl and other gems of pegmatite origin; perhaps the miners high-graded these. As opposed to gem miners, professional and semiprofessional lapidaries in the Northwest were busy furnishing jewelers with cabochon quartzes and agates, cut from stones collected in previous years, to supplant the European cheap jewelry which was no longer available. In the East, several firms are dyeing onyx black to be used in cheap jewelry.

As producers, the leading States ranked as follows: Montana, California, Wyoming, Oregon, Washington, Colorado, and Idaho.

The Montana sapphire industry produced about 20,000 ounces of sapphire worth some $20,000. The Perry-Schroeder Mining Co. of Helena was the principal producer. Charles H. Carpp of Philipsburg was also a producer. Although a small part of the product was of gem grade, practically all of it was sold for cutting into watch and instrument jewels. Toward the end of the year, synthetic corundum undercut the natural market badly.

The agate and other quartz species in 1943 were of the same order of value produced as sapphire. Dr. H. C. Dake reports that production, even at well-known localities in Washington and Oregon, was greatly reduced from that of previous years. Idaho's production decreased also.

The moss agate in the gravels of Yellowstone River in Montana continues to be collected, but to a smaller extent than in previous years. The collectors bring these to the two principal cutting and curio shops in Billings. After splitting the pebbles, the shops buy what small percentage they fancy.

Perhaps $15,000 worth of Wyoming jade was sold in 1943. Nephrite occurs mainly as boulders and pebbles, some of them large, on the hill slopes near Lander. It also occurs in place. The better material, green translucent nephrite, brings as much as $5 a pound, although the 4,000 pounds sold to lapidaries brought but $3 a pound. Several large boulders, one weighing over 8,000 pounds, were found in 1943. A boulder weighing 2,410 pounds and polished on one side is now on exhibition at the Chicago Natural History Museum. Some of the material is being stocked, in the hope of selling it to China after the war to be cut into objets d'art. All the Lander material is nephrite.

Turquoise production languished. The King and Ashcroft mines in Colorado produced turquoise in 1943, although the Hall mine (principal producer in 1942) did not operate. It is stated that the Mineral Park (Ariz.) district produced some turquoise, as did certain deposits in western New Mexico. The manufacturers of Indian jewelry, however, look to Nevada and Colorado for their turquoise, although there is no evidence at hand that the Nevada mines operated in 1943. A turquoise deposit in Culberson County, Tex., is being developed.

Alfred M. Buranek reports that some good plume agate was collected at Jericho, Juab County, Utah, as was fortification agate at the new locality in Sanpete County near Levan; that some 500 pounds of fine variscite was mined at Lucin; that some superb malachite and azurite were recovered from the Dixie Apex mine near St. George; that the black obsidian with white christobalites found near Black Creek (trade names, Flowering Obsidian, Night Blooming Cereus, and Snowflake Obsidian) is increasing in popularity; and that Utah Jade, fabricated into book ends, table tops, and other articles, is merely a quartzite of the Harrison formation of pre-Cambrian age colored by chrome-bearing mica.

Stuart A. Northrop states that some attractive "moonstone" (presumably sanidine) appears to be coming from Grant County, N. Mex., and that during the year there was a small demand for garnets from the Navajo Reservation, staurolites from Taos County, and agate from near Hot Springs, Sierra County.

Stanley I. Perham reports among other gem stones found in Maine during the year: Purple apatite at Greenwood, Oxford County; beryl approaching a light emerald in color and golden beryl from West Peru; fine golden beryl from Waterford and Brunswick; white caesium beryl and rose quartz at Newry; and aquamarine and asteriated rose quartz from Albany.

Little pipestone (only about 1,000 pounds) was mined at Pipestone, Minn., as most of the former diggers are in the army.

Scott's Rose Quartz Co. (South Dakota) reports the sale of about 800 pounds of rose quartz, although little was mined because of the labor shortage.

Edward P. Henderson reports that the National Museum has an 18.7-carat brilliant cut from transparent scheelite from Kernville, Kern County, Calif. The stone has good brilliancy although a bit frosty, and makes quite an attractive gem.

Quartz for use in radios and radar equipment was mined in California, Arkansas, and North Carolina. The usability of American quartz is low, but some of it may be suitable for objets d'art.

A few small diamonds were recovered at Murfreesboro, Ark. (see Diamond—World production).

Other gems produced in the United States in 1943 included agate (Maine); aquamarine (Maine, North Carolina, and Virginia); bloodstone (San Bernardino County, Calif.); chrysocolla (Arizona); golden beryl (Virginia); jasper (Maine); banded "onyx" (calcite) (Lusk, Wyo.); malachite (Arizona); petrified wood (Arizona); pink beryl and tourmaline (Pala district, Calif.); and smoky quartz (Maine).

CANADIAN GEM STONES

A small amount of clear, glassy beryl from the Winnipeg River and Bird River pegmatite areas in Manitoba is cut for the Winnipeg tourist jewelry trade. Dr. A. L. Parsons reports that excellent rock crystal has been found in Lansdowne Township, Ontario, and a little iolite in Haliburton Township. Both localities furnish material for amateur lapidaries.

IMPORTS [1]

The value of imports of precious and semiprecious (real and imitation) stones (exclusive of industrial diamonds) totaled $72,109,788, over two and one-half times that of 1942. The big increase was in the importation of rough and cut diamonds and cut precious stones. Details are as follows:

Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1942–43

Commodity	1942		1943	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty free	278,437	$11,546,712	751,874	$37,443,240
Cut but unset, suitable for jewelry, dutiable	126,004	14,640,236	193,701	31,453,840
Emeralds:				
Rough or uncut, free	6,506	676	8	248
Cut but not set, dutiable	21,209	205,717	3,194	32,508
Pearls and parts, not strung or set, dutiable:				
Natural		179,169		167,284
Cultured or cultivated				107
Other precious and semiprecious stones:				
Rough or uncut, free		72,895		47,726
Cut but not set, dutiable		1,583,600		2,589,904
Imitation, except opaque, dutiable:				
Not cut or faceted		195		2,621
Cut or faceted:				
Synthetic		87,062		167,166
Other		97,857		100,841
Imitation, opaque, including imitation pearls, dutiable		2,622		8,149
Marcasites, dutiable:				
Real		101,785		96,154
Imitation		1,544		
		28,520,070		72,109,788

[1] Figures on imports compiled by M. B. Price, of the Bureau of Mines, from records of the United States Department of Commerce.

GOVERNMENT REGULATIONS

Owing to the war, Government regulations covering the jewelry industry and originating in 1943 were legion. Many were primarily to raise revenue and to discourage luxury spending (for example, the 100-percent tax on jewelry sales in Great Britain); others to conserve labor or to control the supplies of valuable metals; others to prevent the export of easily converted wealth; and still others to protect home industries (for example, to protect its precious stone industry, Brazil requires a permit, difficult to obtain, to import synthetic stones).

In Germany all shops selling jewelry were closed in February, and jewelry manufacture was prohibited after April 1. In all, 3,300 shops were closed, the blow of course falling most heavily on middle class proprietors. German war prisoners in Canada, remembering what happened to the mark after World War I, are buying plain gold rings.

The Nazis closed jewelry shops in the Netherlands in March. The Germans continue to buy any fine jewels they can in the Netherlands black market, even if the prices are exorbitant. On September 29, the Nazi-controlled Department of Commerce decreed that pearls, rubies, sapphires, and emeralds could be bought only against surrender of ration coupons. Precious stones were one of the few means left for the Netherlanders to invest money. The decree will force such excess money into the Netherlands Bank, where the Nazis can confiscate it.

EFFECT OF WAR ON GEM-STONE TRADE

War continues to change the picture of the gem trade; for example, the recent reopening of the Dutoitspan pipe is a direct result of the tremendous fall in world diamond stocks due to war's insatiable demand for industrial diamonds and the large demand for gem diamonds. We are, on the other hand, cut off from the ruby and sapphire fields of Burma and Thailand; the Burmese jade fields are languishing because China, their main market, is no longer open to them; and the Badakshan lapis lazuli mines have lost their former market, Germany.

Our boys overseas are matching their wits with those of local jewelers of many lands. Ceylon's precious stones have mounted in price, and not only are jewel brokers bidding for them, but our boys are getting their part there as well as in India. Our soldiers have already purchased most of the lovely old silver jewelry in the Algerian shops; Italians are now attempting to foist flimsy trinkets on them as fine heirlooms.

Our domestic production of gem stones is down, since professional mines are mining strategic minerals, and amateurs have neither the tires nor the gas to seek them. Similarly, in Brazil accelerated quartz and mica mining draws from the same pool of labor as diamond and other gem-stone mining, and in consequence the production of the latter two is affected adversely.

In Great Britain, wedding rings are so scarce that some brides use their grandmothers' or mothers' rings. The production quota of 9-carat utility rings has been increased, and many brides are reluctantly accepting them rather than the better rings they hoped to wear. South African brides refuse to accept them.

War has brought about important (though possibly temporary) geographic adjustments in various branches of the jewelry industry. The wide dispersal of the cutting of gem diamonds is an instance in point. Argentina is making the cheap jewelry which it once imported and even exports some of it. Great Britain and the United States now produce synthetic sapphire and ruby, and after the war these will be used for jewelry. Czechoslovak refugees in each country are making fine colored glasses to be used as imitation precious stones.

One of the few humorous incidents of the war is the fact that our boys find that the South Pacific island natives will do nothing for money but are enchanted to work hard for second-hand "junk" jewelry. Tons are being collected and sent to the Pacific isles.

DIAMOND

Paradoxical as it seems, in 1943—the fifth year of World War II—the diamond industry reached an all-time peak of prosperity, owing to an unprecedented demand for industrial stones and an enormous demand for gem diamonds created by high war wages and fear of inflation.

Production continued downward, that of 1943 being but 88 percent of the 1942 output and only 63 percent of the production in 1940. The war demand has dangerously reduced the large stocks of both industrials and gem stones accumulated in the past 16 years; in consequence, the United Nations have requested the Belgian Congo to double its production of crushing bort, and DeBeers has reopened Dutoitspan, one of its pipe mines. Diamond cutting continued to increase.

Price of gem stones, both rough and cut, surged forward; that of industrial stones continued stable, although sellers of industrial stones claim that the quality of the shipments had deteriorated, amounting to a price rise.

The division between diamonds used for industrial purposes and those used ornamentally is yearly becoming more sharply defined.

Share dealings.—The shares of diamond-mining companies, virtually all of which are listed on the London Stock Exchange, were market leaders and doubled in value in 1943, accentuating their rise in the past 2 years. Indeed, one who had put $1,000 in these shares in mid-1941 would have a value on paper of $4,500 by mid-1943. The 1943 advance culminated late in June; thereafter the market weakened a bit. The companies paid generous dividends in 1943.

Market.—In 1943 the Diamond Trading Co., which in normal times sells about 95 percent of the world output, is said to have sold almost £20,000,000 worth of rough (£10,694,671 in 1942), the highest sales since 1919. Sales of both cuttables and industrials gained. The company instituted the practice of selling crushing bort by the kilogram, although American brokers continue to use the carat.

In 1943 the United States bought large quantities of medium-size diamonds, and the United States, Palestine, and South Africa bought cuttables for their cutting shops. Black markets thrived in all the warring nations, diamonds being a favorite investment of citizens of conquered countries and those of belligerent countries whose war future is precarious. Americans bought fine diamonds heavily, partly to supply their craving for beauty, partly as a hedge against inflation.

Since 1939 the price of fine large rough has increased at least 70 percent, and the price is boosted by the Trading Co. on every favorable occasion. As to cut stones, melee under ¼ carat has tripled or quadrupled in value since 1939; ½-carat sizes have gained 80 to 125 percent; 1-carat stones, 67 to 100 percent; and larger stones progressively less. Increases include the excise tax (1943, 10 percent; 1944, 20 percent). Diamonds have never sold higher; and prices may have been advanced too rapidly for the good of the industry.

Stocks of both fine rough for gem purposes and many grades of industrials have been reduced, possibly to a dangerous degree, since demand has markedly exceeded supply. In America the cutters have a more or less satisfactory supply of most grades of rough; but supplies of melee and fine cut in certain sizes are short.

Imports.—As the following table shows, in 1943 the total value of imports of gem diamonds was 163 percent higher than in 1942, the gain being particularly great in rough or uncut diamonds (225 percent); that in cut was also large (115 percent). The quality of both rough and cut paralleled that of 1942, the rise in price during 1943 accounting for the increased prices per carat.

Diamonds imported into the United States, 1942–43, by countries

[Exclusive of industrial diamonds]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1942						
Argentina				36	$32,013	$889.25
Belgian Congo	205	$4,573	$22.31			
Belgium and Luxemburg				26,755	2,049,057	76.59
Brazil	6,320	477,812	75.60	23,842	2,686,071	112.66
British Guiana	591	19,775	33.46	55	5,810	105.64
British Malaya				278	19,628	70.60
Canada				1	395	395.00
Colombia				18	2,666	148.11
Cuba				2,746	321,863	117.21
France				1,327	184,250	138.85
Germany				162	7,520	46.42
India and Dependencies				1	50	50.00
Mexico				365	41,211	112.91
Netherlands				960	83,341	86.81
Netherlands Indies				117	13,579	116.06
Palestine and Trans-Jordan				20,502	2,994,830	146.08
Switzerland				175	19,346	110.55
Union of South Africa	253,191	10,553,052	41.68	35,351	4,767,308	134.86
United Kingdom of Great Britain and Northern Ireland	1,683	102,154	60.70	13,307	1,410,598	106.00
Venezuela	16,447	389,346	23.67	6	700	116.67
	278,437	11,546,712	41.47	126,004	14,640,236	116.19
1943						
Argentina				67	12,590	187.91
Belgian Congo	1,840	42,294	22.99			
Belgium and Luxemburg	1,369	21,444	15.66	19,630	1,329,527	67.73
Brazil	6,207	557,541	89.82	40,933	6,487,150	158.48
British Guiana	2,254	46,243	20.52	185	21,839	118.05
Canada				49	5,255	107.24
Cuba				21,913	3,337,950	152.33
France				567	99,401	175.31
French Guiana				19	2,010	105.79
Gambia and Sierra Leone	3,861	80,432	20.83			
Gold Coast	1,000	17,653	17.65			
India and Dependencies				63	10,717	170.11

Diamonds imported into the United States, 1942–43, by countries—Continued

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
Mexico				406	$41,273	$101.66
Netherlands				569	121,524	213.57
Palestine and Trans-Jordan				50,361	9,153,273	181.75
Peru				14	1,283	91.64
Portugal	11	$225	$20.45	83	10,888	131.18
Portuguese Guinea and Angola	1,664	40,141	24.12			
Switzerland				112	22,773	203.33
Union of South Africa	702,858	35,338,584	50.28	33,394	6,667,871	199.67
United Kingdom of Great Britain and Northern Ireland	22,833	945,929	41.43	25,336	4,128,516	162.95
Venezuela	7,777	352,754	45.36			
	751,674	37,443,240	49.81	193,701	31,453,840	162.38

Cutting.—Before 1940 the Low Countries cut about 90 percent of the world's diamonds. Since then the industry has been widely scattered over the world. Some 10,000 artisans and apprentices (about one-third of the pre-war force) now supply (except in time of lock-out or strike) an adequate quantity of cut stones. Palestine (3,000 employees), the United States (1,800 employees), and South Africa (550 employees) are now the principal centers of cutting. Brazil, Great Britain, Cuba, Puerto Rico, Canada, India, and Borneo are less important centers.

With the rebirth of the Belgian and Netherlands industries after the war, competition will be keen. Perhaps the United States and South Africa can continue—notwithstanding fantastically high wage scales—to cut large stones profitably, and Palestine may be able to cut small stones.

World production.—Owing to the war accurate diamond-production statistics are not available, but the estimates in the following table are believed to be fairly reliable. World production (gems and industrials) in 1943 is estimated to have been 8,191,360 carats (1.64 metric tons), valued at $27,000,000. The quantity was about 12 percent less and the value 4 percent less than in 1942. The quality was slightly better than in 1942, cuttables making up, by weight, some 22 percent of the total. Belgian Congo was the leading producer, both as to weight and value, although the collective value of the British production exceeded that of the Belgian colony. As DeBeers reopened Dutoitspan on September 1 pipe mines yielded almost 1 percent of the production, but over 99 percent came from placer mines.

The following table shows, as accurately as available statistics permit, world production for the past 5 years.

World production of diamonds, 1939–43, by countries, in metric carats

[Including industrial diamonds]

Country	1939	1940	1941	1942	1943
Africa:					
Angola	690,353	784,270	787,000	[1] 791,850	800,000
Belgian Congo	8,360,000	9,603,000	5,866,000	6,018,000	4,880,000
French Equatorial Africa	[1] 16,000	[1] 16,000	20,000	20,000	20,000
French West Africa	56,314	[1] 75,000	35,000	36,000	36,000
Gold Coast [2]	1,087,652	[1] 825,000	1,000,000	[1] 1,000,000	1,000,000
Sierra Leone	[1] 600,000	750,000	850,000	[1] 850,000	850,000
South-West Africa	35,470	30,017	46,578	56,420	100,000
Tanganyika (exports)	3,445	2,250	[1] 1,750	1,000	500
Union of South Africa:					
Mines	1,089,144	[1] 371,447			[1] 70,000
Alluvial	160,684	[1] 172,027	112,300	117,628	[3] 103,210
Total Union of South Africa	1,249,828	[1] 543,474	112,300	117,628	173,210
Brazil	[1] 350,000	[1] 325,000	325,000	300,000	275,000
British Guiana	32,491	[1] 26,764	27,000	27,000	27,000
Other countries [4]	19,000	31,750	34,350	40,836	29,650
Grand total	12,500,553	13,012,525	9,104,978	9,258,734	8,191,360

[1] Estimated.
[2] 1939–40: Exports; 1941–43: Production.
[3] Cape and Transvaal, without Namaqualand, estimated at 53,210 carats.
[4] 1939: Venezuela, India, Borneo, New South Wales, and U. S. S. R.; 1940–41: Borneo, India, New South Wales, U. S. S. R., and Venezuela (Venezuela produced, respectively, 14,525 and 29,399 carats); 1942: Borneo, India, New South Wales, Rhodesia, U. S. S. R., and Venezuela (Venezuela produced 31,570 carats); 1943: Venezuela (23,020 carats), Borneo, India, New South Wales, U. S. S. R., United States (Arkansas), and Bolivia.

Because of a shortage of supplies, the Belgian Congo produced 19 percent less diamond in 1943 than in 1942, and Brazilian and the South African alluvial production decreased; that of South-West Africa increased somewhat.

Dr. N. R. Junner published a most valuable bulletin on the Gold Coast diamond fields. Sierra Leone produced two large gem stones during the year, thus joining the select coterie of large stone producers—India, Borneo, South Africa, and the Bagagem district in Brazil. The occurrence of diamonds in eastern Bolivia is reported.

The Federal Bureau of Mines did some exploratory work on the diamond-bearing kimberlite pipe at Murfreesboro, Ark. It put down 51 bucket drill holes 30 inches in diameter through the softer surface material. They ranged from 10 to over 50 feet in depth, averaging slightly over 30 feet. In all, over 425 tons of samples were taken. These have been washed by South African methods and all diamonds recovered with adequate safeguard to insure reliability of results. The stones recovered are being evaluated by a number of experts and the data assembled and studied. Results are not yet available.

Industrial diamonds.—In 1835 the great British scientist, Sir David Brewster stated that were the diamond not as a gem the "head of the mineral kingdom," "it would have attained the same distinction from its great utility in the arts." World War II has certainly proved the truth of the statement. There is no important war weapon used by our forces that does not employ the diamond in its manufacture.

The use of industrial diamonds, particularly of crushing bort, continues to increase by leaps and bounds under the stimulus of war, although much of the gain will be retained in post-war times. Consumption greatly exceeds production. Finer grades continue scarce, but research and experience prove that the grades available are satisfactory substitutes.

Germany and Japan are already pinched for industrial diamonds, hence their desperate efforts to smuggle this superabrasive into the homelands. Stocks in the United States are adequate, and in case of need the large stock established in Canada by the Diamond Corporation and the principal producers is available.

Before the war the United States consumed about 1,250,000 carats of industrial diamonds a year. The figure had increased to some 10,000,000 carats in 1943. World consumption must be double present production.

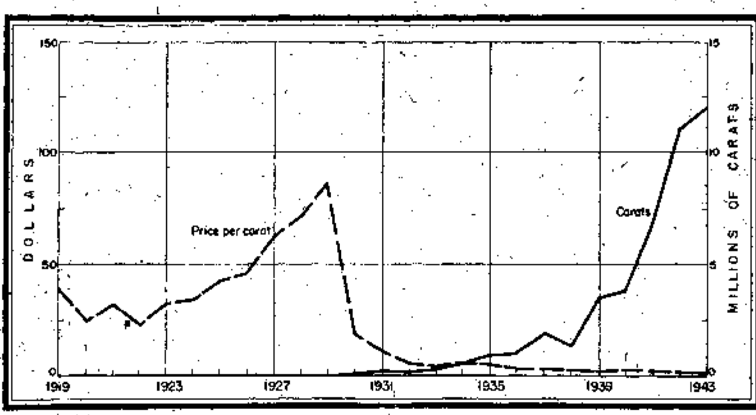

FIGURE 1.—United States imports and average price per carat of industrial diamonds, 1919–43.

Figure 1, prepared by Herbert Backman, illustrates the two outstanding features of the industrial diamond trade in the past quarter century: The tremendous increase in use, particularly since 1938, and the sharp decrease in the average price of the stones used. In 1929 the carbonado market—then the principal source of our imports—was cornered. Now most of our consumption is that of crushing bort.

Imports of industrial diamonds into the United States during the past 5 years were as follows:

Industrial diamonds (glaziers', engravers', and miners') imported for consumption in the United States, 1939–43

Year	Carats	Value		Year	Carats	Value	
		Total	Average			Total	Average
1939	3,568,730	$9,725,683	$2.73	1942	11,203,704	$22,057,577	$1.97
1940	3,809,071	11,026,563	2.89	1943	12,172,679	21,938,368	1.80
1941	6,882,248	14,908,809	2.17				

RUBY, SAPPHIRE, AND EMERALD

The production of fine gem stones—rubies, emeralds, and sapphires—is meager and entirely in the hands of individuals and small partnerships. The ruby mines of Burma and the sapphire mines of Thailand and Indochina may still be operated on a small scale by the natives, but they are shut off from their principal markets, America and western Europe. The Japanese market must be quite restricted.

The Muzo emerald mines have not been operated for several years. The Ceylon sapphire mines and perhaps those of Kashmir are presumably booming, and the American troops stationed in the East constitute an enlarged local market. Before the war the Australian sapphire mines were languishing, and war has also interfered with production at most of the minor gem localities, including the Russian emerald mines and the Montana sapphire mines. Egypt, in its program to develop the mineral resources bordering the Red Sea, has recently announced that the ancient emerald mines are to be reopened; but little, if any, desirable material can be expected from this source.

Paradoxically, there is no dearth of fine gem stones, which, incidentally, have never been more popular. The supply, however, is coming from stocks and from old jewelry, now being bought by almost every jeweler. The restricted production and the phenomenal demand, which are likely to continue after the war, point to higher prices in the future.

Since the war, New York and London have supplanted Paris as the principal colored-stone markets and are now receiving stones direct from the East.

LESSER GEMS

Brazil continues to supply our market with fine and barbarically large aquamarine, topaz and citrine, and other precious stones.

The press reports the Government of Kashmir has authorized exploitation of an opal deposit. If the report is reliable, perhaps Pliny was correct, when 1,900 years ago he emphasized the wealth of India in opal.

From 1890 to the end of 1938, Australia had produced opal worth £1,627,000 in the rough. The 1938 production, largely from South Australia and New South Wales, was worth £8,876, and in 1941 the diggers were said to be busy, so that presumably there is still a small production.

Dr. Henry W. Nichols (see Bibliography) describes a 312-pound block of lapis lazuli exhibited in the Field Museum, Chicago (now Chicago Natural History Museum). It is 2 feet long, 1⅛ feet wide, and three-quarters of a foot thick.

In August importers and retailers unabashedly launched Imperial Mexican Jade on the market in a national advertising campaign. The flagrant fake was detected almost immediately, it being proved that the "jade" was merely calcium carbonate ("Mexican onyx") stained green.

Iran and the United States signed a Reciprocal Trade Agreement on April 8, 1943, by which the import duty on cut turquoise into the United States from Iran is reduced from 10 to 5 percent; uncut turquoise has been duty-free for some time. Owing to adequate turquoise deposits, the United States for some years has imported little cut turquoise from Iran.

INSTRUMENT AND CHRONOMETER JEWELS

When the war started, the United States was dependent on Switzerland and France, not only for the synthetic corundum and spinel from which instrument jewels are made but also for their fabrication. Now, the Linde Air Products Co., the Bulova Watch Co., and several smaller companies produce an adequate supply of synthetics, and other firms have adequate fabricating facilities to satisfy the national demand for instrument jewels, which, of course, has been greatly increased by the war. Production increased 370 percent in 1943. War Production Board Order 4717, issued December 23, 1943, eases controls and restrictions on instrument and jewel bearings.

Thus war has introduced in America two more industries—manufacture of synthetics and fabrication of instrument jewels. That of making synthetics presumably should survive after peace is declared.

Small ball bearings have replaced jewels in watches and some instruments, but it is not believed that this substitution will become general.

Out of synthetic sapphire, one American company is now making gages, Diesel injector nozzles, dies for drawing wire from soft metal, and machining tools for soft metals. The gages are of longer life and closer tolerances than those of steel.

Late in the year, the Government of India inquired of Ceylon whether it could furnish 8,000 sapphires and garnets for instrument jewels; further, whether this material could be cut by local lapidaries into instrument jewels. Owing to a shortage of skilled lapidaries, the Colombo jewelers approached were unwilling to attempt to fabricate the jewels.

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GEM STONES

By Sydney H. Ball

SUMMARY OUTLINE

JEWELRY INDUSTRY IN 1944

The sales value of taxable jewelry in 1944 reached a record total of approximately $1,063,000,000, 7 percent above the previous high of $998,094,416 set in 1943. The gain is attributed principally to increases in prices rather than to a larger volume. Sales were unusually heavy during the first quarter, but from April to August they fell below the corresponding months in 1943, owing to an increase in the excise tax to 20 percent on April 1 and the belief, then current, that the war would end soon. The public had become accustomed to the new tax by September, and for the last 4 months of the year sales exceeded those of the corresponding months of 1943. Christmas shopping, which began as early as September because so many were overseas, also exceeded that of 1943. Diamonds, Swiss watches, rings, and gold-plated silver-based jewelry were the leading items. Medium-price articles sold best, although some very expensive items were purchased, probably as a hedge against inflation.

Taxes on jewelry in 1944 were $152,765,380, an increase of 53.6 percent over those of 1943, due largely to the higher tax rate.

Prices rose somewhat in 1944 but on the whole probably less than those of good clothes or other comparable commodities.

The prosperity of the jewelry trade was based upon a record national income (161 billion dollars, compared with 147.9 billion in 1943), a large number of weddings, much cash in the hands of the average citizen, and subnormal competition for the American spending dollar.

Sales by wholesalers were somewhat less than those of 1943, and, owing to a shortage of labor and restrictions on the use of certain metals, their stocks decreased in 1944. The resale of old jewelry bolstered retailers' volume.

The retailers increasingly feel the competition by the department stores, and the sales of the latter show greater increases than those of the retailer. A number of department stores conduct a brokerage business in used jewelry, said to be profitable. Upstairs distributors and door-to-door solicitors also compete with the sale of medium-price items, the bread and butter of the retailer.

The Canadian retailer had a good year, as did his South African and Australian confreres, although each was plagued by a shortage of stocks. By the purchase and resale of old jewelry, a vestige of life is kept in the British trade.

Costume jewelry is now a big business, sales running into several tens of million dollars a year. Base metals, silver, glass, ceramics, plastics, and a host of other materials are used, and prices of individual items have skyrocketed.

POSTWAR PROSPECTS

As to the postwar outlook, competition within the retail trade will be keen, but for a time the jewelry trade will have an advantage, for its reconversion should be rapid. One encouraging factor is that during the war many Americans have repressed a desire to spend money on beautiful things. However, if in the postwar period a substantial reduction in the national income occurs, the jewelry trade will be more adversely affected than trades dispensing food, clothes, and other necessities. With the re-entry of the European cutters into the market, gem cutters in the United States, South Africa, and Palestine will have keener competition. Some of the war-born cutting centers are likely to shrink in size or disappear. Although the consumption of industrial diamonds may decrease for a time, their expanding use in drill bits and wire-drawing dies indicates that the industrial market will be well-maintained.

FASHIONS IN JEWELS

Diamonds always show to best advantage when set in white metal. Until the war is over, palladium serves as a reasonable substitute for platinum, but thereafter platinum, without much doubt, will be the mounting par excellence for fine gems. Gold, often in two or three tones, was used, particularly in mounting colored stones; silver for the less precious stones. Even ultrafashionable jewelers began mounting garnets and other less costly but effective gems with diamonds, rubies, and sapphires. Flower designs (sometimes mounted on springs), ribbons often tied in bowknots, butterflies, and tiny animals were popular, and Victorian jewelry sprang into popularity. Egyptian motifs in necklaces are effective. Multiple-use jewelry and single-gem ensembles, clips and pins worn on coats, gowns, and hats, bracelets, earrings, and rings remained popular, whereas choker collars and hair ornaments were innovations. Stones of tremendous size are worn in rings, bracelets, and pendants. The double-ring ceremony now predominates at weddings, the service husband desiring a tangible link with his far-off wife; even double engagement rings are now used, the groom-to-be wearing a seal or crest ring.

Melee (small diamonds) to mount fine gems continued to be in short supply and expensive and were replaced in part by cabochon rubies and sapphires. Diamond, ruby, and sapphire (multicolored sapphires continued their vogue) led in popularity, followed by topaz (true and citrine), aquamarine, emerald, and amethyst. Many other stones were worn, and the peridot is deservedly gaining popularity.

The ever-insistent demand for diamonds caused colorless, then blue and red, stones to be dominant, followed by yellow, green, and purple stones.

DOMESTIC PRODUCTION

In 1944, the value of uncut stones from domestic sources used in jewelry and related industries approximated $41,000, which is substantially lower than the $67,000 and $150,000 reported in 1943 and 1942, respectively. The professional gem miner sought strategic minerals; the amateur collector did not have gasoline or tires to pursue his hobby, and the tourist (the principal purchaser of domestic gem stones) was almost nonexistent. The western lapidaries, professional and amateur, largely cut stock collected in a happier day. A few gem stones were byproducts of the intensive search for mica in the New England States.

As producers, the leading States ranked as follows: Arizona, Wyoming, Colorado, Washington, Montana, and Oregon.

Turquoise was the leading gem produced, its value having been about $17,000. Miami, Ariz., is a new locality. The Castle Dome Copper Co., Inc., states that in its open pit "occasional specimens of turquoise are uncovered during routine mining operations. Occurrence is in the form of small veinlets. Although of sufficient hardness for gem purposes, most of this material is of a very pale-green or blue color, requiring impregnation with oil to darken the stones before they are of commercial value." Presumably, the better stones are collected and perhaps sold by the miners.

W. P. King and two miners worked the King mine, 11 miles southeast of Manassa, Colo., for about 3 months in 1944. He estimates the value of the finished product at $7,000. The Hall and Ashcroft turquoise properties in Colorado were not operated. Apparently, the mine near Beowawe, Nev., did not operate in 1944, nor did Los Cerrillos in New Mexico. The Navajo and Pueblo silversmiths look to Colorado, Arizona, and other States for the turquoise used in their jewelry.

Agates, jaspers, and related quartz minerals probably were next in importance. Most of them are obtained in Washington and Oregon. Other producers were Montana (moss agates), Arizona (agatized wood and chalcedony), Idaho, Colorado (agates), South Dakota (agates), and Wyoming (Sweetwater moss agates). Scotts Rose Quartz Co., Custer, S. Dak., sold a little rose quartz for jewelry use and larger quantities of lower-grade material for rock gardens.

Bert A. Rhoades reports that 3,000 to 4,000 pounds of jade (nephrite) were mined in the Lander, Wyo., field. He and Byford Foster ran small cutting shops continuously and readily sold all they could cut. Three other cutters worked part time. Fred Abernathy sank a pit on nephrite in place, but the nephrite so far found is partly altered. In the summer of 1944 rough nephrite was being sold at $1 to $10 a pound. Some of the green jade is of good quality, and the black makes a good material for objets d'art.

Chinese agents purchased 5,890 pounds of Wyoming jade during the year to be shipped to China after the war.

The Montana sapphire industry had a poor year. Virtually all this sapphire is used industrially, only a small percentage being set in jewelry. The Perry-Schroeder Mining Co. of Helena, Mont., operated during only the first 4½ months of 1944. It produced about 4,500 ounces of culled sapphire containing $200 to $300 worth of gem material. No other Montana sapphire mine operated.

Alfred M. Buranek reports that the Clay Canyon, Utah, variscite deposit was worked for a short time in 1944, and that some good nodular variscite was shipped to the East. Smaller amounts were recovered from the Grantsville (Tooele County) and Lucin (Box Elder County) deposits. He estimates the value of the 1944 Utah production at approximately $2,000. He adds that Japanese internees collected some topaz from Topaz Mountain; that a little fine malachite and azurite were obtained from the Dixie Apex mine near St. George; and that other gem stones collected in the State included "snowflake obsidian" (Black Creek), jet (southeastern Utah), and agate and chalcedony. Chalcedony was also found near Fruita, Mesa County, Colo.

Dr. Stuart A. Northrop reports that some fine green smithsonite was produced in the Magdalena district, Socorro County, N. Mex.

Other gem stones produced in the United States in 1944 were transparent albite (Newry, Maine), amethyst (Stow, Maine), aquamarine (Newry, Maine; New Hampshire; North Carolina; and Virginia), caesium beryl (Maine), garnet (Arizona), golden beryl (Maine), obsidian (Arizona), peridot (Arizona), white topaz (Maine), and colored tourmaline (Rumford, Maine).

In 1944, John Adair published a scholarly ethnologic study of American Indian silversmiths, entitled "The Navajo and Pueblo Silversmiths."

CANADIAN GEM STONES

Apparently there was no gem-stone production in Canada in 1944.

A. W. Jolliffe, of the Canadian Geological Survey, writes that in the Yellowknife Beaulieu pegmatites, Northwest Territories, small crystals of blue-green tourmaline are common; larger ones occur, but they are usually of poorer quality; red tourmaline is less common; and deep blue lazulite, possibly of gem grade, also occurs. He reports that sapphire is found in quartz at Outpost Islands, Great Slave Lake; cordierite, in the same region; fine chiastolite at Quyta Lake, 20 miles north of Yellowknife, and translucent brownish to mauve-pink andalusite in quartz bodies cutting aluminous sediments.

ACCESSIONS TO MUSEUMS

Dr. E. P. Henderson, of the United States National Museum, reports that a cat's-eye emerald of 4.56 carats was added to the Roebling collection in 1944. The chatoyant band is well-developed, and the color of the emerald is a good green. He adds that a new mineral, brazilianite, from Brazil, a hydrous sodium-aluminum phosphate, has gem possibilities; and Dr. Frederick H. Pough, of the American Museum of Natural History (New York), reports that he has two gems, each of about 20 carats, cut from brazilianite. They are slightly green-yellow in color and very brilliant.

A number of rock-crystal seals belonging to former Emperors of China have recently been placed on exhibition in the Philadelphia Museum of Art. They and many other examples of Chinese art were given to the museum by Major General and Mrs. William Crozier of Washington.

IMPORTS [1]

The value of imports of precious and semiprecious (real and imitation) stones, exclusive of industrial diamonds, totaled $77,529,806, 8 percent more than in 1943. The value of imports of rough diamonds, emeralds, pearls, and "other precious and semiprecious stones" increased, whereas that of cut but unset diamonds decreased.

Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1943–44

Commodity	1943		1944	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty free	751, 240	$37, 443, 240	896, 547	$43, 445, 219
Cut but unset, suitable for jewelry, dutiable	193, 701	31, 458, 089	169, 097	29, 263, 121
Emeralds:				
Rough or uncut, free	8	248	1, 966	1, 668
Cut but not set, dutiable	3, 194	32, 508	38, 666	81, 233
Pearls and parts, not strung or set, dutiable:				
Natural		167, 284		242, 221
Cultured or cultivated		107		15, 394
Other precious and semiprecious stones:				
Rough or uncut, free		47, 726		105, 401
Cut but not set, dutiable		2, 590, 931		3, 725, 453
Imitation, except opaque, dutiable:				
Not cut or faceted		2, 621		14, 550
Cut or faceted:				
Synthetic		167, 166		503, 718
Other		102, 450		23, 887
Imitation, opaque, including imitation pearls, dutiable		8, 149		23, 113
Marcasites, dutiable: Real		96, 154		84, 828
		72, 116, 673		77, 529, 806

GOVERNMENT REGULATIONS

In January 1944, the use of gold and palladium in the manufacture of jewelry was liberalized, and on August 14, 1944, all restrictions were removed by the War Production Board, the two metals no longer being in short supply. The restrictions against copper interliners in gold-plated and gold-filled stock were almost simultaneously modified. Iridium was released from allocation on July 21, 1944, although the conservation provisions of the allocation order remained in force. The supply of this metal has been increased. No release of restrictions on the use of platinum can be expected for some time, as military and essential requirements for the metal remain large.

The War Production Board virtually prohibited the sale after March 1, 1945, of any jewelry containing tin.

Although brass may be used for silver-plated flatware, no nickel is available for production of nickel-silver. As the silver trade must depend entirely on newly mined silver, the production of silverware in the United States is small today.

[1] Figures on imports compiled by M. B. Price, of the Bureau of Mines, from records of the U. S. Department of Commerce.

Government regulations for control of the jewelry industry are not confined to the United States. As of October 15, 1944, the Japanese Munitions Ministry required that all platinum in the hands of its citizens be sold to the Government, indicating the severe shortage of that important war metal in Japan.

Late in October, Sweden further restricted the importation of gold, platinum, and other valuables, presumably to prevent the Nazis from using Sweden as a haven for their ill-gained wealth.

On August 1, 1944, Canada permitted the importation of jewelry from the United States. However, taxes of one sort or another are so high that it is unlikely that the trade can be large. On September 11, 1944, Canada permitted free production of jewelry and silverware, except that of items in which tin or platinum is used. Price control continues.

EFFECT OF WAR UPON THE GEM-STONE TRADE

Aerial bombing and artillery fire have doubtless destroyed some of the fine, historical, ecclesiastical jewelry of Europe; for example, that of St. Gennaro, patron of Naples, said to have been sent for safekeeping to the Monte Cassino monastery.

In October, the State Department announced that that department and Great Britain had asked neutral countries to deny protection for the Nazi loot, including jewelry. Some of the latter is in safe-deposit boxes in neutral countries under non-German names.

The war industries have borrowed from the jewelry trade methods of precision casting, both the "lost wax" and plaster-of-paris methods.

Although colored stones, especially ruby and sapphire, and many of the lesser gem stones have never been more popular, most of the world's colored-stone mines (except those of Brazil) are shut down. Consequently, many of the colored stones used today in jewelry are coming from stocks or from old jewelry. The restricted supply accounts for the rise in prices.

With the fall of the Vichy Government, the diamond production of French Guiana, perhaps totaling 20,000 carats a year, fell into the hands of the United Nations.

As the year ended, the Mogok ruby mines, heavily bombed in December, were still in the hands of the Japanese, but the Burmese jade and amber mines had been regained by the United Nations. The Mogok ruby mines apparently were won early in March 1945.

Of course, the gem mines of Thailand and Indochina were still in enemy hands. The shortage of fine cultured pearls, Japan-grown, is reflected in higher prices.

The Chinese, having been until recently cut off from one of their principal sources of jade (Burma), are investing in fine jade, the stock of which is depleted.

Our boys in the Armed Forces in India and Ceylon have purchased cultured pearls, synthetic gem stones, and glass imitations as real gems. The swindle is usually first detected when the "gems" are appraised by the American customs authorities or by some organization like the Gemological Institute of America. Similar tricks are age-old in the Orient, and even the expert is on his guard when buying gems in the East.

On the other hand, some of our men overseas make worthwhile purchases, and the star sapphires, emeralds, and cameos they acquire may well be valuable heirlooms generations hence.

DIAMOND

Although 1944, the sixth year of World War II, was not quite as good a year in the diamond industry as 1943, under the circumstances, it was much better than might have been expected. The demand for both industrial and gem stones was excellent.

Production expanded owing largely to greater production of bort from the BCK mines and of gem stones from South Africa. West African output (Gold Coast and Sierra Leone) also may have been larger. Stocks continued to decrease, consumption again exceeding production, particularly of industrial grades.

Diamond cutting appeared stabilized at about 11,000 artisans, enough to satisfy the world demand for "virgin" cut, supplemented, as it was, by well-cut stones from old jewelry.

The price of gem stones (both rough and cut) increased, but in the early fall, when some foresaw the immediate reopening of the Belgian cutting shops, the price of small cut slumped badly. By the end of the year, however, the loss had been overcome. The price of industrial stones remained stable.

Share dealings.—The shares of diamond-mining companies, virtually all of which are listed on the London Stock Exchange, registered a slight loss during the year, their performance being less satisfactory than that of the average stock on either the London or the New York exchange.

Market.—Sales in 1944 by the Diamond Trading Co., which in prewar times sold about 95 percent of the world's production, were somewhat over £17,000,000 worth of rough, compared with £20,400,000 in 1943, the record year. Sales of gem stones held up better than did those of industrials. At several of the "sights," more stones could have been sold if there had been enough sorters to prepare them.

The American retail trade prospered in 1944, and diamond sales probably reached a peak, topping those of 1943 slightly. Sales of diamonds at retail have probably doubled since World War II began.

The price of fine cuttable rough continued to advance in 1944. Since 1939, small cut has tripled or quadrupled in price; fine cut stones have doubled in price, the increase in the case of larger stones being somewhat less.

Stocks of diamonds, both in the producers' and the Diamond Corporation's hands, have continued to decrease, and for some fine grades of industrials we are now dependent entirely on production.

Imports.—The total value of imports of gem diamonds in 1944 exceeded that of 1943, a gain of 16 percent in rough or uncut imports offsetting the loss of 7 percent in cut but unset diamonds. The quality of rough imports decreased somewhat, but that of cut, considering the slight increase in price in 1944, was constant in the two years.

Diamonds imported into the United States, 1943–44, by countries

[Exclusive of industrial diamonds]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1943						
Argentina				67	$12,590	$187.91
Belgian Congo	1,840	$42,294	$22.99			
Belgium and Luxemburg	1,369	21,444	15.66	19,698	1,341,493	68.12
Brazil	5,773	557,541	96.58	40,933	6,487,150	158.48
British Guiana	2,254	46,243	20.52	185	21,839	118.05
Canada				49	5,255	107.24
Cuba				21,913	3,340,950	152.46
France				567	99,401	175.31
French Guiana				19	2,010	105.79
Gambia and Sierra Leone	3,861	80,432	20.83			
Gold Coast	1,000	17,653	17.65			
Mexico				406	41,273	101.66
Netherlands				569	121,524	213.57
Palestine and Trans-Jordan				50,361	9,153,273	181.75
Peru				14	1,283	91.64
Portugal	11	225	20.45	83	10,888	131.18
Portuguese Guinea and Angola	1,664	40,141	24.12			
Switzerland				112	22,773	203.33
Union of South Africa	705,429	35,502,163	50.33	33,394	6,667,871	199.67
United Kingdom of Great Britain and Northern Ireland	20,262	782,350	38.61	25,336	4,128,516	162.95
Venezuela	7,777	352,754	45.36			
	751,240	37,443,240	49.84	193,701	31,458,089	162.41
1944						
Australia				1	500	500.00
Belgium and Luxemburg	(1)	5	5.00	641	137,063	213.83
Brazil	25,619	726,378	28.35	25,031	4,219,310	168.56
British Guiana	2,613	64,405	24.65	532	61,162	114.97
Cuba				43,683	6,749,686	154.52
Gambia and Sierra Leone	725	13,164	18.16			
Gold Coast	1,350	24,860	18.41			
Mexico				1,092	30,738	28.15
Netherlands				20	11,423	571.15
Palestine and Trans-Jordan				53,883	9,337,281	173.29
Union of South Africa	854,239	42,197,278	49.40	32,676	6,514,128	199.36
U. S. S. R.				1,436	202,180	140.79
United Kingdom of Great Britain and Northern Ireland	6,201	233,977	37.73	10,102	1,999,650	197.95
Venezuela	5,800	185,152	31.92			
	896,547	43,445,219	48.46	169,097	29,263,121	173.06

1 Less than 1 carat.

Cutting.—Before 1940, about 90 percent of the world's diamonds were polished in the Low Countries—Belgium and the Netherlands. Since then the industry has been widely scattered over the world. The 11,000 artisans and apprentices (about one-third the prewar force) adequately supplied the world with cut stones, notwithstanding the fact that for perhaps 20 percent of their time they were unemployed (strikes, lockouts, and shortage of rough). The United States, Palestine, and Brazil are the current cutting centers.

World production.—Owing to the war, accurate figures as to diamond production are not available. The figures given for 1944 production in the table that follows are entirely estimates, but the grand total is probably approximately correct.

The world production of diamonds in 1944 is believed to have been valued at about $40,000,000. The increase in caratage is due to an increase in BCK's crushing bort production of some 2,650,000 carats; to expansion of output in Sierra Leone, the Gold Coast, and the

South-West African alluvial mines; and to an appreciably larger production in the South African pipe mines. The value as well as the production was larger, because of increased pipe production. Of the total, some 80 percent was industrials and 20 percent gem stones.

Figures showing the production for 1940–44, corrected in minor details from those published in the chapter of this series for 1943, follow.

World production of diamonds, 1940–44, by countries, in metric carats
[Including industrial diamonds]

Country	1940	1941	1942	1943	1944 (estimated)
Africa:					
Angola	784,270	787,000	[1] 791,850	794,990	800,000
Belgian Congo	9,603,000	5,866,000	6,018,236	4,880,000	7,540,000
French Equatorial Africa	[1] 16,000	30,000	20,000	20,000	5,000
French West Africa	[1] 75,000	35,000	20,000	20,000	20,000
Gold Coast	[1] 825,000	1,000,000	[1] 1,000,000	1,000,000	1,000,000
Sierra Leone	750,000	850,000	[1] 850,000	850,000	850,000
South-West Africa	30,017	46,578	56,420	100,000	154,000
Tanganyika [2]	6,222	29,052	40,327	52,998	53,000
Union of South Africa:					
Mines	[1] 371,447			170,885	550,000
Alluvial	[1] 172,027	158,422	117,628	[3] 131,444	148,525
	543,474	158,422	117,628	302,329	698,525
Brazil	[1] 325,000	325,000	300,000	275,000	(4)
British Guiana	[1] 26,764	27,000	27,000	27,000	27,000
Other countries [5]	31,750	34,350	40,836	29,650	34,000
	13,016,497	9,188,402	9,282,297	8,351,967	[6] 11,500,000

[1] Estimate.
[2] 1940 and 1944: Exports; 1941–43: Production.
[3] Cape and Transvaal, without Namaqualand, estimated at 53,210 carats.
[4] 250,000 to 370,000 carats.
[5] 1940–41: Borneo, India, New South Wales, U. S. S. R., and Venezuela (Venezuela produced, respectively, 14,525 and 29,399 carats); 1942: Borneo, India, New South Wales, Rhodesia, U. S. S. R., and Venezuela (Venezuela produced 31,570 carats); 1943: Venezuela (23,020 carats), Borneo, India, New South Wales, U. S. S. R., United States (Arkansas), and Bolivia; 1944: Venezuela (22,037.07 carats), Borneo, India, New South Wales, and U. S. S. R.
[6] Approximate.

Industrial diamonds.—World War II has been fought not only by cannon and other heavy munitions but by industrial diamonds, quartz plates, calcite prisms, and cathode-ray tubes. The diamond in over-alls is used in making virtually every kind of war munition, owing to the closer tolerances gained and time saved by its use.

Industrial diamonds are normally a byproduct of gem mining. However, in the carbonado mines of Bahia, Brazil, and the large BCK mines in the Belgian Congo, the gem stone is the byproduct.

Although the United Nations have at their disposal the production from about 99.9 percent of the world's diamond mines, yet, notwithstanding the increased production of industrials in 1944, at least a quarter of the stones used by them must be drawn from stocks mined before the war.

The supply situation of the United Nations is believed to be comfortable. Japan, on the other hand, is desperately attempting to confiscate gem stones for industrial use, and the Germans were using sintered-carbide-tipped tools as a substitute.

The demand for crushing bort continues at a record level. Dr. H. Whittaker emphasizes that the cheaper grades of industrials can replace the more expensive grades for most purposes at a saving in cost. The consumer is learning to use the cheaper grades, as many of the finer grades are in short supply.

Owing to the exploration boom in the gold fields, more drilling was probably done in Canada in 1944 than ever before. The use of the diamond drill in blast-hole drilling is also expanding.

Fine, sound diamonds, some of gem grade, are used in making diamond dies. Since the war began, the United States has become self-sufficient in the production of dies, even those with small apertures.

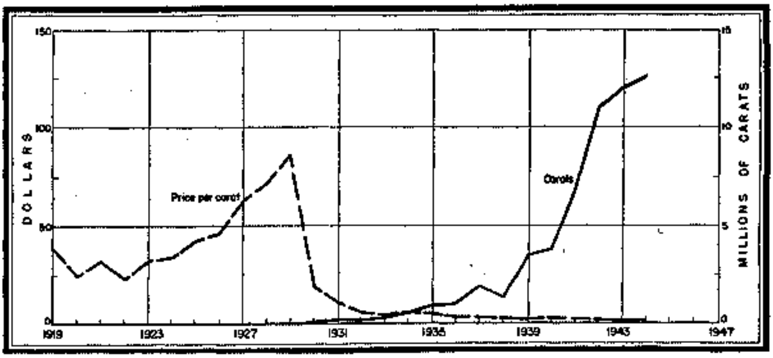

FIGURE 1.—United States imports and average price per carat of industrial diamonds, 1919–44.

Figure 1, prepared by Herbert Backman, illustrates the tremendous increase in use and the sharp decline in average price per carat of industrial diamonds during recent years.

Imports of industrial diamonds into the United States during the past 5 years were as follows:

Industrial diamonds (glaziers', engravers', and miners') imported for consumption in the United States, 1940–44

Year	Carats	Value		Year	Carats	Value	
		Total	Average			Total	Average
1940	3,809,071	$11,026,563	$2.89	1943	12,084,133	$21,890,568	$1.81
1941	6,882,248	14,908,809	2.17	1944	12,614,507	22,816,827	1.81
1942	11,203,704	22,057,577	1.97				

RUBY, SAPPHIRE, AND EMERALD

The emerald mines of Colombia were not operated. The Burmese, Siamese, and Indochinese gem mines (largely sapphire and ruby) may have been operated on a small scale; they were in enemy hands. The Ceylonese mines were bled of labor by the island graphite mines. The production of gems, therefore, was small in 1944.

An unusually large star sapphire was exhibited for sale in New York early in 1945. It is said to have weighed over 800 carats in the rough; it was cut into a stone of 392¾ carats.

LESSER GEMS

Dr. Frederick H. Pough, in a series of articles that appeared in the Jewelers' Circular-Keystone in 1944, has made an important contribution to our knowledge of the Brazilian gem stones. The articles contain valuable data on gem-stone prices received by miners in the field as well as dealers' prices at Rio; geographical and geological occurrence of the various gems; the heat-treatment of some of the gems; and the Brazilian cutting industry. At present Brazil is the largest producer of the lesser gem stones.

Up to the end of 1939, Australia had produced opals valued at £1,987,090. Incomplete returns for 1939 follow: New South Wales, £1,020; Queensland, £50 (only seven miners); South Australia (Coober Pedy field), £6,020—a total of £7,090. In 1944, it was reported that the black-opal fields were no longer operated.

The Anglo-American Corporation of South Africa and the South-West Africa Co. in 1943 formed the Kaokoveld Exploration Co. to prospect for minerals and precious stones in the Kaokoveld territory. This area, of 40,000 square miles, is in the northwestern part of South-West Africa.

Rubellite (red tourmaline) of excellent quality is reported to occur in Mozambique (Portuguese East Africa).

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GEM STONES

By Sydney H. Ball

SUMMARY OUTLINE

JEWELRY INDUSTRY IN 1945

Jewelry sales (taxable) reached a peak in 1945 (tax, $198,944,988); in consequence, retail jewelry-store sales—considering nontaxable sales together with taxable sales by department stores and others—amounted to about $1,200,000,000, an all-time peak and a gain of some 12 percent over 1944. Sales in the first quarter of the year were distinctly below those of 1944; from April to July they exceeded those of 1944 by 20 percent. The surrender of Japan in August decreased but did not stop increased sales in August and September, and in the last quarter of the year sales forged ahead. Montana, Texas, and Utah showed particularly large gains. Christmas time sales reached unusual proportions. Admittedly, certain stocks were in short supply, but the populace had money and bought what was available. All holiday records were exceeded. Jewel sales, generally including diamonds, in five figures were not unusual. Americans were not the only heavy buyers; Brazilians and South Africans were equally extravagant. Retail jewelers' stocks in America decreased somewhat during the year.

Sales by wholesale jewelry houses were up slightly from those of 1944, and in dollar value their inventories increased slightly in 1945. The wholesale trade centers in New York City.

Jewelry prosperity in 1945 was built upon the people's large wartime savings; demobilized GI's returning home with their savings; a high national income; a flood of marriages (only slightly below the 1943 peak); and the dearth of other durable goods to attract money from the industry. It should, however, be emphasized that in the past decade wealth has shifted from the "400" to the medium- and lower-income brackets. The carriage trade is almost extinct, and hereafter the retailers will sell fewer expensive items and more medium- and low-priced goods.

The numerous women gainfully employed during the past 6 years have, on the average, spent more money on clothing and luxuries than the housewives. In department stores particularly, sales of medium- to high-priced costume jewelry have expanded the business of the jewelry departments.

Some jewelers anticipate a recession in sales; in consequence, the Jewelry Industry Publicity Board has had a study made of conditions in the industry, in the hope of maintaining activity in the future.

FASHIONS IN JEWELS

More jewelry was worn in 1945 than ever before. Platinum is again available for mounting, and we may expect to see palladium relegated to the side lines, except in earrings and certain clips, where its lightness is a distinct advantage. Stones mounted in invisible settings are particularly attractive. Two-toned gold retains its popularity.

In view of the shortage of skilled goldsmiths, the work of the designers merits praise. On the whole, designs were lighter and more artistic than in recent years. The three most popular motifs—flowers (sometimes in sprays or bouquets); sunburst, star, and snowflake designs; and leaves—were attractive.

Necklaces, particularly the flexible type fitting snugly to the neck, were fashionable. Clips were worn not only on dresses but attached to the necklace and on the hat. Earrings were in vogue due to the up-swept hair mode. Bracelets, singly or in groups, are as popular as ever. Rings were characterized by high pavé-domes, set with small stones rather than single gems. More and more they are being worn over gloves. Lanyards and barrettes, bandeaus, and stars for the hair are gaining in popularity.

Old jewelry is still sold but was a less-important element in the trade than in 1944.

Ensemble jewelry, three or four pieces set with the same gem, finds ready sale, as does jewelry that may be divided into two or more pieces as need arises. The double wedding-ring ceremony is now standard.

Marquise and other unusual diamond cuts are gaining in favor. Small diamonds for mountings are still in short supply, hence tiny cabochon rubies and sapphires in part supplant them. Diamond, ruby, and sapphire, including the lighter-color Ceylonese stones, led in popularity, followed by the yellow-brown gems (topaz and citrine), pearl, amethyst, turquoise, and aquamarine. Aquamarine held its own; amethyst and turquoise gained; but citrine and topaz, to a considerable extent, lost their appeal. The emerald had pride of place among the sophisticated.

The ever-insistent demand for diamonds caused colorless gems to be most popular, followed by red and blue gems; yellow, purple, and green gems were in lesser demand, in the order named.

DOMESTIC PRODUCTION

Mining for gold and mining for gem stones have been affected by war more adversely than any other branches of the industry. Production value of gem stones in 1945 dropped to about $40,000, the lowest in a decade. The decline is attributed to shortages of labor, mining supplies, tires, and gasoline. The gem hobbyists and the amateur and semiprofessional lapidaries could not replenish their stocks of rough; and most of their best customers, the touring automobilists, stayed at home. Further, the supply of most strategic minerals became adequate early in the year, and pegmatite mining waned. It should be stated, however, that pegmatite mining during the war furnished disappointingly few gem stones. Late in the year, gasoline and other supplies became available; and this, with the return of men from the war, will doubtless encourage greater production in 1946.

Oregon and Washington lapidaries were active in 1945. There are at least 50 shops, and the value of the 1945 output is variously estimated at $100,000 to $500,000.

For the first time the value of jade produced certainly exceeded that of sapphire and probably that of turquoise. In 1945 Wyoming produced a number of tons of light-green nephrite and almost as much black jade. The publicity the press has given Wyoming jade (all produced from float) has attracted a number of outside prospectors to the State. The largest boulders yet found were located during 1945.

There are three professional and half a dozen amateur cutters at Lander, and the Lander region remains the chief producer. Black nephrite, which takes a fine polish, is being obtained from the Red Desert. Discovery of jade in the Laramie Range is reported. The white "jade" said to have been found near Kemmerer is, according to reliable information, chalcedony. The so-called jade as found is sold at $1 to over $5 a pound. When peace is restored, China, may well become a good market for Wyoming jade. (Personal communications from Fred Abernathy, H. C. Dake, O. W. Plaga, Bert A. Rhoads, and Horace D. Thomas.)

Alaska jade appeared on the market in 1945. The locality, on the north side of Kobuk River, has been well-known to the local Eskimos and Indians since the Thule stage of Eskimo culture (A. D. 600 to 1600).[1] Late in 1945 the Arctic Exploration Co. of Fairbanks located mining claims in the district and flew a considerable shipment of jade to Fairbanks. Some of the material is stated to be of gem quality, but most is fit only for objets d'art. The Chinese have purchased some of it. It is reported that three or four men were collecting boulders from the bed of Kobuk River last summer. The better Alaskan material compares favorably with the better New Zealand nephrite. It is suitable for tourist jewelry and objets d'art.

Turquoise is occasionally found at the Castle Dome copper mine in Arizona. It is "high-graded" by the miners and sold in Miami or Globe. Some of it is of fine quality. A company official states—

> As in the past, turquoise of an undetermined amount was recovered during routine mining operations. As a whole, the quality of the material recovered at greater depth has improved, both in hardness and in color, the latter occurring in the lighter shades of blue.

Turquoise mining was relatively active in Nevada, particularly in the Tonopah and Battle Mountain districts. Most of the material is shipped to New Mexico, although some is cut locally, there being five cutting shops at Battle Mountain (personal communication, Jay A. Carpenter). Alfred L. Ransome states that the lessors, Lee Hand

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[1] Ball, Sydney, H., The Mining of Gems and Ornamental Stones by American Indians: Bureau Am. Ethnol., Anthropol. Paper 13, 1941, p. 37.

and Paul Bare, of the Pedro claim on the Copper Basin property of the Copper Canyon Mining Co., Battle Mountain, produced 3,601 pounds of cobbed turquoise in 1945. The Elko County mines appear to have made no shipments in 1945.

In Colorado the King mine, now renamed the Lickspittle, was operated in 1945 by Charles King of Manassa, Colo. Twelve men were employed. The Hall mine, near Villagrove, Saguache County, will soon be operated again. There are rumors of a new turquoise deposit in the Cripple Creek district. New Mexico produced no turquoise, although Indians sorted some material from the dumps. Stuart A. Northrop states that the Indian jewelers are using chrysocolla, malachite, and chalcedony, largely from Arizona, as substitutes for turquoise. Reports indicate intermittent work on the turquoise deposit near Van Horn, Tex.

The agate deposits on the Priday property in Jefferson County, Oreg., a large producer by hand methods, are to be operated mechanically in the future (personal communication from Dr. H. C. Dake). The moss agate deposits of Yellowstone River in Montana, long productive, are said to have produced less than usual in 1945. The easily accessible material is exhausted. Philip S. Hoyt produced some chalcedony in New Mexico and Arizona, which, after staining, is set in costume jewelry. Considerable rose quartz was produced in South Dakota, but most of it (which was poor quality) was sold to decorate rock gardens. Some fine rose quartz was found at the Bon Ami workings at Plumbago Mountain, Newry, Maine, according to Stanley I. Perham.

Utah produced less variscite in 1945 than in the recent past. Junius J. Hayes reports that the Clay Canyon deposit (Utah County) produced about 1,000 pounds; that the Amatrice Hill deposit near Grantsville (Tooele County), although not regularly worked, produced about 200 pounds; and that the Lucin deposit (Box Elder County) probably was not worked.

No sapphires were produced during the year in Montana; as Dr. Francis A. Thomson explains, they have lost their commercial market to the synthetic stones. A little ruby and sapphire were reported to have been produced in Franklin and Clay Counties, N. C. Charles E. Hunter reports that Linten B. Greene procured a fine sapphire at the Corundum Hill mine, Macon County. It is a deep-blue tabular crystal ½ inch thick and 1 inch across. He intends to keep it in his collection as a rough crystal.

Dr. A. M. Butler reports that a considerable amount of "marekanite" (black obsidian nodules in Arizona perlite beds) is being cut cabochon and set in "Indian" silver jewelry. The Superior district south of Queen Creek is the most important locality.

Eldred D. Wilson (Arizona Bureau of Mines Bull. 152, Tucson, Ariz., October 1944) estimates the production value of precious stones in Arizona from 1900 to 1921 at $300,000, an average of $13,636 a year. In recent years production has been much less. Wilson lists the precious stones found in the State, apparently in order of production, as follows: Turquoise, silicified wood, oxidized-copper minerals (azurite, malachite, and chrysocolla), garnet, peridot, Mexican onyx, opal, tourmaline, and obsidian; and, of less importance, rock crystal, amethyst, chrysoprase, agate, dumortierite, and catlinite. Small pyrope garnets and peridot are collected by Navajo Indians, the former from Garnet Ridge and Buell Park in Apache County and the latter from the same localities and from west of San Carlos, Gila County. At the latter locality, peridots of over 233-carat weight have been found.

Deep blue dumortierite resembling lapis lazuli occurs as boulders in gravel along the Colorado River 30 miles north of Yuma.

Mrs. E. M. Roe states that only one Sioux Indian mined catlinite at Pipestone, Minn., in 1945 but that a number of returned Indian servicemen expect to dig catlinite and fabricate it.

When the test atom bomb was dropped in New Mexico, the sand near the crater, according to the press, was fused to a grayish green glass. It was dubbed "atomsite," and souvenirs are said to have been made from it.

The States and Territory leading in gem production in 1945 were Wyoming, Oregon, Alaska, Nevada, Utah, and Arizona.

Other gem stones produced in small amounts in 1945 include agate (Idaho, Wyoming, and Luna and Sierra Counties, N. Mex.); amazonite (Amelia, Va.); amethyst (North Carolina and Mineral Valley, Millard County, Utah); aquamarine (Mitchell, Yancey, Avery, Macon, and Ashe Counties, N. C.); asteriated rose quartz (Newry, Maine); chalcedony (Nevada); citrine (North Carolina); emerald (Mitchell and Yancey Counties, N. C.); garnet and golden beryl (Mitchell County, N. C.); jasper (Idaho and near Hot Springs, N. Mex.); moonstone (New Mexico and Mitchell County, N. C.); moss agate (Wyoming); opal (Idaho and Virgin Valley, Nev.); opalized wood (Nevada and New Mexico); rock crystal (Hot Springs district, Ark.); sapphire (Idaho); green smithsonite (Magdalena, N. Mex.), and smoky quartz (North Rumford, Maine).

Heizer and Treganza have written an interesting article on the California Indian Mines and Quarries (see Bibliography). They list 142 sites worked by the Indians for various stones. Turquoise, quartz crystal, chrysocolla, chrysoprase, tourmaline, and malachite were among the gem materials used. They found that the San Bernardino County turquoise mines were worked by the Pueblos of New Mexico and Arizona, who made periodic trips to the mines.

CANADIAN GEM STONES

Canada apparently produced no precious stones in 1945, but a number of amateur lapidaries, particularly near Toronto, cut such Canadian rough as they could get. G. G. Waite,[2] an amateur lapidary, lists a large number of Canadian precious stones suitable for cutting; few, if any, of them are of commercial importance. Some of the Thunder Bay amethyst, however, is of fine color.

ACCESSIONS TO MUSEUMS

The National Museum, Washington, D. C., has added several fine gems to its collection, notably an unusually large and fine green chrysoberyl (120.45 carats) from Ceylon and a zincite (5.12 carats)

[2] Waite, G. G., Contributions to Canadian Mineralogy: University of Toronto, No. 49, 1944, pp. 75-78.

from Franklin, N. J. During the year the American Museum of Natural History acquired a 16-carat cut zincite and a 19-carat oval-cut brazilianite. The latter gem is of pleasing lemon-yellow color and quite brilliant, although it is so soft that it is suitable only for mounting as a pendant. The University of South Carolina recently acquired the Colburn mineral collection of Southern Appalachian gem stones, comprising notably representative specimens of hiddenite, rhodolite, and emerald.

During the year, the well-known star sapphire, The Star of Artaban (300 carats), was presented to the National Museum in Washington.

NOMENCLATURE

The Precious Stone Dealers Association of New York on October 11, 1945, adopted preferred names for gem stones.[3] The use of a geographic designation ("Burma sapphire," for instance) for precious stones similar to the normal type produced by the country named, even if the stone may come from another country thousands of miles away, is highly recommended. It is poor practice, however, to name any member of the quartz family "topaz"; the proper name for yellow or brownish rock crystal is "citrine" or less acceptably "topaz quartz." Even the latter term is incorrect and undesirable. The association attempts in its nomenclature to draw a sharp line between natural and treated stones. The nomenclature committee consisted of H. N. Paskow (chairman), Leo Nathan, and Thomas H. Benedict.

EDUCATION IN GEM STONES

GI's are now permitted, as an educational benefit for service rendered, to enroll in the courses of the Gemological Institute of America. Gem courses in American institutions of learning apparently have a record number of students. The Australian Gemological Association has been formed to advance the knowledge of gem stones in that continent.

The Gem Trade Laboratories, Inc. (36 W. 47th St., New York City), sponsored by the colored-stone and pearl merchants of the city, now identifies stones and will make tests of them on a commercial basis. Dr. A. E. Alexander is in charge.

A new film, The Magic Stone, publicizes the diamond.

IMPORTS

The value of imports of precious and semiprecious real and imitation stones, exclusive of industrial diamonds, as listed by the United States Department of Commerce, totaled $114,435,231, 48 percent more than in 1944. The great gains were in polished diamonds and in cut stones of other types, both natural and synthetic. The figures for imports follow.

[3] Jewelers' Circular-Keystone, National Jewelers: November 1945, p. 214.

Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1944–45

Commodity	1944		1945	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty free	896,547	$43,445,219	893,761	$43,122,622
Cut but unset, suitable for jewelry, dutiable	169,097	29,263,121	377,243	64,185,406
Emeralds:				
Rough or uncut, free	1,966	1,668	1,085	252
Cut but not set, dutiable	38,666	81,233	106,684	181,834
Pearls and parts, not strung or set, dutiable:				
Natural		242,221		352,947
Cultured or cultivated		15,394		155,548
Other precious and semiprecious stones:				
Rough or uncut, free		105,401		134,698
Cut but not set, dutiable		3,725,453		5,113,937
Imitation, except opaque, dutiable:				
Not cut or faceted		14,550		3,220
Cut or faceted:				
Synthetic		503,718		805,838
Other		23,887		242,988
Imitation, opaque, including imitation pearls, dutiable		23,113		31,136
Marcasites, dutiable:				
Real		84,828		101,140
Imitation				3,665
		77,529,806		114,435,231

GOVERNMENT REGULATIONS

The end of the war has not diminished greatly the number of Government regulations affecting trade in precious stones.

In the United States, the OPA relinquished price control on "synthetic and semiprecious stones for jewelry purposes" on October 15, 1945. On December 27, the United States Government liberalized the export of jewelry, including that containing diamonds, but has refused to reduce the excise tax (20 percent) on jewelry sales, an element that encourages a black market in the jewelry trade. Canada early in the year removed price controls on jewelry.

As a postwar measure, during the year Australia permitted the import and export of jewelry. On October 21, 1945, Mexico removed the export duty on silver jewelry, even if set with stones of local origin; and Argentina, as of May 4, unified at 5 percent its sales tax on jewelry. In the fall Mexico imposed a 3-percent sales tax on jewelry. As of October 1945, South Africa still required export permits for gold and diamond jewelry. Late in the year the Italian Government removed the ban on trade in precious metals and gems.

To protect its mines and its cutters of precious stones, Brazil (January 22, 1945) required import licenses for all precious stones, diamonds, and quartz crystals; after May 25, 1945, upon presentation of import licenses, 1 unit of cut synthetic gems could be imported, provided at the same time 10 units of rough synthetic gems were imported.

In Uruguay the sales tax (February 23, 1945) on jewelry became 13 percent. On March 31, 1945, France increased the luxury tax on jewelry sales from 10 to 25 percent, and late in the year Bolivia increased the luxury tax to a point that threatens the disappearance of jewelry from the retailers' shelves in that country.

As to taxes, the Quebec jewelers find themselves in what would be a ludicrous position, were it not serious. Their sales are subject to a 25-percent Federal tax, a 6-percent Provincial tax, and a 2-percent municipal tax.

DIAMOND

Nineteen forty-five was a highly prosperous year in the diamond industry. The sales of the Diamond Trading Co., the principal seller of rough stones, reached £24,500,000—an all-time peak; presumably, the sales of cut goods also attained a record. Indeed, the United States imports of cut were appreciably above those of the lush 1920's. Again consumption greatly exceeded production, and the drain on stocks was heavy. Stocks in certain categories of both rough and cut are depleted, and in no grade are they large. In consequence, both the gem and industrial diamond trades must look more and more to current production for their diamonds. Additional mines are being equipped, but no great increase in production can be expected for 3 or 4 years.

World production was almost 14,000,000 carats, a fifth greater than that of 1944. Of the total, 83 percent by weight were industrials and 17 percent gem grades.

The price of gem rough again advanced, although there has been no increase in the wholesale price of industrials in 7 or 8 years. Uncut gem diamonds are now quoted at more than twice the prewar price. Cut has never been so high. Since 1939, melee has at least tripled in price, and larger cut has more than doubled in price. The price of large stones (10 carats or more) is a matter of negotiation between buyer and seller. Fine cut, in the United States at least, was in short supply much of the year.

Industrials, once a drug on the market, now represent about 20 percent, in dollar value, of the world's rough sales. Yearly the distinction between gem grades and industrials is defined more sharply.

With the war's end, investment in diamonds has not ceased. The people of much of the world have more confidence in diamonds than in their own countries' currency.

Share dealings.—The shares of diamond-mining companies, virtually all of which are listed on the London Stock Exchange, gained about 17 percent in 1945 as contrasted with the slight loss suffered in 1944. Strangely enough, quotations were affected only slightly by the surrender of Germany and Japan, but much more so by sales of rough, dividend declarations, and publication of annual reports. Of the eight principal mining companies, all paid dividends in 1945, although the yield at year-end prices varied greatly.

Imports.—Imports of gem diamonds into the United States increased from $26,186,948 in 1942 to $107,308,028 in 1945, or almost 310 percent.

The following table shows comparative figures of imports during 1944 and 1945. The figures for rough are almost identical; those for cut show an increase, respectively, of 123 percent by weight and 119 percent by value. The grade of the imports was somewhat poorer in 1945 than in 1944.

Diamonds imported into the United States, 1944–45, by countries

[Exclusive of industrial diamonds]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1944						
Africa:						
British:						
Gambia and Sierra Leone	725	$13,164	$18.16			
Gold Coast	1,350	24,860	18.41			
Union of South Africa	854,239	42,197,278	49.40	32,676	$6,514,128	$199.36
Australia				1	500	500.00
Belgium and Luxembourg	(1)	5	5.00	641	137,063	213.83
Brazil	25,619	726,378	28.35	25,031	4,219,310	168.56
British Guiana	2,613	64,405	24.65	532	61,162	114.97
Cuba				43,683	6,749,686	154.52
Mexico				1,092	30,738	28.15
Netherlands				20	11,423	571.15
Palestine and Trans-Jordan				53,883	9,337,281	173.29
U. S. S. R				1,436	202,180	140.79
United Kingdom	6,201	233,977	37.73	10,102	1,999,650	197.95
Venezuela	5,800	185,152	31.92			
	896,547	43,445,219	48.46	169,097	29,263,121	173.06
1945						
Africa:						
British:						
British East Africa	7,413	207,556	28.00			
British West Africa [2]	1,158	21,402	18.48			
Union of South Africa	834,393	41,290,329	49.49	46,096	10,720,816	232.58
Argentina				4	2,000	500.00
Austria				12	1,136	94.67
Belgian Congo	10,054	86,793	8.63			
Belgium and Luxembourg				104,840	14,612,123	139.38
Brazil	14,349	628,325	43.79	28,472	4,988,200	175.20
British Guiana	1,774	42,715	24.08	580	67,471	116.33
Canada	1,110	16,650	15.00	1	100	100.00
Cuba				64,737	11,439,698	176.71
France				44	7,511	170.70
Germany				1,230	133,496	108.53
India and Dependencies				703	134,641	191.52
Mexico	13,838	504,641	36.47	9	5,003	555.89
Netherlands				2,599	520,516	200.28
Palestine and Trans-Jordan				105,899	17,684,997	167.00
Portugal				18	6,405	355.83
Switzerland				271	39,738	146.63
U. S. S. R				3,569	562,617	157.64
United Kingdom	5,699	173,797	30.50	17,535	3,176,270	181.14
Venezuela	3,973	150,414	37.86	624	82,668	132.48
	893,761	43,122,622	48.25	377,243	64,185,406	170.14

[1] Less than 1 carat.
[2] Effective Jan. 1, 1945, includes Gambia and Sierra Leone.

Cutting.—Due largely to revival of part of the Belgian cutting industry, the number of artisans employed jumped from 14,000 at the end of 1944 to 25,000 at the end of 1945. The amount of rough gem material has not been increased proportionately; and, because of shortages of rough, there will presumably be considerable unemployment in the trade in 1946. The best cutting of large stones today is done in the United States and the finest small cut in the United

States, Palestine, and Belgium. The Belgian industry has made a remarkable come-back and at the year end had 10,000 operatives. The other principal cutting centers are New York City, Palestine, Brazil, and Holland.

World production.—Owing to the war, accurate diamond-production statistics are not available, but the estimates in the following table are believed to be fairly reliable. World production (gems and industrials) in 1945 is estimated to have been 14,257,000 carats (3.129 short tons), worth about $64,750,000. The quantity was about 22 percent greater and the value 35 percent greater than in 1944. Of the total, cuttables made up about 18 percent of the total, a smaller proportion than last year because of the large production of crushing bort by BCK, a Belgian Congo producer. By weight, some 5,125 pounds were industrials and 1,130 pounds gem stones.

The Belgian Congo was the leading producer by weight (72.9 percent), although it represented but 13 percent of the value. On the other hand, the British Empire, accounting for only 19.2 percent of the weight, represented 71 percent of the value.

Compared with 1944, the Belgian Congo increased its production, by weight, 38 percent. Tanganyika Territory continued its gain in output; in consequence, DeBeers sent engineers to look over the field. DeBeers operated its Dutoitspan and Bulfontein pipe mines and is beginning to reopen Premier and New Jagersfontein, although it will be several years before these are producing. The South African alluvial production increased. The Venezuelan production continued to decrease, and that of Brazil probably was less than in 1944.

The following table shows as accurately as available statistics permit world production for the past 5 years.

World production of diamonds, 1941–45, by countries, in metric carats

[Including industrial diamonds]

Country	1941	1942	1943	1944	1945
Africa:					
Angola	786,980	791,850	794,990	800,000	786,000
Belgian Congo	5,866,000	6,018,236	4,881,000	7,540,000	10,386,000
French Equatorial Africa	[1] 30,000	[1] 20,000	[1] 20,000	[1] 5,000	[1] 5,000
French West Africa	57,726	1,500	[1] 35,000	[1] 60,000	[1] 60,000
Gold Coast	[1] 1,000,000	[1] 1,000,000	[1] 1,000,000	[1] 1,000,000	[1] 500,000
Sierra Leone	[1] 850,000	[1] 850,000	[1] 850,000	[1] 700,000	[1] 800,000
South-West Africa	46,578	56,420	[1] 88,000	154,000	156,000
Tanganyika	29,046	41,000	52,998	90,667	115,666
Union of South Africa:					
Mines			175,885	639,000	878,713
Alluvial	158,422	118,821	126,444	270,000	262,527
Total Union of South Africa	158,422	118,821	302,329	909,000	1,141,240
Brazil	[1] 325,000	[1] 300,000	[1] 275,000	[1] 370,000	[1] 275,000
British Guiana	26,427	22,208	18,272	13,911	17,251
Other countries	34,350	40,836	29,650	34,000	[2] 15,000
Grand total	9,210,529	9,260,871	8,347,239	11,676,578	14,257,157

[1] Estimated.
[2] Includes Venezuela (12,769 carats), Borneo, India, New South Wales, and U. S. S. R.

Industrial diamonds.—With the end of World War II, it was expected that imports (roughly, consumption) would fall markedly. Many war contracts were canceled after VJ-day but imports, as to weight, held up surprisingly, although the drastic decline in value indicates that crushing bort formed an ever-increasing percentage of American imports. Consumption again largely exceeded production, and stocks were heavily drawn on and are perhaps dangerously low; certainly, they are largely depleted as to some sizes and grades. Manufacturers of diamond-set tools have, through inertia, demanded of the trade a type of diamonds that may be in short supply. Provided they show ingenuity in using diamonds physically more or less similar, they will find a fair stock at their disposal. American industrial diamond merchants probably have a relatively large stock.

Thanks to the large production of BCK, the 1945 output of industrials was an all-time record, but much of it was crushing bort, and no great increase in the production of bort can be expected for 2 or 3 years.

After VJ-day, the United States Government removed many of its controls over industrial diamonds, although import and inventory controls are still in effect. The British Government removed all controls in the Empire in December.

Diamond drilling was exceedingly active in 1945 due to the mining boom in Canada and the increasing use of diamond bits in stope drilling. Diamond consumption in drilling increased greatly. Diamond-impregnated wheels—the bond being a plastic, a ceramic product, or a powdered metal—are having wide peacetime use. Standardization of diamond powders has been accepted by the industry. War-born uses for diamond tools and dies insure a satisfactory peacetime demand.

Figure 1, originally prepared by Herbert Backman several years ago, shows the tremendous increase in use and the sharp declinein price per carat in American imports in the last 27 years.

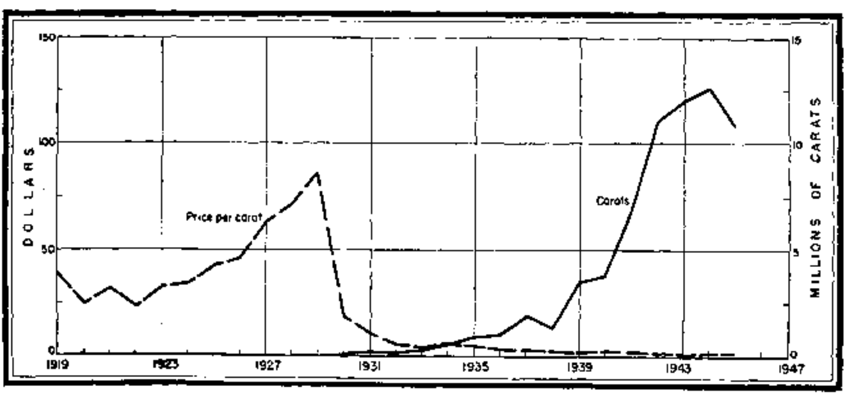

FIGURE 1.—United States imports and average price per carat of industrial diamonds, 1919–45.

Imports of industrial diamonds into the United States during the past 5 years were as follows:

Industrial diamonds (glaziers', engravers', and miners') imported for consumption in the United States, 1941–45

Year	Carats	Value		Year	Carats	Value	
		Total	Average			Total	Average
1941	6,882,248	$14,908,809	$2.17	1944	12,614,507	$22,861,401	$1.81
1942	11,203,704	22,057,577	1.97	1945	10,729,869	12,810,932	1.19
1943	12,084,133	21,890,568	1.81				

RUBY, SAPPHIRE, AND EMERALD

Of the world's purchases of precious stones, at least 95 percent are diamonds. Because of this and because the types of the deposits of the ruby, sapphire, and emerald do not lend themselves to large-scale operations, successful gem mining by large companies is confined to the diamond. It is true that Burma Ruby Mines, Ltd., for over 3 decades worked the Burmese ruby mines and that several entrepreneurs have leased and worked the Colombian emerald mines, but such enterprises were failures. Fine rubies come from Burma; gem sapphires from Thailand, Indochina, Kashmir, and Ceylon; and emeralds from Colombia and the Urals in Russia. In the first half of 1945, the United States imported from Russia 1,682 carats of cut emeralds valued at some $31,000, or roughly $18.50 a carat. The price suggests that the quality was poor. Today some of these deposits are shut down; Indochina and Kashmir are practically exhausted, or at least it is so reported; the Colombian emerald deposits are dormant; and during World War II the Ceylonese gem miners were recruited to mine graphite. Furthermore, the colonial laws made the marketing of gems complicated, if not almost impossible. Shipments from Ceylon to America are inferior to prewar shipments. The Ceylonese have more money than formerly to buy fine gems, and they have lost their European markets for inferior gems. The native miners of Burma, Thailand and Indochina in 1945 continued to mine a few gems, although they could scarcely have sold many to the Japanese. Happily, the Burma ruby mines were reoccupied by the United Nations on March 20, 1945, and Thailand and Indochina later.

In consequence of the above circumstances, very few newly mined colored gems are coming on the market, and today we look to jewelers' stocks and old jewelry for our supply. Some fine emeralds are being obtained from once-wealthy nationals of Spain and England, and rubies and sapphires from the out-moded jewelry of England and the Continent. The demand is insistent, but the supply is inadequate. Although prices today are very high, they are likely to follow the law of supply and demand and go higher.

Fine rubies, sapphires, and emeralds of size are hard to find in New York today and are by no means modestly priced. The New York market must also compete with the Far Eastern market, where colored stones are highly regarded, not alone for their beauty, but also as the safest of investments. Compared with the diamond the noble gems, particularly the emerald, have a more restricted group of admirers, although these may well be the more intelligent and intellectual of the populace. The diamond, therefore, has a higher rank as an investment.

At present, demand and supply are badly out of balance and will be in the immediate future, unless demand becomes less insistent.

Our soldiers in the East continue to buy gems, and as amateurs they are commonly duped with synthetic or inferior gems. At times, however, they may pick up lucky bargains. Their purchases have forced up prices appreciably.

It has been noted that colored glass used to direct traffic on American airfields in Burma disappeared; it is a possible source of some of the "gems" the boys are buying. The members of the American Gem Society have offered to test free for veterans the stones they have purchased.

The Muzo and Coscuez emerald mines in Colombia have been shut down since 1938. The Colombian Government desires to turn the ownership of these mines from a liability into an asset. The emeralds in the Bank of the Republic owned by the Government, valued by Modero and Dixon at pesos 1,200,459.26, were said to have been sold early in 1946 to an American jewelry firm for some $685,000 United States currency.

LESSER GEMS

In America the opal has been used more in fine jewelry in the past year than for several generations; and our armed forces, when stationed in Australia, bought many fine gems. The stone's beauty deservedly warrants its revived popularity. During the war few Australian opals were produced, and the Mexican production has been small, hence the price trend of all grades is upward.

A new gem stone of considerable beauty, brazilianite, was discovered during the year. Zincite of an attractive deep-red color, from Franklin, N. J., has recently been cut into gems. Reference has been made to both of these gems in the section on Accessions to Museums and in the bibliography.

The aquamarine remains one of the most popular gem stones, so popular, in fact, that blue topaz, which if fine in quality is a superior stone, is appearing on the market as a substitute. Price has moved up markedly, apparently to an unwarranted extent. Brazil is the premier producer, particularly Minas Gerais and to a lesser extent Ceará. Minas Gerais includes the production of aquamarine with tourmaline. In 1936 over 7,235,000 carats of the two gems were produced; since then production has fallen and in 1943 was only 1,469,000 carats. Exports of aquamarine to the United States, however, have increased considerably—in 1943 158,695 carats valued at about $232,000 ($1.46 per carat) and in 1944, 364,285 carats valued at $578,506 ($1.58 per carat). Brazil also produces a much smaller amount of kunzite, a few emeralds, a little topaz, fine garnets, and much rock crystal and citrine.[4] Brazil stains a certain amount of chalcedony to black onyx, some of the product being exported.

[4] See also Pough, Frederick H., Jewelers' Circular-Keystone, February 1945, pp. 143-144, 158-163.

The Madagascar gem-mining industry, which was negligible during the war, may revive, as certain French firms wish to import rough gem stones.

The gem production of Ceylon during the war was small, labor being diverted to more important industries.

South African jewelry manufacturers are attempting to interest the public in the Dominion's rather mediocre gem stones, the diamond of course, being the exception.

It is reported that production at the Nishapur (Iran) turquoise mine has been very small during the past few years (personal communication from Lester S. Thompson). Lithuania is again beginning to produce and fabricate amber. Meerschaum was one of the principal exports of Turkey before the war; to a certain extent the industry is reviving (1944 production, 9,520 kilograms).

Asteriated quartz colored blue is being offered on the market as a substitute for the star sapphire.

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Gem Stones

By SYDNEY H. BALL

JEWELRY INDUSTRY IN 1946

JEWELRY sales in 1946 totaled some $1,709,000,000, an appreciable gain over the previous record year of 1945. For the first 6 months, sales by retail jewelers showed greater gains over those of the previous year than did those of other retailers. During the period many purchases of consequence were made, and the question of price was immaterial; thereafter sales dwindled, and in the last quarter the slight gain over the corresponding period of 1945 was due, not to volume, but to higher prices. The Christmas trade was slightly less than that of 1945, and high-priced goods—including fine diamonds—moved slowly. Customers were more discriminating and more interested in the quality of the goods offered. By the year end prices of mediocre diamonds were appreciably off. The more fashionable stores fared less well than the average. Sales by wholesalers showed greater gains than did those of the retailers, and in consequence retail jewelers' stocks increased during the year.

The 1946 prosperity of the industry was built on a high national income, full employment, an all-time high in marriages, and some drawing upon wartime savings.

On April 29, 1946, platinum was released for civilian use, and thereafter the industry had all the raw materials it needed. In the fall the last price controls were removed from jewelry merchandise.

In 1947 the jeweler will have more competition for the consumer dollar from durable goods, and his customers will seek better values than in 1946. Sales could dip appreciably, however, and the industry remain prosperous.

FASHIONS IN JEWELS

With the war behind us, formal functions are increasing in number; in consequence, there is a more lavish display of jewels, and many a fine gem has emerged from safety-deposit boxes. For evening wear, the white motif is dominant—platinum and diamonds or pearls. The latter have staged a slight come-back. Palladium is still being used, particularly in imposing earrings and clips, where its lightness is an advantage. Gold, often of several tones, is still widely worn, particularly with black gowns. Jewelry continues to gain in colorfulness; diamond pieces often are set with rubies, sapphires, or even less valuable colored gems. More women are acquiring jewelry especially designed to their taste.

Styles in the past year have changed little; but there is a tendency to abandon massive designs, and many of today's designs are lacy and delicate, with fragile look. Motifs were myriad; flowers were dominant, but leaves, bowknots, snowflakes, sunbursts, and pinwheels were also popular.

Clips, pins and brooches, bracelets, earrings, necklaces, and rings held their popularity, while the use of jeweled hair ornaments grew. Bracelets and necklaces frequently were woven of flexible wire. Necklaces tended to be longer. Many had pendant jewels and others, attached clips. The vogue of pendants from earrings increased; other earrings were clips attached to the top and bottom of the ears.

Some women wore a number of matching clips of graduated size; others, two or more bracelets and even several necklaces. Ensembles of like gems and mountings, say, matching clips, earrings and bracelets are highly prized. Jewelry which can serve a double purpose—an imposing pin separable into two clips or a necklace which can be divided into bracelets—is serviceable and is gaining in popularity.

Although the double-wedding-ring ceremony has become normal, an attempt to induce men to wear more jewelry has been only slightly successful.

The demand for old jewelry, much of it Victorian, is tapering off.

Small cabochon rubies and sapphires replace melee diamonds in some jewelry. The diamond was, by far, the most popular stone, followed by the ruby, sapphire, pearls (both natural and cultured), the emerald, aquamarine and turquoise. Fine aquamarine, while rare and expensive, holds its popularity; turquoise is gaining, but citrine and topaz are losing ground.

The ever-insistent demand for diamonds caused colorless gems to be most popular, followed by blue and red gems; green, yellow, and purple gem stones were in less demand, in the order named.

DOMESTIC PRODUCTION

Plenty of gasoline and greater leisure have permitted the mineral hobbyist to collect more minerals, some of which warrant cutting. The lapidary industry, professional and amateur, in the Western States continues to expand markedly; and now that its best customer, the auto tourist, is again on the road, the demand for cut-gem stones has increased. The American costume-jewelry industry, shut off during the war from European sources of supply, is a second outlet for the product. In consequence, production of gem stones may have skyrocketed from an estimated value (at the source) of $40,000 in 1945 to some $325,000 in 1946, but these figures are at best, rough estimates.

Prices during the year increased considerably, warranting the producer in risking capital today that he would not have dared to do in prewar days.

Jade, followed by agate, turquoise, and then variscite, were the most important gem stones produced. Of the States and Territories, Wyoming led, followed by Oregon, Alaska, Washington, and Nevada.

The jade (nephrite) industry of the Kobuk River region, Alaska, is likely to employ a few miners and may employ some of the local Eskimos cutting for the tourist trade. Nephrite occurs as float and pebbles, also in place in the Jade and Cosmos Hills. Most of the material is poor, but part is suitable for objets d'art and for tourist jewelry. The Arctic Circle Exploration Co. is the principal producer and fabricator. B. D. Stewart, Alaska Commissioner of Mines, informs the author that, in the summer of 1946, the company shipped 13¾ tons of jade and that a Fairbanks trader exported 100 pounds, some of which was of excellent quality. Some of the material in the rough is worth $5 a pound, and selected material is said to have brought $55 a pound.

Wyoming increased its production of nephrite from the Lander region, and at least one new occurrence of jade in place is reported. Many miners from outside the State visited the area in 1946. There are three lapidaries at Lander; in addition, some jade is exported to China, where it is cut. Some of the rough was sold for as much as $15 a pound. Most of the material is of more or less the quality of New Zealand jade, although some is said to be equal to that of Chinese Turkestan. Much of the jade land was located under the Placer Act, but apparently only in a few instances has enough work been done to hold them legally. Whether one buys or sells jade boulders, he gambles, for in no case is the value of the material known until it is cut.

After jade, agate and related quartz minerals, were the most important gem stones produced and are the principal materials cut by the large number of professional and amateur lapidaries in the West. Although some deposits have been worked out, the numerous agate prospectors have found deposits more than compensating for the exhaustion of the old deposits. Where virtually all of the float has been collected, underground work has started in several districts, a condition permitted by the higher price paid for the raw material. Dr. H. C. Dake, Portland, Oreg., believes that central Oregon is the chief producer. From a single pocket near Post, $8,000 worth of agate was recovered in 3 days, including a single mass weighing 186 pounds, which was sold for $1,000. Plume agates and other types of chalcedony are the principal products. Washington was perhaps the next most important producer.

The moss agate deposits of the flats of the Yellowstone River, Mont., are partly exhausted, but they still supply material to six professional lapidary shops and to scores of amateur lapidaries. A. Harrington reports that Idaho's production of moss agate increased in 1946 but that there were no new discoveries of importance. Owyhee County is one of the larger producers. The nodules called "thunder eggs" are in demand.

Gordon Bowser of San Luis Obispo, Calif., produced about a ton of moss agate worth $6,000. A little agate was also produced in San Bernardino County. Considerable plume agate was produced in south central Colorado, according to Richard M. Pearl, and from the Embargo mining district, Colo. T. D. Benjowsky reports that red jasper was mined near Hot Springs, Sierra County, N. Mex., and other agate species in Socorro and Catron Counties. A new source of dendritic chalcedony was discovered during the year near Fort Cummings, Luna County, N. Mex. When cut, it finds a ready market in the Southwest and in southern California.

Charles E. Hill reports finding a new agate locality in Yavapai County, Ariz., from which he mined some fine stones.

Agate nodules, weathering from lavas in Trans-Pecos, Tex., were collected in quantity in 1946 and sent to various lapidaries. Arizona produced some agate.

Alfred M. Buranek reports that the number of lapidary shops in Utah has grown remarkably during the year and that several new deposits of agate have been discovered. Agate was produced in the Dugway area, and moss agate and jasper from the Topaz, Jericho, and Beaver areas. So much material is being shipped to other States that the Mineralogical Society of Utah is preparing a bill to be presented to the legislature to prohibit nonresidents from shipping these minerals in quantity beyond the State boundaries.

In value, turquoise was probably the third most important American gem stone produced in 1946, although statistical data are scanty. Nevada was probably the leading producer. The Nevada Turquoise Co., of Mina, Mineral County, is said to have produced turquoise valued at more than $20,000. The Pedro claim of the Copper Canyon Mining Co. produced perhaps nearly as much. During the last 5 months of 1946, rough turquoise was recovered by the Castle Dome Copper Co., Inc., through the sorting of a small percentage of the ore broken in its routine mining operations, according to R. W. Hughes, general manager. The turquoise so recovered ranged in grade from thin, hard flakes with deep blue color through various degrees of hardness and shades of blue down to colorless chalky material.

The King turquoise mine at Manassa, Conejos County, Colo., leased by Horace and Wallace King, produced 2,000 pounds worth $30,000.

A "composite turquoise" (small fragments of Arizona turquoise in a matrix of black cement) is on the market and is rather attractive. Los Cerrillos, N. Mex., produced a little turquoise, largely by local labor near the mine. It was sold to lapidaries in the vicinity. The United Indian Traders Association has set up standards for hand-made Navajo and Pueblo jewelry and is prepared to license its mark.

Utah continues to produce some variscite. Alfred M. Buranek reports that the Clay Canyon deposits were worked, as was the Lucin (Box Elder County) on a somewhat smaller scale. Junius J. Hayes reports that collectors got some variscite from the Grantsville deposit in Tooele County.

Some geophysical work was done in the vicinity of the Murfreesboro, Ark., diamondiferous pipes. The main company is again in litigation. Some 40 years ago a few small, alluvial diamonds were reported to have been recovered at a gold placer near McCall, Idaho. Late in 1946 that ground was leased and some development work started.

Montana apparently produced no sapphire in 1946.

A considerable amount of "flowering" obsidian was mined in Utah. In Arizona some "marekanite" was produced. This is a semitransparent smoky glass nodule occurring in obsidian.

Kelley and Branson[1] describe small Tertiary pegmatite masses on the west slope of the Black Range, Grant County, N. Mex. The pegmatite consists largely of quartz and sanidine; the latter, which occurs in fair-size masses, "displays blue and white opalescence, giving rise to a moonstone of commercial quality." A little may have been produced in 1946.

[1] Kelley, V. C., and Branson, O. T., Bull. Geol. Soc. America, vol. 57, December 1946, p. 1255.

The Barton Mines Corp., North Creek, Warren County, N. Y., sells some of its garnets to lapidaries. The color is good, but the market is of limited scope. Valley and Adams Counties, Idaho, have garnet deposits, but as far as is known none was worked in 1946. In the extreme southeastern part of Utah pyrope garnets of good color, some over a half inch in diameter, occur in gold placers.

Other gem stones produced in small amounts in 1946 include agatized wood (Arizona and New Mexico); alabaster (South Dakota); amethyst (Dugway area, Utah); aquamarine (Deep Creek, Utah, and San Diego, Calif.); kunzite (San Diego, Calif.); kyanite (Upson County, Ga.); opal (17 miles south of Marsing, Idaho); opalized wood (central Washington); pipestone (Pipestone, Minn.); rock crystal (Crystal Mountain, Ark.); rose quartz (South Dakota); staurolite (Cherokee County, Ga.); topaz (Tarryall Mountains, Colo., and Topaz Mountain, Utah); and tourmaline (San Diego, Calif., and Mount Apatite, Maine).

GOVERNMENT REGULATIONS

A number of Government regulations enacted in 1946 affected the trade in precious stones. The majority of such measures were passed in the hope of increased revenue.

The United States removed control from all jewelry items, but apparently for some time to come is not to reduce the excise tax (20 percent). Maine in 1946 placed a 5-percent luxury tax on jewelry sales in addition to the 20-percent Federal tax. During the year, the United States also removed controls on the price and export of industrial diamonds and diamond-set tools.

Canada removed all controls from diamonds and gem stones on March 15, 1946, and India on July 29, 1946. Import duties on jewelry were increased by Argentina, Czechoslovakia, Mexico, and Paraguay. Luxury taxes on jewelry were established in China (50 percent), Spain (20 percent), and France (25 percent), and Mexico added a 5-percent sales tax on jewelry sold in the Federal district. Italy, permitted the purchase, sale, and transfer of jewelry and precious stones after April 26, 1946, but not their exportation. Egypt, while still prohibiting transit trade in gold and jewelry, now permits the importation of gold, provided it is reexported within 6 months. France no longer requires a license for exporting jewelry and precious stones. On the other hand, such commodities exported from Burma require a license granted by the Reserve Bank of India. As France received fewer industrial diamonds than its needs, the commodity was placed under Government control.

IMPORTS

The value of imports of precious and semiprecious, real and imitation stones, exclusive of industrial diamonds, as listed by the United States Department of Commerce, totaled $189,017,646—65 percent more than in 1945. Diamonds were over 88 percent of the total. Fine gem stones and pearls and cut imitation stones showed large increases.

Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1945–46 [1]

Commodity	1945		1946	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty free	893,761	$43,122,622	1,044,517	$48,668,843
Cut but unset, suitable for jewelry, dutiable	377,243	64,185,406	604,638	117,968,206
Emeralds:				
Rough or uncut, free	1,085	252	544,711	579,745
Cut but not set, dutiable	106,684	181,834	11,902	210,274
Pearls and parts, not strung or set, dutiable:				
Natural		352,947		619,463
Cultured or cultivated		155,548		1,280,867
Other precious and semiprecious stones:				
Rough or uncut, free		134,698		329,552
Cut but not set, dutiable		5,113,937		8,932,862
Imitation, except opaque, dutiable:				
Not cut or faceted		3,220		68,108
Cut or faceted:				
Synthetic		805,838		1,640,426
Other		242,988		8,044,674
Imitation, opaque, including imitation pearls, dutiable		31,136		298,545
Marcasites, dutiable:				
Real		101,140		344,907
Imitation		3,665		31,174
		114,435,231		189,017,646

[1] In the corresponding table in Minerals Yearbook, 1945, p. 1548 and Minerals Yearbook, 1944, p. 1518 data for 1944 should be revised as follows: Diamonds, rough or uncut, $43,549,837; cut but unset, $29,003,536; emeralds, cut but not set, $70,924; pearls and parts, natural, $244,879; total value, $77,367,188.

DIAMOND

For mining companies, wholesalers, and retailers, 1946 was even a better year in the diamond industry than the previous record year, 1945. The cutters, on the other hand, had a far from satisfactory year.

Production was less by weight than in 1945 but greater in value. Output of gem stones in southern Africa and Tanganyika Territory increased, whereas the break-down of war-worn machinery cut deeply into Belgian Congo's production, which is dominantly of industrial grades.

Sales of rough by the principal wholesaler, the Diamond Corp., were £30,000,000, or 22 percent greater than those of the previous record year 1945. Production did not meet sales, and stocks were depleted further; the day when all sales must be made from current production approaches.

With the war over, the market for cut diamonds is broadening, but few countries are as yet able to pay for luxuries, although investment buying continues. The American retailer never sold so many cut diamonds, although demand weakened in the last quarter of the year.

The cutting industry alone was not prosperous. During and since the war the industry mushroomed, and its capacity to cut exceeds the rough now available. In consequence, unemployment, strikes, and lock-outs were common, and there was a tendency toward lower wages.

Prices of rough were raised moderately in gem grades and somewhat more so in industrials, which during the war sold at less than prewar prices. Prices of polished diamonds were slightly increased in the first half of the year but weakened in the last quarter, particularly prices of mediocre-quality stones.

As was to be expected, with the end of the war, fewer industrials were used. In 1946 the users were, however, importing stones of finer quality than those used during the war, hence the dollar value approached that of wartime imports.

Share Dealings.—The shares of the leading diamond mining companies on the London Stock Exchange, their principal market, gained about 17 percent. Quotations early in June 1946 were at practically an all-time high. Thereafter they fluctuated and declined slightly. All of the principal diamond-mining companies except Premier paid dividends in 1946.

Imports.—Imports of gem diamonds into the United States increased from $107,308,028 in 1945 to $166,637,049 in 1946—a gain of 55 percent.

The accompanying table shows comparative figures of imports during 1945 and 1946. The imports of rough in the latter year were greater by 17 percent, as to carats, and 13 percent, as to value. The gain in imports of cut was 60 percent, as to carats, and 84 percent as to value. The grade of the 1946 rough imports was poorer, and the grade of cut about the same.

Diamonds imported for consumption in the United States, 1945–46,[1] by countries

[Exclusive of industrial diamonds]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1945						
Argentina				4	$2,000	$500.00
Austria				12	1,136	94.67
Belgian Congo	10,054	$86,793	$8.63			
Belgium and Luxembourg				104,840	14,612,123	139.38
Brazil	14,340	628,325	43.79	28,472	4,988,200	175.20
British East Africa	7,413	207,556	28.00			
British Guiana	1,774	42,715	24.08	580	67,471	116.33
British West Africa	1,158	21,402	18.48			
Canada	1,110	16,650	15.00	1	100	100.00
Cuba				64,737	11,439,698	176.71
France				44	7,511	170.70
Germany				1,230	133,496	108.53
India and Dependencies				703	134,641	191.52
Mexico	13,838	504,641	36.47	9	5,003	555.89
Netherlands				2,599	520,516	200.28
Palestine and Trans-Jordan				105,899	17,684,997	167.00
Portugal				18	6,405	355.83
Switzerland				271	39,738	146.63
Union of South Africa	834,393	41,290,329	49.49	46,096	10,720,816	232.58
U. S. S. R.				3,569	562,617	157.64
United Kingdom	5,699	173,797	30.50	17,535	3,176,270	181.14
Venezuela	3,973	150,414	37.86	624	82,668	132.48
Total 1945	893,761	43,122,622	48.25	377,243	64,185,406	170.14

See footnote at end of table.

Diamonds imported for consumption in the United States, 1945–46,[1] by countries—Continued

[Exclusive of industrial diamonds]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1946						
Argentina				114	$20,754	$182.05
Belgian Congo	5,649	$48,834	$8.64			
Belgium and Luxembourg	3,104	135,882	43.78	288,929	51,150,251	177.03
Brazil	59,142	2,766,768	46.78	15,939	3,228,079	202.53
British East Africa	12,685	636,129	50.15			
British Guiana	3,246	175,033	53.92	752	84,802	112.77
British Malaya	2,500	20,169	8.07	617	177,379	287.49
Canada				127	8,674	68.30
Cuba	383	4,743	12.38	38,325	7,502,503	195.76
Denmark				4	610	152.50
Egypt				34	10,082	296.53
France				6,042	1,186,641	196.40
Greece				240	16,444	68.52
Hungary				107	4,575	42.76
India and Dependencies				929	183,941	198.00
Iran				200	40,243	201.22
Japan				3	1,215	405.00
Mexico				313	62,566	199.89
Netherlands	124	15,335	123.67	37,473	7,724,355	206.13
Palestine and Trans-Jordan	3,566	115,927	32.51	121,627	21,972,027	180.65
Portugal				671	146,431	218.23
Siam				40	9,411	235.28
Sweden				10	2,183	218.30
Switzerland				7,776	1,470,574	189.12
Union of South Africa	935,824	44,015,089	47.03	56,120	16,783,704	299.07
U. S. S. R.				4,796	1,002,000	208.92
United Kingdom	10,693	351,113	32.84	23,198	5,134,475	221.33
Venezuela	7,601	383,821	50.50	252	44,287	175.74
Total 1946	1,044,517	48,668,843	46.59	604,638	117,968,206	195.11

[1] In the corresponding table in Minerals Yearbook, 1945, p. 1550 and Minerals Yearbook, 1944, p. 1521, data for 1944 should be revised as follows: Rough or uncut: Brazil, total value, $830,996; average value, $32.44. Grand total value, $43,549,837; total average value $48.58. Cut but unset: Brazil, total value, $4,014,301; average value, $160.37; U. S. S. R., total value, $147,604; average value, $102.79. Grand total value, $29,003,536; total average value, $171.52.

Cutting.—At the end of 1945 there were some 25,000 cutters in the world; at the end of 1946, some 35,000. Decreases in Brazil, the United States, Cuba, and Puerto Rico were more than offset by a large increase in Belgium and a smaller one in Palestine. Even in 1945 there was inadequate rough to insure full employment; and in 1946, as the supply was not much greater, there was a chronic shortage of rough, resulting in unemployment for the artisans and inadequate profits for the master cutters. Belgium is by far the largest cutting center, followed by Palestine, New York, and Cuba. Some of the war-born centers will disappear over the next few years, and others will be deflated. The best cutting of sizes is done in the United States and that of melee in Palestine, Belgium, and the United States.

World Production.—Accurate figures regarding diamond production still are not available for many countries, but the estimates in the following table are believed to be fairly reliable. World production (gems and industrials) in 1946 is estimated to have been 10,313,000 carats (2.27 short tons) worth at the mine about $81,400,000 which compares with 14,384,000 carats (3.17 short tons) in 1945. The quantity was 72 percent of that of 1945, but the value at the mine showed an increase of about 25 percent. The increase in value was due to the increased production of gem grades (both as to carats and value) and the advance in the price of cuttables. By weight, about 1,228 pounds were gem stones and 3,315 pounds industrials.

Belgian Congo was the leading producer by weight (59 percent), although it represented only 11 percent of the value. On the other hand, the British Commonwealth, accounting for only 29 percent of the weight, represented about 70 percent of the value.

Union of South Africa, South-West Africa, Tanganyika Territory and Gold Coast showed gains, and Belgian Congo a loss. At Kimberley, the Dutoitspan and Bulfontein pipe mines continued to operate, and in a year or two Premier and New Jagersfontein will resume production.

The accompanying table shows available statistics and estimates of world production for the past 5 years.

World production of diamonds, 1942–46, by countries, in metric carats

[Including industrial diamonds]

Country	1942	1943	1944	1945	1946
Africa:					
Angola	791,853	794,990	799,120	803,887	[1] 808,000
Belgian Congo	6,018,236	4,881,639	7,533,365	10,386,000	6,033,452
French Equatorial Africa	46,345	56,183	60,000	82,849	87,381
French West Africa	49,866	36,193	69,726	79,802	51,834
Gold Coast [2]	1,055,735	1,317,798	1,165,858	812,451	830,000
Sierra Leone	1,046,187	834,492	608,744	504,309	559,229
South-West Africa	56,420	94,427	154,379	152,629	163,611
Tanganyika	40,327	52,998	90,667	115,666	[1] 119,446
Union of South Africa:					
Mines	858	84,342	552,974	878,713	1,025,019
Alluvial	117,963	217,987	380,708	262,529	256,768
Total Union of South Africa	118,821	302,329	933,682	1,141,242	1,281,787
Brazil [1]	300,000	275,000	301,000	275,000	325,000
British Guiana	22,207	18,272	[2] 13,911	15,442	30,958
Venezuela	34,048	22,846	22,037	12,769	20,912
Other countries	6,788	6,804	12,000	2,000	[3] 1,600
Grand total	9,587,000	8,694,000	11,764,000	14,384,000	10,313,000

[1] Estimated.
[2] Exports.
[3] Partly estimated; includes India, Borneo, Australia (New South Wales), and U. S. S. R.

Industrial Diamonds.—In the first year after World War II ended, the imports of industrial diamonds decreased markedly in carats but in dollar value compared favorably with all previous years except 1942–44. Consumption and production approached balance, but many grades were in short supply. Manufacturers of diamond-set tools must still be careful in using those industrial stones available.

From the spring of 1946 on, the principal wholesaler of industrial stones was Industrial Distributors (1946) Ltd.

On July 23, 1946, the Strategic and Critical Materials Stock Piling Act (Public Law 520, 79th Congress) was approved. All diamonds then in the hands of Government agencies were transferred to the stock pile, and additional industrials are to be purchased.

After World War II broke out, the price of crushing bort was halved and that of other grades remained steady during the war. In 1946 the price of crushing bort was raised 80 percent and that of other grades somewhat less.

The year saw many improvements, but few innovations, in the use of industrial diamonds.

Figure 1, originally prepared by Herbert Backman several years ago, shows the tremendous increase in use and the sharp decline in the price per carat of American imports in the past 28 years.

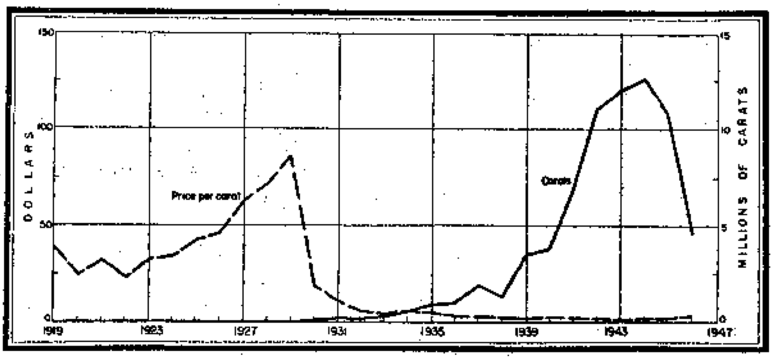

FIGURE 1.—United States imports and average price per carat of industrial diamonds, 1919–46.

Imports of industrial diamonds into the United States during the past 5 years were as follows:

Industrial diamonds (glaziers', engravers', and miners') imported for consumption in the United States, 1942–46

Year	Carats	Value		Year	Carats	Value	
		Total	Average			Total	Average
1942	11,203,704	$22,057,577	$1.97	1945	10,729,869	$12,810,932	$1.19
1943	12,084,133	21,890,568	1.81	1946	4,625,282	14,297,536	3.09
1944	12,614,507	22,894,244	1.81				

RUBY, SAPPHIRE, AND EMERALD

Because of the dominant position of the diamond in the gem market and the fact that ruby, sapphire, and emerald deposits do not lend themselves to large-scale operations, gem mining by large companies is confined to the diamond. Fine rubies come from Burma; sapphires from Siam, Ceylon, Indochina, and Kashmir (according to rumor, the deposits in the latter two countries are practically exhausted), and emeralds from Colombia and U. S. S. R. Burma, Siam, and Indochina are none too peaceful at the moment, a condition scarcely conducive to large production. The Colombian emerald mines are not being operated, and the Ceylon sapphire production is still subnormal. Shipments from the mines are greater than in the past war years; but fine gems are in short supply, and jewelers' stocks and outmoded jewelry still contribute the major part of our supply.

Fine gems are by no means modestly priced, and American buyers must compete with Oriental lovers of these gems.

Wadia and Fernando (see Bibliography) have written an interesting article on gem mining in Ceylon, an important producer of sapphire and many of the lesser gems.

Siam would welcome American capital in developing its gem resources, but so far there have been few candidates. Who will eventually own the sapphire deposits on the common boundary of Siam and Indochina is at the moment in doubt. Sapphires and even a few rubies occur in Brazilian gravels, but no known occurrence is of commercial importance.

During the year, the Bank of the Republic of Colombia (the Government hoping to interest tourists in emerald matrix) sold 828.75 carats of cut and 342,552 carats of rough emerald, long held by it for the Government, for 573,076 pesos. The Government is now considering the advisability of reopening the mines, inactive since December 1938.

Transvaal, South Africa, produces a few gem beryls, some of which are dark enough to be classed as emeralds; they are largely, however, of mediocre grade. The principal producer is the Somerset mine of the South Africa Beryl Mining Co. Most of the stones are exported to India. In the first quarter of 1946, 2,902 carats worth £1,433 (about $5,732, or $1.98 per carat) were sent to India.

It is reported that the American synthetics, "Chatham synthetic emeralds," are being improved in size, depth of color, and quality.[2]

LESSER GEMS

In 1946, there was a scarcity of desirable gem stones; due to this, plus higher cutting costs and good demand, prices advanced. In the last quarter of the year, prices softened, and particularly those of mediocre qualities fell.

In February 1946 new and rich opal fields were found at Coober Pedy, Central Australia, 1,200 miles from Adelaide.

Due to the inflation in China, the Chinese are investing in jade, and prices are 5 to 10 times those of prewar days. Shelves of the dealers are practically bare, and little is being exported to the United States. The jade centers of Peking and Canton are languishing, war having cut them off from the jadeite of Burma and the nephrite of Turkestan. As master cutters no longer receive imperial subsidies, the lapidary art is deteriorating.

The popularity of aquamarine continues to grow. The supply of fine Brazilian is inadequate, and prices still are rising. Late in October, an aquamarine weighing 56 pounds was flown from Brazil to New York. The stone was found near Resplendor, Minas Gerais. It is a rough, hexagonal prism, 11 inches high and 10 inches in diameter. The stone, it is claimed, was insured for $500,000, and the owners hope the cut stones from it will be worth $2,500,000. The Indian deposits of beryl have recently been described.[3] The Bisundni Mine, Rajputana, produces a little gem material of pale green color, as well as rose quartz,

[2] Switzer, George, Gems and Gemology, Spring 1946, pp. 305–307.
[3] Bureau of Mines, Mineral Trade Notes: Vol. 22, No. 3, March 1946, pp. 4–9.

and the Vasanta Kalyani mica mine, Madras, some beryl suitable for gem purposes.

The precious stone industry of Brazil is, under government patronage, to create a Precious Stone Exchange. Among the objects are to assist diamond mining, protect cutters, reduce taxes on precious stones, and simplify exporting. Before World War II, Brazil exported most of its precious stones to the Idar district, Germany. During the war, lapidary shops sprang up in Brazil. Attempts are now being made to introduce modern methods in these shops.

Emerson I. Brown, minerals attaché at the United States Embassy in Rio [4] gives an interesting summary of the precious stone industry in Brazil. He states that supply exceeds demand, the American market being dull, although the European market is becoming active. Export prices are off as much as one-third.

Edward R. Swoboda describes the spodumenes of Brazil (see Bibliography). While most of the material is colorless, kunzite and yellow spodumene also occur, and rarely deep green spodumene.

Philip Lichtenberg [5] describes the mica-tourmaline deposit of Cruzeiro, Minas Gerais, which he says is the most important producer of tourmaline in Brazil.

Some fine olivines have appeared on the American market from stocks of the mining company that once operated the well-known deposit on Zebirget Island in the Red Sea.

The Soviet Government, under the current 5-year plan, is to increase notably the production of its lapidary trust, Russkie Samotsvety. Sverdlovsk and a town in the Altai are cutting centers, and the personnel is to be increased. The production of the lesser gems and ornamental stones is to be raised, and objets d'art and stones for jewelry cut.

The French are attempting to revive the gem-mining industry of Madagascar, an important producer of gems for jewelry as well as industrial applications. Mining taxes were reduced as of June 2, 1945. Madagascar produces a large number of gem stones, but the percentage suitable for cutting is small, most of them being used industrially.

E. Ruff [6] describes the large number of gem stones which occur in New Zealand. Jade (nephrite) alone is, however, of commercial importance.

Before World War II, South-West Africa was an important source of gem stones for the German lapidary industry. In 1939, the last year of export to Germany, the total value was but £1,132.

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[4] Bureau of Mines, Mineral Trade Notes: Vol. 23, No. 5, November 1946, pp. 49–52.
[5] Jewelers' Circular-Keystone, December 1946, pp. 236–238, 310–311.
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Gem Stones

By SYDNEY H. BALL

THE JEWELRY INDUSTRY IN 1947

JEWELERS in 1947 had more competition for the consumer's dollar from dealers retailing other durable goods, long unobtainable, and also found their customers more discriminative. Consequently, whereas retail sales as a whole increased 18 percent in value, jewelry sales were—in dollar value ($1,390,000,000)—about 19 percent below those enjoyed in 1946 and—in volume—owing to increased prices, perhaps 15 percent less. During the wartime boom the jewelers had little competition. They now have returned to their prewar position and must fight for their trade. Although Christmas sales were large, they were somewhat less than in 1946 and were characterized by the slowness with which expensive items moved—especially large diamonds. Retailers' stocks decreased somewhat in 1947, and wholesale jewelers' sales ($494,000,000) were 14 percent less than those of 1946. Factories were plagued by a shortage of skilled labor.

The profits of the industry were built on an exceptionally prosperous national economy—high industrial wages, a record national income, and record exports. Marriages were exceeded in number only by those of 1946.

Exports of jewelry were large, the chief customers—notwithstanding certain Government restrictions—being Brazil, Canada, and the Philippines.

FASHIONS IN JEWELS

Life in 1947 was more formal and entertainment more lavish than in wartime. A greater display of jewels was therefore the order of the day. Costumes required colorful jewelry by day and sparkling jewelry by night, in many instances with movable parts that shimmer in the light. More and more jewelry was selected to suit the type of the wearer; her complexion was as important in her choice of jewelry as in the choice of her gown.

Jewelry in demand during 1947 was notably graceful in lines and delicate in workmanship, emphasizing the femininity of the wearer.

Clips and pins, earrings, bracelets, and rings held their popularity, while bracelets hiding a tiny watch under a jeweled cover were new. A number of small clips of the same design were worn by some. Earrings frequently had long pendants or drops, similar to classical Greek or Roman designs. Choker necklaces remained popular, and bib necklaces of ancient Egyptian design became favorites. Snake necklaces of woven wire frequently carried detachable pendants or clips. Rings were often large. Link bracelets or wide, flexible bracelets with crestlike ornamentation, or tailored ones of bulky gold, were popular.

Ensembles were more and more in vogue—a necklace, a bracelet, a ring, and earrings all of the same design and mounted with the same kind of stone. Formal jewelry that can be broken into two or more pieces continues to gain in popularity—a necklace, for instance, that can also be used as clips and brooches.

The insistent demand for diamonds caused colorless gems to be by far the most widely used, with blue and red almost tied as a poor second, followed by green, yellow, and purple. Emeralds and colored diamonds seemed to be gaining in the finest jewelry. Opal was seen more commonly; aquamarine held its own; and topaz and citrine continued to lose ground.

DOMESTIC PRODUCTION

Although by no means an important factor in the national economy, the value of gem stones produced and their value after cutting has increased impressively for the past 3 years, due mainly to the awakened interest of Americans in the Western States to the beauty of such minerals and the fun of cutting them. Activity in this field is fostered by journals, technical societies, and educational institutions. An adequate supply of gasoline permits not only collectors—amateur miners—to visit the field, but brings to the door of lapidaries and curio shops their best customers, automobile tourists. A broadening demand and reduced imports from Europe have increased prices since the beginning of World War II. Some small mining companies are purchasing bulldozers and other mining machinery to be used on their properties.

No reliable statistics exist as to the value of the domestic product. Last year the writer estimated the value, in the rough, at $325,000. In 1947 it was more—perhaps $570,000—and, after processing, the value might have been several times this figure.

In Idaho, California (San Diego), and Maine, some of the old gem deposits changed hands, and production may increase in the future.

The myriad forms of agate, attractive and widely distributed, easily found and as easily cut, led the field, followed by jade, turquoise, and variscite. Of the States and Territories, Oregon, Wyoming, Washington, Colorado, Alaska, and Nevada produced in about that order of quantity of output.

Agate.—H. C. Dake, in a personal communication, states that he believes Oregon alone produced in 1947 agates to the value of $1,000,000. Oregon has many quartz operations, particularly in the central part of the State, equipped with bulldozers and power shovels, and also an enthusiastic group of lapidaries, amateur and professional, and curio venders. Certain Oregon beaches have also produced well. In "Gem Mining, a New Oregon Industry" (see Bibliography), Dr. Dake describes in detail the various agate-producing districts.

Washington produces considerable opalized wood and other agate gems, part of which are cut in the State. Idaho produces some quartz gem stones, and there are a number of lapidaries at Boise.

The fine moss agate of the Yellowstone Valley, Mont., is still being gathered, but the terrace gravels have been largely picked over. The 1947 production was worth perhaps $10,000. Montana moss agate is sold widely in the West. The west Texas region also produces considerable agate. Arizona has some fine agates, particularly from near Cave Creek. Complaints have been lodged with the Government that so much agatized wood is stolen from the Petrified Forest, an Arizona national park, that the beauty of the park is jeopardized. New Mexico, particularly Luna County, produced some agate, which was shipped to the west coast for cutting.

Turquoise.—In 1947 turquoise production, in dollar value, probably exceeded that of jade. Dan E. Mayers (see Bibliography) contributed interesting data on the American Indian and turquoise. The Southwest Gem & Jewelry Co. produced a fair amount of turquoise, perhaps 200 pounds, from its properties in Mineral Park, Ariz. Collection of turquoise from Castle Dome, N. Mex., was said to be perquisite of being a miner there. Later the company recovered turquoise as a byproduct. It is reported that most of the open-cut is now below the turquoise horizon. The company reported that during 1947 it "recovered several hundred pounds of rough turquoise, as it has for the last few years." G. M. Butler reported that the lapidaries of Miami and Globe, Ariz. treat the stones with an oily substance, improving both the color and the hardness of the chalky, feebly colored product. State highway engineers, drilling to locate the Pinto Creek bridge foundation near Miami, encountered an old tunnel. A cave-in followed, revealing the presence of turquoise among other minerals. The Colorado State Mineral Resources Board stated that in 1947 the King Mine, Manassa, Colo., produced turquoise valued at $30,000. An unusually large turquoise mass, weighing 10¾ pounds originally and 8¾ pounds after trimming, was included. The proprietors were offered $1,000 for it. A little turquoise was produced from the Hachita Mountains, N. Mex. Some development work was done on Los Cerrillos deposit, New Mexico, but net results were not encouraging.

Nevada produced but little in 1947. Some was mined in the Copper Basin district and cut there, but later in the year keen competition from Arizona forced a shut-down.

Jade.—B. D. Stewart, Department of Mines of Alaska, reported that the Kobuk River region produced much less jade in 1947 than in 1946, due to curtailed operations by the principal producer. The local demand exceeded supply, and there was none for export. In addition, at least one Eskimo collected and shipped some material. From $25,000 to $30,000 worth of jade being shipped to China in the spring of 1947 by the Arctic Exploration Co., Inc., was stolen but later recovered. It consisted of boulders weighing 200 to 1,500 pounds each.

In Wyoming there were a number of jade hunters around Lander, but as few large boulders and little high-grade gem material was recovered, results were disappointing compared to those of 1946. A new occurrence was reported in the Shirley Mountains.

The californite locality near Happy Camp in northern California, which furnishes a fair imitation of jade, has long been known, but James L. Kraft, reported boulders of true jade in the vicinity. The California Division of Mines reported that mineral collectors pick up boulders of nephrite from the beaches of Monterey County, between Big Sur and the San Luis Obispo County line. Austin F. Rogers described a massive rock, an intimate mixture of grossularite and idocrase (vesuvianite), from Placer County, Calif. It is white to gray and an attractive ornamental stone that might well serve as a substitute for jade.

Diamond.—The litigation between Glenn L. Martin, the airplane manufacturer, and the Diamond Corp. of America, which once held a 50-year lease on the principal Pike County, Ark., diamond deposit, during the summer of 1947 was dismissed, and $325,000 of the corporation's funds were released. In August 1945, according to the California Division of Mines, a small diamond was found in Yuba County a short distance below Parks Bar by Lewis Drade, while placering. Confirmation of the reported discovery of a 19½-carat stone in the summer of 1947 at Rock Flat 4 miles west of McCall, Idaho, is not yet available.

Other Gem Stones.—In 1947 the Montana sapphire mines reported no production. Synthetic sapphire producers have won the principal market, the industrial uses.

At one time Niagara Falls, N. Y., produced satin spar, which James Potter cut for the tourist trade. The local supply is now exhausted.

Mrs. E. M. Roe reported that in 1947, at Pipestone, Minn., more catlinite was mined than for some years by two Indians. Total production probably approached $5,000.

Other gem stones produced in small amounts in 1947 include *agate*, Colorado; *alabaster*, Montana; *amazon stone*, Colorado; *amethyst*, Colorado, Maine, North Carolina; *apatite* (green), Maine; *aquamarine*, Colorado, Georgia; *asteriated quartz*, Maine, North Carolina; *cesium beryl*, Maine; *garnet*, Colorado, New York, North Carolina; *kunzite*, California; *lapis lazuli*, Colorado; *moonstone*, New Mexico; *peridot*, Maine, New Mexico; *rose quartz*, Maine; *sapphire*, Colorado; *smoky quartz*, Maine, New Hampshire, North Carolina; *topaz*, California, Colorado, New Hampshire, Utah; *tourmaline*, California, Colorado, Maine; and *triphylite* (chatoyant), Maine.

CANADIAN GEM STONES

Time has not fulfilled the hopes of the earlier Canadian explorers. Canada is probably even poorer in gem stones than the United States. A couple of thousand dollars would doubtless cover the value of a normal year's production. There are relatively fewer lapidaries, professional or amateur, in Canada than in the United States; in consequence, a considerable percentage of the present small production is shipped across the border for cutting. Labrador has for decades been the premier source of labradorite; sodalite, albitic moonstone, ordinary moonstone, amazon stone, and chatoyant tremolite are found in the Bancroft area, Hastings County, Ontario; rock crystal near Black Rapids (Lyndhurst P. O.), Ontario, and agate in the Lake Superior region. Scapolite, rose quartz, rhodonite, and sphene (titanite) also occur. F. G. Smith informed the writer that he shipped from about 90 miles northwest of Yellowknife, Northwest Territories, some 200 pounds of iolite which could be cut into 200 carats of flawless gems worth perhaps $10 a carat.

GOVERNMENT REGULATIONS

Regulation of the jewelry industry did not decrease with VJ-day. With few exceptions, the laws attempt either to increase national revenue or to keep currency at home.

Cuba, the Union of South Africa, Palestine, and Singapore, however, reduced certain taxes and the United States some duties in accordance with the General Agreement on Tariffs and Trade, at Geneva, October 30, 1947. In both the United States and Canada, on the other hand, substantial luxury taxes continued to apply to jewelry sales. Peru, Trinidad, and Great Britain introduced or increased luxury taxes. A number of countries, particularly Latin American countries, prohibited the import of jewelry.

IMPORTS [1]

The value of imports of gem stones, real and imitation, exclusive of industrial diamonds, into the United States, as listed by the United States Department of Commerce, totaled $110,537,647, 42 percent less than in 1946. Diamonds comprised 87 percent of the total. Practically every class was less than in the previous year.

[1] Figures on imports and exports compiled by M. B. Price, of the Bureau of Mines, from records of the U. S. Department of Commerce.

Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1946–47 [1]

[U. S. Department of Commerce]

Commodity	1946		1947	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty free	1,044,517	$48,668,843	1,075,478	$43,051,210
Cut but unset, suitable for jewelry, dutiable	604,638	117,968,206	347,810	53,471,539
Emeralds:				
Rough or uncut, duty free	544,711	579,745	7,385	258,062
Cut but not set, dutiable	11,902	210,274	4,133	82,747
Pearls and parts, not strung or set, dutiable:				
Natural		619,463		360,963
Cultured or cultivated		1,280,867		737,753
Other precious and semiprecious stones:				
Rough or uncut, duty free		329,552		298,393
Cut but not set, dutiable		8,932,862		3,662,382
Imitation, except opaque, dutiable:				
Not cut or faceted		68,108		118,168
Cut or faceted:				
Synthetic		1,640,426		483,313
Other		8,044,674		7,688,827
Imitation, opaque, including imitation pearls, dutiable		298,545		15,566
Marcasites, dutiable:				
Real		344,907		300,175
Imitation		31,174		8,549
		189,017,646		110,537,647

[1] In the corresponding table in Minerals Yearbook, 1946, p. 540, revisions for 1945 are as follows: Diamonds, rough and uncut, (carats) 895,219, (value) $43,131,784; cut but unset, (carats) 377,594, (value) $63,815,581. Emeralds, cut but not set, (carats) 107,591. Other precious and semiprecious stones, rough or uncut, $135,062; cut but not set, $5,158,408; cut or faceted, other, $252,388. Total value, $114,128,803.

DIAMOND

Nineteen forty-seven was a good year for diamond wholesalers, a fair or better year for the producers and retailers, and a poor year for master cutters and their employees.

World production was about 4 percent less than in 1946. Union of South Africa and Tanganyika Territory fell off somewhat, but Venezuela percentwise increased markedly. Output from the Belgian Congo, largely industrial stones, continued on the low side.

Sales of rough by the principal wholesalers, the subsidiaries of the Diamond Corp., were £24,500,000, as compared with £30,000,000 in 1946, but the difference was largely made up by rough purchased by the cutters from overstocked American brokers and cutters and from sellers of "outside goods" in the first half of the year. Rough stocks were again depleted.

Retail sales in the United States were good, although less than in 1946. At Christmastime, however, high-priced items moved slowly.

Prices of rough were stable, but some of the less expensive smalls were raised by the beginning of 1948. Cut, particularly that of mediocre quality, declined in the first 7 months of the year, but by the year end had regained its loss.

Industrial imports were lower in weight, but as better stones were bought the dollar value of imports showed only a small decline.

Share Dealings.—The shares of the leading diamond mining companies on the London Stock Exchange, their principal market, lost

Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1946–47,[1] by countries

[U. S. Department of Commerce]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1946						
Argentina				114	$20,754	$182.05
Belgian Congo	5,649	$48,834	$8.64			
Belgium	3,104	135,882	43.78	288,929	51,150,251	177.03
Brazil	59,142	2,766,768	46.78	15,939	3,228,079	202.53
British East Africa	12,685	636,129	50.15			
British Guiana	3,246	175,033	53.92	752	84,802	112.77
British Malaya	2,500	20,169	8.07	617	177,379	287.49
Canada				127	8,674	68.30
Cuba	383	4,743	12.38	38,325	7,502,503	195.76
Denmark				4	610	152.50
Egypt				34	10,082	296.53
France				6,042	1,186,641	196.40
Greece				240	16,444	68.52
Hungary				107	4,575	42.76
India				929	183,941	198.00
Iran				200	40,243	201.22
Japan				3	1,215	405.00
Mexico				313	62,566	199.89
Netherlands	124	15,335	123.67	37,473	7,724,355	206.13
Palestine and Trans-Jordan	3,566	115,927	32.51	121,627	21,972,027	180.65
Portugal				671	146,431	218.23
Siam				40	9,411	235.28
Sweden				10	2,183	218.30
Switzerland				7,776	1,470,574	189.12
Union of South Africa	935,824	44,015,089	47.03	56,120	16,783,704	299.07
U. S. S. R.				4,796	1,002,000	208.92
United Kingdom	10,693	351,113	32.84	23,198	5,134,475	221.33
Venezuela	7,601	383,821	50.50	252	44,287	175.74
Total 1946	1,044,517	48,608,843	46.59	604,638	117,968,206	195.11
1947						
Austria				2	300	150.00
Belgium	3,482	45,579	13.09	205,650	30,368,217	147.67
Brazil	29,322	533,796	18.20	7,227	900,317	124.58
British Guiana	822	39,155	47.63	223	26,356	118.19
British Malaya				320	62,884	196.51
British West Africa	1,680	11,680	6.95			
Canada				7	1,924	274.86
China				1,033	245,648	237.80
Cuba				6,422	866,997	135.00
Egypt				6	4,126	687.67
France	131	13,293	101.47	4.339	756,758	174.41
French West Indies	21,093	351,188	16.65			
Germany				1	250	250.00
Hungary				125	23,374	186.99
India				136	28,158	207.04
Italy				9	3,861	429.00
Mexico	70	16,455	235.07	1,021	318,211	311.67
Netherlands				24,011	3,742,952	155.88
Palestine and Trans-Jordan				35,474	4,297,767	121.15
Portugal				96	13,940	145.21
Siam				102	4,902	48.06
Switzerland				4,798	625,621	130.39
Syria				10	2,000	200.00
Union of South Africa	963,969	40,421,913	41.93	38,255	8,749,590	228.72
U. S. S. R.				9,270	707,959	76.37
United Kingdom	10,725	480,310	44.78	9,273	1,719,427	185.42
Venezuela	44,184	1,137,841	25.75			
Total 1947	1,075,478	43,051,210	40.03	347,810	53,471,539	153.74

[1] In the corresponding table in Minerals Yearbook, 1946, p. 550, revisions for 1945 are as follows: Rough and uncut: Belgian Congo, (carats) 15,054, (value) $108,985, (average value) $7.24; Union of South Africa, (carats) 830,851, (value) $41,277,299, (average value) $49.68. Total, (carats) 895,219, (value) $43,131,784 (average value) $48.18. Cut but unset: Belgium and Luxembourg, (carats) 104,953, (value) $14,544,028, (average value) $138.58; Brazil, (carats) 28,573, (value) $4,653,438, (average value) $162.86; India, (value) $135,764, (average value) $193.12; Palestine and Trans-Jordan, (carats) 106,036, (value) $17,716,906, (average value) $167.08. Total, (carats) 377,594, (value) $63,815,581, (average value) $169.01.

about 7 percent during 1947, as compared with an over-all loss of 2 or 3 percent on the New York Stock Exchange. Quotations were at their low in July–August, after which investment buying and Indian speculation caused a moderate improvement up to the year end. All the principal companies except Premier paid dividends.

Imports.—Imports of gem-grade diamonds into the United States decreased from $166,637,049 in 1946 to $96,522,749 in 1947, a loss of 42 percent. The dollar value of rough was off 12 percent and that of cut, 55 percent. In both cut and rough, quality deteriorated. In 1946 Belgium furnished 43 percent of the cut and in 1947, 57 percent. Palestine fell from 19 percent to 8, while Union of South Africa gained a bit (from 14 percent to 16). Cuba and Brazil lost their importance.

Judging from prices per carat, the Union of South Africa and United Kingdom furnished the best cut and Cuba and Palestine the poorest.

Cutting.—The gross overstaffing of the cutting industry has become apparent, and employment shrank from about 30,200 employees in 1946 (excluding those in Borneo and India) to 26,500 in 1947. Wages continued to fall—principally owing to competition caused by shortage of rough—and strikes, lock-outs, and lay-offs still consumed at least one-third of the men's time. Cuba and Brazil almost disappeared as cutting centers, and Palestine found the political situation withering. The United States continued unsurpassed as a cutter of large stones.

World Production.—Accurate figures regarding diamond production are not available for all countries, but the estimates in the following

World production of diamonds, 1943–47, by countries, in metric carats

[Including industrial diamonds]

Country	1943	1944	1945	1946	1947
Africa:					
Angola	794,990	799,120	803,887	[1] 806,961	799,210
Belgian Congo	4,881,639	7,533,365	10,386,000	6,033,452	5,474,469
French Equatorial Africa	56,183	60,000	82,849	87,381	[1] 90,000
French West Africa	36,193	69,726	79,802	51,834	[1] 90,000
Gold Coast [2]	1,317,798	1,165,858	812,451	653,196	852,493
Sierra Leone	834,492	608,744	504,309	559,229	605,554
South-West Africa	94,427	154,379	152,629	163,611	180,739
Tanganyika	52,998	90,667	115,666	[1] 119,446	74,825
Union of South Africa:					
Mines	84,342	552,974	878,713	1,025,019	918,042
Alluvial	217,987	380,708	262,529	256,768	[3] 286,692
Total Union of South Africa	302,329	933,682	1,141,242	1,281,787	1,204,734
Brazil [1]	275,000	301,000	275,000	325,000	275,000
British Guiana	18,272	[2] 13,911	15,442	22,413	24,669
Venezuela	22,846	22,037	12,769	20,912	61,634
Other countries	6,804	12,000	2,000	[4] 1,600	[5] 3,500
Grand total	8,694,000	11,764,000	14,384,000	10,127,000	9,737,000

[1] Estimated.
[2] Exports.
[3] Includes an estimate of 100,000 carats for State Mines of Namaqualand.
[4] Partly estimated; includes India, Borneo, Australia (New South Wales), and U. S. S. R.
[5] Includes India, Russia, Borneo, New South Wales, and United States.

table are believed to be fairly reliable. World production (gems and industrials) in 1947 is estimated to have been 9,737,000 carats (2.15 short tons), worth at the mine some $75,105,000, which compares with 10,127,000 carats (2.23 short tons) in 1946. This is about 96 percent of the 1946 production as to weight and 92 percent as to value. By weight, 1,120 pounds were gem stones and 3,173 pounds industrials.

Belgian Congo was the leading producer, by weight (56 percent), although it represented only 12 percent of the value. On the other hand, the output of the British Commonwealth, which was only 30 percent of the weight, represented 68 percent of the value. The Belgian Congo, the Union of South Africa, and Tanganyika produced less than in the previous year, while the Gold Coast, Sierra Leone, Southwest Africa, and Venezuela produced more.

Industrial Diamonds.—It appears that during the recent World War brokers of industrial diamonds and manufacturers of tools utilizing them overstocked, contributing to the decline in the quantity of industrials imported in 1947. Imports were much below those of 1942–44, whereas values were comparable. Early in 1948 production and consumption were in approximate balance, assuming that manufacturers are ingenious enough to use the grades available.

Industrial diamonds are being stockpiled by the Munitions Board.

The year saw many advances in the use of industrials mechanically, but only one new use, as counters for alpha, beta, and gamma rays, replacing in some instances the Geiger-Muller counter. As the diamond is sensitive to radioactivity, fine colorless crystals form the most sensitive and enduring counters.

The use of the diamond drill in oil-well and blast-hole drilling increased.

Figure 1, originally prepared by Herbert Backman several years ago, shows the tremendous increase in use and the sharp decline in the price per carat of American imports in the past 29 years.

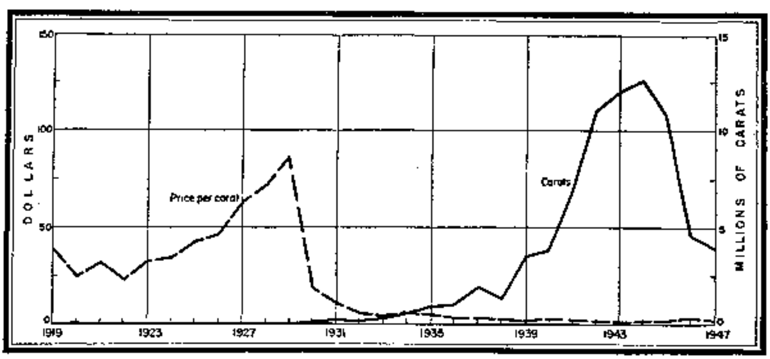

FIGURE 1.—United States imports and average price per carat of industrial diamonds, 1919–47.

Imports of industrial diamonds into the United States during the past 5 years are shown in the accompanying table.

Industrial diamonds (glaziers', engravers', and miners') imported for consumption in the United States, 1943–47

[U. S. Department of Commerce]

Year	Carats	Value		Year	Carats	Value	
		Total	Average			Total	Average
1943	12,084,133	$21,890,568	$1.81	1946	4,625,282	$14,297,536	$3.09
1944	12,614,507	22,894,244	1.81	1947	3,920,012	12,840,866	3.28
1945	10,733,411	12,823,962	1.19				

In 1947 the United States exported 92,626 carats of industrial diamonds valued at $512,273 or $5.53 per carat.

RUBY, SAPPHIRE, AND EMERALD

Compared with the diamond, the 1947 sales of rubies, sapphires, and emeralds were small. As most of the deposits of the noble gems do not lend themselves to large-scale operations, precious-stone mining by large companies is confined to the diamond, notwithstanding the fact that fine emeralds and rubies bring higher prices than most fine diamonds. Fine rubies come from Burma; sapphires from Siam, Ceylon, Indochina, and Kashmir (rumor has it that the deposits of the last two countries are virtually exhausted), and emeralds from Colombia and the U. S. S. R. Political conditions in most eastern countries are not conducive to successful mining, and the Colombian emerald mines are not being operated. But fine gems are not only in demand, they are also in short supply—a deficiency met only partly by stones from outmoded jewelry.

The gem gravels of Ceylon furnish not only rubies and sapphires but also many other gem stones. The gem diggers of the Ratnapura district, while active, are not increasing their output, notwithstanding the very high prices gems bring. The mining is done by Singhalese diggers, who work only in certain seasons. The annual value of production is from £66,000 to £82,500, unless exceptionally valuable stones are found.

C. C. Morton (Queensland Government Mining Journal, vol. 47, November 1946, p. 340) describes the Willow sapphire field, Central Queensland. The gems occur in white clay at from 1 to 10 feet below the surface. The good stones are yellows and blues, although the dominant colors are green or blue-green. One yellow weighed about 218 carats. Sapphires were first found at Withersfield, Queensland, in 1870. Partial records of the production of sapphires and associated gems in Queensland from 1892 to the end of 1946 totaled £657,180.

Transvaal, South Africa, produces a few gem beryls, some of which are dark enough to be classed as emeralds; on the average, they are of mediocre grade. The principal producer is the Somerset mine of the South Africa Beryl Mining Co. If the stock on hand brings a satisfactory price (the stock is about 100,000 carats), the Beryl mine (Beryl Mining Co., Ltd.), may be reopened and cutting be done in the company's own shop.

In the first half of 1947, South Africa produced 7,260 carats of emeralds as compared with 5,572 carats in the corresponding period of 1946.

Neither the Colombian Government mine, Muzo, nor the company-owned Chivor mines has been operated for some time, although in 1947 the Government gave the right to the Banco de Republico to exploit Muzo, and it is reported that the bank, in turn, has contracted for the mining, grading, and cutting of the stones. A decree effective August 1, 1947, is aimed at suppressing the rather large black market in emeralds, which has existed for some years in Colombia, by controlling the mining, sale, possession, export, and cutting of rough emeralds. (Information received in part through the courtesy of Clinton Bernard.)

LESSER GEMS

The American Gem Society, by a vote of its members, has discontinued the use of the term "semiprecious," as the adjective is considered to be meaningless.

The finest of opals, the Australian, is growing in popularity and increasing in price, partly due to the purchases by GI's stationed "down under." There is some evidence that the Lightning Ridge, Queensland, black opal deposits are playing out. In the heyday of the field (1910), a thousand miners worked the field; today, only 20 to 30, and buyers avidly snap up the few gems found, even at present high prices. The "Shallow Four Mile" workings, once largely neglected, are the site of today's main workings. From 1892 to the end of 1946, Queensland had an official opal production of £189,150.

New Zealand jade (nephrite) used to be recovered as a byproduct of gold sluicing, but with the decline in alluvial mining, the supply does not satisfy local demand.

H. Buttgenbach described a fine topaz crystal weighing 2½ kilograms found near the Gitshie River, a branch of the Kungwe, in the Ruanda, Belgian Congo.

A large, fine aquamarine brooch was presented to Mrs. Harry Truman when, late in 1947, she and President Truman visited Brazil for the Pan American conference. Raymond M. Miller reports that Brazilian gem merchants still export quantities of blue topaz, particularly to the Central American and Cuban markets, as aquamarine. In Brazil, he says, aquamarine sells at three times the price of blue topaz.

M. F. Beliakov reports lazulite in a quartz vein in the vicinity of Mount Sura-iz, northern Urals. The quality of some warrants its use in jewelry.

Edward R. Swoboda[2] describes the garnet deposits of Brazil opened up since the war-boom development of the national lapidary industry. Both fine essonites and almandites are produced.

In 1947 andalusite of fine color but small size appeared on the American market. The American Gem Society believes it comes from the gravel near Santo Teresa, State of Esperitu Santo, Brazil. The discovery was made in wartime prospecting for strategic minerals. The stone ranges in color from brick-red to yellowish-green and is quite brilliant.

Raymond M. Miller reported that the recent find of large pockets of deep-colored amethyst near Bahia has caused a fall in the price of that stone in Brazil. The Bahia amethyst, when burned, turns to a fine "citrine." Natural citrine also occurs near Bahia.

The best Ceylonese gem zircon, one of the dominion's widely disseminated gems, is found in Dediyagalemukulane, in the Southern Province.

It is stated that India yearly exports 118,000 rupees worth (about $35,000) of agate.

SYNTHETIC GEM STONES

Nineteen forty-seven was a year of great advance in making synthetic gem stones. Late in September the Linde Air Products Co. astonished gem experts by putting on the market synthetic star sapphires and rubies. Both "star" and color are well-developed in many examples. Production was limited, but the synthetic stars can be sold at one-tenth or even one one-thousandth of the price of the natural gem. By microscopic examination, the differentiation of natural and synthetic stones is easy. While one cabochon stone weighed 109.25 carats, most of the cut stones released weighed from 4 to 15 carats. The stones, clearly advertised as synthetic, were being sold through a single channel.

Carroll F. Chatham of San Francisco improved appreciably the size and quality of his synthetic emeralds; these can readily be differentiated from the natural gems by the microscope. Such synthetic gems are still relatively small.[3]

During the war, German scientists found that bearings could be shaped from synthetic spinel with the use of only 30 percent of the diamond dust required for sapphire or ruby. Later, upon being heated to 950° to 1,050° C., the spinel bearings hardened and replaced sapphire bearings satisfactorily.

[2] Jewelers' Circular-Keystone, March 1947, pp. 270-272.
[3] Pough, Frederick H., Jewelers' Circular-Keystone, 1947, pp. 176, 178, 224-226.

Linde Air Products Co. and the National Lead Co. in 1947 produced synthetic rutile of several colors. While not as yet on the market, eventually gems of high brilliancy, but rather too soft for many jewelry purposes, may be available.

During the recent World War, both Great Britain and the United States became self-sufficient in producing synthetic corundum and in shaping it for watch and instrument jewels. In 1946 import of foreign synthetics was resumed, and in October 1946 prices dropped markedly. The synthesis of corundum continued after the war in America, and ruby and sapphire were used in medium-price jewelry, for bearings, in various tools, gages, and tips for micrometers and for small mortars and pestles.

A Swiss manufacturer has produced ball bearings from synthetic corundum. In comparison with steel balls, they are hard and have a high modulus of elasticity, great chemical resistance, and physical stability.

It is reported that during the war Germans produced a sintered-ruby material superior as an abrasive to other aluminum oxide abrasives.

RELATIVE VALUE OF GEM STONES

Gem stones are valued for many reasons but mainly for their beauty and rarity. Value is so dependent on perfection that it is difficult to rank gems rigidly. A fine spinel may well be more valuable than a diamond of mediocre quality. In a broad way, the noble gems rank highest, about as follows: Deeply and attractively colored diamonds (fancies), emeralds, rubies, colorless diamonds, and sapphires. The other gems follow in about this order: Imperial jade, star ruby, black opal, cat's eye, alexandrite, star sapphire, spinel, demantoid, kunzite, morganite, peridot, aquamarine, topaz, white opal, jade, tourmaline, amethyst, zircon, garnet, citrine, turquoise, and moonstone. To assign a dollar value to the foregoing would have little meaning. A pound of "fancies" might be worth $11,350,000, or $5,000 a carat, and a pound of turquoise but $15, or, say, 1 cent a carat.

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Gem Stones

By SYDNEY H. BALL [1] AND G. W. JOSEPHSON

THE JEWELRY INDUSTRY IN 1948

AMERICAN jewelers found that in 1948 competition for consumers' dollars was increasing from dealers retailing other durable goods, long unobtainable, and further found their customers more discriminating. In consequence, sales ($1,203,000,000) were below those enjoyed in 1947. The 1948 Christmas trade was satisfactory; but expensive items, particularly large diamonds, moved slowly. Retailers' stocks decreased somewhat in the latter part of 1948; and although wholesale jewelers' sales ($530,000,000) were slightly higher than those of 1947, this fact is accounted for by extremely heavy sales in the first half of the year, which overbalanced slack sales in the latter half.

The industry operated under an exceptionally prosperous national economy, high industrial wages, a record national income and large exports especially to Latin American countries. The marriage rate, while high, was lower than in 1947.

FASHIONS IN JEWELS

Interest in jewels increased in 1948. Jewelry is yearly becoming more individualistic. On the whole, jewelry designs are becoming more delicate, graceful, and lacy, and the old compact, solid look is passing. In 1948 the dominant motifs were flowers, leaves, and, to a smaller extent, birds, bowknots, and butterflies.

Clips, brooches, and pins were approximately as popular as necklaces, earrings, and ear clips. Bracelets, rings, and tiny watches hidden in bracelets or rings were also frequently seen.

A large number of gem stones were mounted—diamonds notably, then emeralds, rubies, and sapphires. Among some 20 other gem stones used, amethysts, pearls, and aquamarines ranked high. Few "fancies" (decidely colored diamonds) were mounted; but, of course, such stones are rare.

[1] Deceased April 8, 1949. This chapter was compiled principally from an incomplete manuscript and notes left by Mr. Ball.

Wide use of the diamond and a certain popularity of pearls, real and cultured, caused colorless gems to be by far the most widely used, followed by green, red, and blue and then by purple and yellow stones.

Sets of jewels of the same design and set with the same stone are still popular, as are "utility" jewels, which can be separated into two or more components. Pendants commonly hang from necklaces or dangle from earrings. Odd cuts of diamonds support the brilliant and square cut more frequently. Scatter pins became popular late in the year. They were even used on sandals, as were other stones, and the latter were even set in spectacle frames.

Forty years ago the possession of a diamond-set ring indicated that the American man had attained financial success; now he rarely wears a diamond, although he may wear a star sapphire. A definite attempt last year to interest Americans in masculine jewelry apparently met but little success.

DOMESTIC PRODUCTION

In the past 129 years or thereabouts, the United States has produced a large number of different gem stones but has never been an important factor in world gem production. Exceptions might be the Maine tourmaline deposits over 125 years ago, the turquoise deposits of the Southwest in prewhite days, agate and variscite deposits in the recent past, and jade deposits in the present and near future. But gem mining has been and probably will be one of our minor mining industries.

No large gem-mining companies exist in the United States, but several prospectors in a number of instances have banded together to work certain deposits for a time; a few small companies have been formed to mine jade; and certain professional lapidary shops employ a few miners. In addition, amateur lapidaries spend many weekends searching for material, particularly of the agate family, to feed their lathes. If they are not collectors the product goes to the local jeweler or to one of a host of roadside curio shops, particularly in the Northwestern States, California, Arizona, New Mexico, Utah, and the Black Hills, stocked with souvenirs of local or of pretended local origin. The chief customers are automobile tourists. As a fad or a quasi-business, the lapidary craft is spreading rapidly.

No reliable statistics exist as to the value of the domestic output of gem stones; in the rough, it may approximate $400,000 to $500,000 and more than double that after cutting.

The many forms of agate, attractive and widely distributed, led the field, with jade second and turquoise a poor third. Of the States and Territories, Oregon, Wyoming, and Washington were the leaders.

Agate.—Agate production in Oregon, including "thunder eggs," is holding its own, and interest in the lapidary craft grows. The well-known Yellowstone River moss-agate locality in Montana is still producing but appears yearly to be nearer exhaustion. Production is falling, and good material is getting scarce; prices consequently are rising. Much of it is cut locally and sold in roadside shops. The Black Hills lapidaries are reported to depend on Montana for their rough moss agate, claiming that it is better than their own.

Considerable agate is produced in west Texas, although some authorities state that intensive exploitation in recent years has reduced the reserves markedly. Most of it is sent to California for cutting.

Washington produces considerable agate of several varieties.

A relatively large amount of agatized wood is collected on the borders of the Petrified Forest National Monument, Ariz. Other localities in Arizona have furnished agate for cutting.

Apparently the Wyoming moss-agate deposits and the plume-agate deposits of New Mexico were not vigorously exploited in 1948.

Utah produces considerable agate. In the past year or two, fine moss agate has been coming from a locality east of Park City.

Georgia reports a new locality for heliotrope in Catoosa County.

Jade.—Allan Branham of Lander, Wyo., stated that the old Wyoming deposits furnishing light-green jade have been largely depleted, although three or four individuals hold some. He further reported that the tremolite-jade mine changed hands and that, in the summer of 1948, it was vigorously worked, the product being sent to Denver in truck loads.

"Thunder," said to be the largest statuette ever carved in jade (20 inches high, weight 104 pounds) portrays an American Indian sitting cross-legged on rain clouds and pulling thunder from a small drum suspended from his shoulder. Donald Hord of San Diego, Calif., was the sculptor. The rough was found by Marcia Branham near Lander, Wyo., and the original boulder weighed 460 pounds.

Bert Rhodes produced considerable jade from a property 60 miles southeast of Lander. Some was said to have been exported to Shanghai, China.

Robert M. Hawk, a manufacturing jeweler of Denver, reports that in 1946, while on a fishing trip, he and two companions found a large jade deposit north of Lander. This was producing during the summer of 1948. The jade is in place; it is claimed that there are 50,000 tons of it. It varies in color from light green to black and is said to be worth $3 to $50 a pound. Some will be cut in Denver into lamp bases, book ends, etc., while some has been exported to China.

Although the Alaska jade deposits of the Kobuk River region were not worked in 1948, considerable was reported to have been exported during the year from Pacific ports to China.

Some nephrite was sold from Monterey County, Calif. A nephrite dike in place is said to have been recently found in San Benito County near King City, Calif.

Green-stained quartz is reported to have been produced somewhere in Colorado and sold under names such as "king jade."

Turquoise.—In 1948 the Southwest probably produced less turquoise than in recent years. The Southwest Gem & Jewelry Co. in 1948 produced about 200 pounds from its Mineral Park, Ariz., deposit. Dr. G. M. Butler reported that, as depth is attained at the Castle Dome Copper Co. property, the quantity of turquoise decreases. In 1948 the company ceased trying to recover turquoise as a byproduct, but some recovery by miners probably continued. Dr. Butler stated that much of the Arizona turquoise is artificially colored and that even a clever imitation of matrix turquoise is on the market.

Some turquoise was produced at Battle Mountain and Tonopah, Nev. The King mine at Manassa, Conejos County, Colo., was operated on a small scale; in addition, some turquoise was sorted from the dump. The Cerrillos mine, New Mexico, was not operated during 1948.

Other Gem Stones.—Alfred M. Buranek reported that Utah mines in 1948 produced about the normal amount of variscite. Most of it came from the Clay Canyon deposit but a little from Grantsville and Lucin.

Utah, according to Prof. Junius J. Hayes, produced a new gem stone, a transparent yellow labradorite which occurs as phenocrysts in an andesite from Clear Lake, Millard County. Stones are small, and cut stones seldom exceed 1 carat; stones weighing as much as 10 to 15 carats are very rare. They are being sold cut at Salt Lake City for \$3 to \$6 per carat.

The Barton Mines Corp., North Creek, Warren County, N. Y., miners of abrasive garnet, produced a few gem garnets. Pyrope garnets late in 1947 and early in 1948 were cut at Moab, Utah, in considerable quantities.

Montana reported no sapphire production in 1948, either from its dredges or from its lode mine. The latter, Yogo Gulch, Judith Basin County, was up for sale in 1948 but so far as known no transfer of title resulted. Guy B. Ellermeier of Denver reported that at the old sapphire locality near Turret, Colo., first discovered in 1886, the stones occur in a bed of corundum schist 1 foot thick lying on garnetiferous metamorphic limestone. While the corundum stones are a fine blue, they are too small to be of commercial interest.

Arkansas continued to produce some rock crystals, and the sale of these—largely to mineral collectors—continued to be an important source of revenue to a few of the individuals.

It was hoped in 1947 that changes of ownership in certain gem mines in the Pala area near San Diego would increase the California production of tourmaline, aquamarine, kunzite, and topaz in the Aguanga Mountain area nearby. The hope has only partly been fulfilled, although a little kunzite, aquamarine, garnet, and topaz has been produced.

Other gem stones produced in small amounts in 1948 in the United States follow: Plume agate, New Mexico; agate, Illinois; amethyst, Georgia (Union County); apatite, yellow, Mesilla Park, N. Mex.; aquamarine, Pikes Peak, Colo.; carnelian, New Mexico; rose quartz, South Dakota; satin spar, Perry Peak, Colo.; and topaz, Pikes Peak and Tarryall Mountains, Colo., and Topaz Mountain, Utah.

CANADIAN GEM STONES

Again in 1948 Canada produced little in the way of gem stones. Rock crystal (Black Rapids, Ontario), peristerite (Lyndoch Township, Ontario), and some other attractive gem-stone material is either exported to the United States or sold to an enthusiastic coterie of amateur lapidaries in Toronto. The Labrador labradorite, the finest in the world, can now be credited to Canada.

The annual value of Canada's gem-stone production probably does not exceed a few hundred dollars.

GOVERNMENT REGULATIONS

The jewelry industry doubtless has never been subject to as many regulations as at present. Most of the laws attempt to increase national revenue, keep currency at home, or obtain dollar exchange. A few examples follow.

Both Canada and the United States continued their luxury sales taxes. Exports of certain industrial diamonds from the United States required a special export license and customs inspection. Some countries, such as the Union of South Africa, prohibited import of jewelry from nonsterling areas. Importation of diamonds into India, Pakistan, and Ceylon was subject to various restrictive rules. There were severe limitations on any movement of jewelry over the borders of Hungary.

IMPORTS [2]

Imports of gem stones, exclusive of industrial diamonds, in 1948, as reported by the United States Department of Commerce, totaled $115,990,280, about 5 percent more than in 1947. Of the total, diamonds comprised 87 percent.

Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1947–48 [1]

[U. S. Department of Commerce]

Commodity	1947		1948	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty free	[2] 996,514	[2] $42,589,592	912,762	$44,460,365
Cut but unset, suitable for jewelry, dutiable	347,810	53,471,539	389,314	56,244,934
Emeralds:				
Rough or uncut, duty free	7,385	258,062	4,937	28,054
Cut but not set, dutiable	[2] 2,286	[2] 75,420	11,213	286,566
Pearls and parts, not strung or set, dutiable:				
Natural		[2] 366,024		772,763
Cultured or cultivated		737,753		748,302
Other precious and semiprecious stones:				
Rough or uncut, duty free		298,393		258,553
Cut but not set, dutiable		[2] 3,664,048		3,160,778
Imitation, except opaque, dutiable:				
Not cut or faceted		118,168		53,133
Cut or faceted:				
Synthetic		483,313		777,224
Other		7,688,827		8,904,941
Imitation, opaque, including imitation pearls, dutiable		15,566		59,610
Marcasites, dutiable:				
Real		300,175		216,003
Imitation		8,549		19,055
Total		[2] 110,076,029		115,990,280

[1] In the corresponding table in Minerals Yearbook, 1947, p. 536, revisions for 1946 are as follows: Diamonds, cut but unset—carats, 566,313; value, $110,465,703. Other precious and semiprecious stones, cut but not set, $8,932,984. Total value, $181,515,265.
[2] Revised figure.

[2] Figures on imports and exports compiled by M. B. Price, of the Bureau of Mines, from records of the U. S. Department of Commerce.

DIAMOND

The year 1948 was a good one for diamond producers and wholesalers, fair for retailers, and poor for cutters.

World production was about 3 percent greater than in 1947. Output in the Union of South Africa was approximately the same as in the previous year, but the Belgian Congo registered an increase. In Tanganyika, production also increased markedly percentagewise.

Sales of rough by the principal wholesalers, the subsidiaries of the Diamond Corp., were a little over £38,000,000 in 1948 as compared with about £24,500,000 in 1947. In July the corporation took over marketing of Tanganyika Territory's production and that of French Equatorial Africa; and its buyers sometimes purchase in the "outside" alluvial fields of South Africa, Brazil, and British Guiana.

Retail sales in the United States were only fair, and retail prices declined. High-price articles moved very sluggishly.

Prices of rough were strong during the early part of the year but weakened considerably during the latter part.

Share Dealings.—From 1944 to date the diamond shares have lacked sparkle as market performers. In 1948 the four principal quoted shares had an average gain of 5½ percent but only fluctuated between 100 and 110 percent. Quotations were at their peak early in May and then declined. All the principal diamond-mining companies except Premier paid dividends in 1948.

Cutting.—In 1948 the cutting industry expanded its world-wide personnel to 29,500–31,000, a 10- to 12-percent increase over 1947. Half the cutters were Belgians. The Palestine industry had a hectic year. The number of cutters was too great for the rough available and the demand for cut; hence black markets, unemployment, reduced wages, and price deterioration of cut followed.

Netherlands, the United States, and South Africa are considered most firmly established as cutters of large stones, and Belgium and perhaps Palestine of small.

Imports.—Imports of gem-grade diamonds into the United States increased from $96,061,131 (revised figure) in 1947 to $100,705,299 in 1948, an increase of 5 percent. The dollar value of both rough and cut increased. The quantity of cut increased, whereas that of rough decreased. Belgium furnished 56 percent of the cut (value) in 1948.

Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1947–48,[1] by countries

[U. S. Department of Commerce]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1947						
Austria				2	$300	$150.00
Belgian Congo [1]	70	$16,455	$235.07			
Belgium [1]				205,650	30,368,217	147.67
Brazil	[2] 25,918	[2] 498,631	[2] 19.24	7,227	900,317	124.58
British Guiana	822	39,155	47.63	223	26,356	118.19
British Malaya				320	62,884	196.51
British West Africa	1,680	11,680	6.95			
Canada				7	1,924	274.86
China				1,033	245,648	237.80
Cuba				6,422	866,997	135.00
Egypt				6	4,126	687.67
France [1]				4,339	756,758	174.41
French West Indies	21,093	351,188	16.65			
Germany				1	250	250.00
Hungary				125	23,374	186.99
India				136	28,158	207.04
Italy				9	3,861	429.00
Mexico [1]				1,021	318,211	311.67
Netherlands				24,011	3,742,952	155.88
Palestine and Trans-Jordan				35,474	4,297,767	121.15
Portugal				96	13,940	145.21
Siam				102	4,902	48.06
Switzerland				4,798	625,621	130.39
Syria				10	2,000	200.00
Union of South Africa	[2] 892,022	[2] 40,054,332	[2] 44.90	38,255	8,749,590	228.72
U. S. S. R.				9,270	707,959	76.37
United Kingdom	10,725	480,310	44.78	9,273	1,719,427	185.42
Venezuela	44,184	1,137,841	25.75			
Total 1947	[2] 996,514	[2] 42,589,592	[2] 42.74	347,810	53,471,539	153.74
1948						
Austria				1	215	215.00
Belgian Congo	119	3,870	32.52			
Belgium				213,207	31,475,099	147.63
Brazil	15,878	295,294	18.60	4,762	578,774	121.54
British Guiana	786	29,219	37.17	116	12,535	108.06
Canada				21	13,388	637.52
China				328	67,032	204.37
Colombia				20	5,683	284.15
Cuba				4,790	657,520	137.27
Egypt				14	1,875	133.93
France				13,471	925,673	68.72
French Morocco				61	13,300	218.03
Germany				11,624	399,714	34.39
Hong Kong				324	83,282	257.04
Iran				113	12,724	112.60
Italy				3	1,088	362.67
Jamaica				2	230	115.00
Japan				2	539	269.50
Lebanon				23	6,283	273.17
Mexico				80	9,954	124.43
Netherlands				34,246	5,109,945	149.21
Pakistan				1	488	488.00
Palestine and Trans-Jordan	1,120	114,921	102.61	39,995	4,139,345	103.50
Portugal				99	10,439	105.44
Siam				1,049	197,868	188.63
Sweden				1	450	450.00
Switzerland				18,298	3,044,693	166.39
Tangier				2	1,067	533.50
Union of South Africa	832,022	42,379,244	50.94	33,060	7,974,210	241.20
U. S. S. R.				9,303	775,378	83.35
United Kingdom	6,112	310,098	50.74	4,297	724,968	168.71
Venezuela	56,725	1,327,719	23.41			
Yugoslavia				1	275	275.00
Total 1948	912,762	44,460,365	48.71	389,314	56,244,934	144.47

[1] In the corresponding table in Minerals Yearbook, 1947, p. 537, revisions for 1946 are as follows: Cut but unset—Cuba is deleted. Total—carats, 566,313; value, $110,465,703; average value, $195.06. For 1947, imports were erroneously reported for Belgian Congo, Belgium, France, and Mexico.

[2] Revised figure.

World Production.—Accurate figures on diamond production are not available for all countries, but the figures in the accompanying table are believed to be close approximations. World production (gems and industrials) is estimated to have been 10,028,000 carats (2.21 short tons) in 1948, worth at the mine some $70,000,000, which compares with 9,742,000 carats (2.15 short tons) and $75,000,000 in 1947. Therefore, as compared with 1947, production in 1948 increased 3 percent in weight and decreased 7 percent in value. It is estimated that, by weight, 2,244,600 carats or 990 pounds were gem stones and 7,783,400 carats or 3,432 pounds industrials.

Belgian Congo was the leading producer by weight (58 percent), although it represented only 13 percent of the value. On the other hand, the British Commonwealth produced 29 percent by carats and over 66 percent by value of the total.

Among noteworthy developments were the increases in output in the Belgian Congo and Tanganyika. With few exceptions, production in French territories compared favorably with the previous year.

World production of diamonds, 1945–48, by countries, in metric carats

[Including industrial diamonds]

Country	1945	1946	1947	1948
Africa:				
Angola	803,887	806,961	799,210	795,509
Belgian Congo	10,386,000	6,033,452	5,474,469	5,824,567
French Equatorial Africa	82,849	87,381	107,076	[1] 100,000
French West Africa	79,802	51,834	62,310	77,970
Gold Coast [2]	812,451	653,196	852,493	[1] 850,000
Sierra Leone	504,309	569,229	605,564	465,518
South-West Africa	152,629	163,611	179,554	200,691
Tanganyika	115,666	119,446	92,229	148,169
Union of South Africa:				
Lode	878,713	1,025,019	918,042	[1] 930,000
Alluvial	262,529	256,768	[3] 286,692	[1] [3] 270,000
Total Union of South Africa	1,141,242	1,281,787	1,204,734	[1] 1,200,000
Brazil [1]	275,000	325,000	275,000	250,000
British Guiana	15,442	22,413	24,669	36,301
Venezuela	12,769	20,917	61,634	75,513
Other countries	2,000	[4] 1,600	[5] 3,500	[5] 3,500
Grand total	14,384,000	10,127,000	9,742,000	10,028,000

[1] Estimated.
[2] Exports.
[3] Includes an estimate of 100,000 carats for State Mines of Namaqualand.
[4] Partly estimated: includes India, Borneo, Australia (New South Wales), and U. S. S. R.
[5] Includes India, Russia, Borneo, New South Wales, and United States.

Industrial Diamonds.—Sales of industrial diamonds in 1948 were very large. American and other industries purchased normal quantities, and in addition Government missions to London purchased large quantities for the American strategic stock pile. Prices slashed by the Diamond Corp. at the outbreak of the war were again increased. Its present stocks are small. For economy's sake, the trend is toward the use of smaller stones wherever possible.

The use of diamond drills in exploring for and breaking ore (blasthole drilling) and in developing oil fields where the rock is hard is expanding. The use of diamond-impregnated wheels, particularly the vitrified type, for shaping carbide tools is increasing.

Figure 1 shows the tremendous increase in quantity and the sharp decline in the price per carat of American imports of industrial diamonds in the past 26 years.

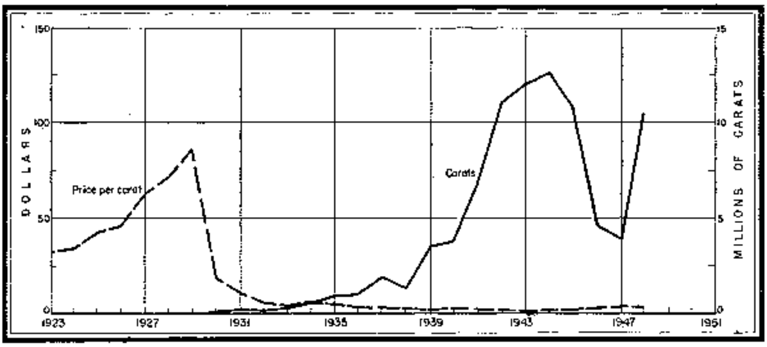

FIGURE 1.—United States imports and average price per carat of industrial diamonds, 1923–48.

In 1948 imports of industrials into the United States were much greater than in 1947. Imports of industrial diamonds during the past 5 years are shown in the accompanying table.

Industrial diamonds (glaziers', engravers', and miners') imported for consumption in the United States, 1944–48

[U. S. Department of Commerce]

Year	Carats	Value		Year	Carats	Value	
		Total	Average			Total	Average
1944	12,614,507	$22,894,244	$1.81	1947 [1]	3,999,119	$13,312,668	$3.33
1945	10,733,411	12,823,962	1.19	1948	10,418,316	32,521,501	3.12
1946	4,625,282	14,297,536	3.09				

[1] Revised figures.

In 1948 the United States exported 47,747 carats of industrial diamonds valued at $312,364.

RUBY, SAPPHIRE, AND EMERALD

These fine gem stones are increasing in price due to short supply of fine newly mined stones. Notwithstanding the excellence of the synthetic star sapphires and rubies introduced to the market in September 1947, natural stones are more popular then ever, and prices are more than holding their own.

The Anakie sapphire field, Queensland, whose principal center is now Rubyvale, was described.[3] The gravel, up to 50 feet thick, is worked either by open-cuts or shafts with drifts. The gravel is dry-sieved and hand-picked. Dark blues predominate; but fine yellows, greens, and particolored stones also occur. Zircon, pleonaste, tourmaline, and jasper are associated. The years from 1907 to 1925, except

[3] Squires, S. J., Commonwealth Jeweler and Watchmaker, Dec. 11, 1948, pp. 104–105.

for the First World War years, were the most productive and at times 1,000 diggers worked the field. The Rubyvale miners in 1947 sold gems to the value of £3,540.

The Black Star of Queensland widely exhibited in 1948 by American jewelers came from this field. It weighed rough 1,156 carats and cut 733 carats.

In 1948 a giant blue sapphire (1,958 carats) was found in the same general region by a digger's wife on a picnic. It was sold to the manager of a nearby claim.

A water shortage restricted production at the Willow Fields sapphire field.

South Africa continues to produce a few emeralds (1946, 11,533 carats; 1947, 7,753 carats). Six thousand, four hundred and ninety-two carats were exported in 1946 valued at £3,101, or 9s. 6.6d. per carat. A few are mounted locally.

Interesting data regarding Colombian emeralds were presented.[4] Emeralds of good color but of poor water occur in Mewar, India. The association is the frequent one, biotite schist intercalated in hornblende schist.[5]

According to Guhler's (see Bibliography) valuable study of Siamese gem stones, a few rubies have been mined for 500 or more years at several places. The sapphire deposits of Bo Ploi are described in some detail. Large sapphires are rare. Most gems are cut in Bangkok by Siamese, Chinese, or Gulas. Guhler considers the future of the industry bright. Siam ships considerable quantities of gems to the United States.

Ceylon produces not only ruby and sapphire but also alexandrite and cat's eye and a variety of stones of lesser value. All except moonstone are recovered from gravels by placer mining including some dredging. Singhalese are the only miners; dealers buy the stones in the field at auctions or private sales and Moslems then cut them. A half million dollars worth of gems is produced in a year.

LESSER GEMS

The Australian Government is to study whether, by pushing the production of its opal fields, by far the most important in the world, its supply of dollars can be increased.

At present only about 100 men are engaged in Australian opal mining; and the 1947 production—practically all of which came from South Australia (Coober Pedy and Andamooka)—was valued at only A£63,000. At Lightning Ridge, New South Wales, only a score of men mine and cut the black opal. The gem occurs as seams or nodules in a Cretaceous sandstone, beneath conglomerate and quartzite. The opal bearing layer is from a few inches to 2 feet thick.[6] A little opal is coming from Quilpi, Queensland. Most foreign gem purchasers buy from dealers in Sydney, Brisbane, or Melbourne, who visit the fields periodically.

There are three zircon-mining centers in French Indo-China (Bokeo, Pailin, and Cheon-Ksam). Burmans mine the stones, which occur

[4] Apolmor, Hermano Maria, Acad. Colomb. Rev. 7, No. 27, 1947, pp. 324-327.
[5] India Geological Survey, Minerals, vol. 1, No. 1, 1947, pp. 28-30.
[6] Squires, S. J., The Commonwealth Jeweler and Watchmaker, (Sydney, Australia), July 10, 1948.

almost at the surface, so little equipment is required. The stones are heat-treated and cut locally. They range in value from \$0.50 to \$660. Annual production, according to the Department of Commerce, is about \$140,000. The mines are close to the Siamese border. The zircon production of Cambodia is large.

The Lithuanian amber industry with its center at Palanga was almost destroyed during the war but is recovering.

Brazil continued to produce a large caratage of the lesser gems Madagascar is producing little owing to the effects of war and rebellion. Because of the war damage to Pforzheim, where the stones were cut and mounted, the production of South-West Africa has declined.

Before the war, Turkey exported meerschaum crude to Germany and Austria but now makes it into smoking utensils and souvenirs.

The turquoise deposits of Southern Sinai were described.[7] The author believes that the flat-lying deposits were formed by post-Tertiary meteoric waters. Even today the Arabs produce a little, either re-sorting the ancient dumps now over 2,000 years old, or doing a little gouging.

TECHNOLOGY

Tourmaline is being used in piezo-electric gages for measuring blast pressures in air and under water. It has recently been synthesized.[8]

Mullite refractories can be made from topaz.

Synthetic spinel watch jewels heated after shaping are apparently as satisfactory as synthetic sapphire jewels, quicker to make, and cheaper to produce.

Synthetic sapphire bearings, acid proof and having great hardness, are finding wide application in industry. There is also a continuing interest in the use of natural sapphire in precision instruments.

The California (Chatham, San Francisco) method of making synthetic emerald has been described.[9] The crystal grows from seed in about 10 months. They are now on the market. The German method was described.[10]

There may come on the market in the near future synthetic rutile, supposedly as a cheap substitute for the diamond. These products have high dispersion and birefringence. They have a hardness of 6½ on Mohs' scale, and careful polishing is required to eliminate scratching; careful crystallographic orientation in cutting is required.

A film of fluoride on zircon has recently been detected in some stones in the trade. This appears to be a new method to "doctor" gems. The film is inert to most acids and to fairly high temperatures. In strong daylight or bright artificial light, the coating becomes a dull iridescent film.

Education and Laboratories.—Not only are the universities of America enlarging their courses in the study of gems but the City College of New York has this year an evening course in lapidary, said to be the sole course of its kind in America.

The excellent correspondence courses and resident lectures of the Gemological Institute of America (Los Angeles and New York) are

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7 Davey, John C., Mining Magazine, March 1948, pp. 148–152; April 1948, p. 212.
8 American Mineralogist, vol. 32, November-December 1947, pp. 680–681.
9 Chemical Engineering, vol. 55, No. 2, 1948, p. 174.
10 Geological Magazine (London), vol. 8, No. 2, 1947, pp. 98–100.

open to qualified students. Similar institutes exist in England and Australia. It and the American Gem Society work together on a number of problems. They have decided to substitute "flawless" for "perfect" in diamond grading.

The Diamond Council of America was organized early in 1949 to further the study of gemology. Prof. Paul J. Storm of the University of Pennsylvania is to conduct the classes.

The Gem Trade Laboratory, 36 West Forty-seventh Street, New York, was established to furnish identification of gem stones and pearls. Dr. A. E. Alexander is director.

During 1948 the Cincinnati branch of the Gemological Institute of America established a laboratory for gem identification under the direction of Edward Herschede, Jr.

A Diamond Trading Club similar to the New York Diamond Dealers Club was organized in Los Angeles. There are about 40 local members and additional members from San Francisco and San Diego. Los Angeles is said to be the third largest jewelry manufacturing city in the United States and second in retail diamond sales.

It is stated that over 15,000 veterans of World War II are studying, with Government aid, to become jewelers.

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Gem Stones

By W. F. Foshag,[1] George Switzer,[1] and G. W. Josephson

THE JEWELRY INDUSTRY IN 1949

AT THE close of 1948 business as a whole in the United States was at its all-time peak. The jewelry volume had declined from its sensational 1947 peak. The traditional seasonal pattern of the jewelry industry reasserted itself for the first time in 10 years. Prices in general began to decline in early 1949, and jewelers liquidated their stocks to establish low inventories. During spring and early summer business was quiet but became active in July and August, when business confidence was restored, and was reasonably so during the fall months; the weeks before Christmas saw the traditional rush for jewelry-store merchandise. High-priced diamond jewelry lagged, however, because of anticipated reduction of present excise taxes. According to a survey made by the National Wholesale Jewelers' Association, diamond sales showed a 19-percent decline in 1949 compared to 1948.

The Jewelers' Circular-Keystone, using United States Department of Commerce statistics and Internal Revenue (excise tax receipts) data, figured that the volume done by jewelry stores in 1949 was approximately $1,055,000,000, a decline of 12 percent from 1948.

FASHIONS IN JEWELS

The fashion aspect of the jewelry industry received more recognition in 1949 than ever before. The Jewelry Industry Council appointed a fashion director and began to include jewelry fashion shows and other forms of jewelry entertainment for the fashion press in its regular schedule of activities. A fashion advisory committee of the Jewelry & Allied Industries was organized to bring together designers, artisans, and promoters in the fields of apparel and jewelry. These organizations deal with costume jewelry as well as with diamonds and other precious jewelry.

The fashion picture as a whole was conservative. Paris made no radical change in styles. However, there was a strong trend in America toward the styles of the 1920's, and the persistence of this trend is slowly affecting the design of jewelry. Bracelets are becoming increasingly popular, as are longer chains and pendants. The most noticeable change in jewelry fashion was the return to pendant earrings. The trend is more and more toward white metals for the

[1] Smithsonian Institution; consulting mineralogist to Bureau of Mines.

mounting of diamonds, but in the more elaborate pieces very little metal was visible. Manufacture was ingenious from the standpoint of mechanical construction. Diamonds were set in hundreds of tiny links, invisibly hinged to form mobile showers of baguettes and "trembling" leaves, stems, and petals. Kite, keystone, and triangle cuts were incorporated into this fine jewelry, and the marquise and pear shape continued to be used.

In diamond engagement-ring mountings the locked-together types of engagement ring and wedding band have become more common. Ingenuity continued to make small diamonds look larger. The demand for straight-sided stones, especially diamond, increased.

DOMESTIC PRODUCTION

For many years the United States has produced a large variety of gem materials but has never been an important factor in world gem production. Gem mining has been and probably will continue to be a minor mining industry.

No large gem-mining companies exist in the United States. A few small companies have been organized from time to time to work certain deposits, such as jade, turquoise, sapphire, and tourmaline. Some professional lapidary shops employ a few miners. In addition, thousands of amateur lapidaries spend their vacations and weekends searching for gem materials, particularly for varieties of quartz (agate, jasper, and petrified wood). Many of their products go to local jewelers or roadside curio shops, particularly in southwestern, western, and northwestern States. As a hobby, the lapidary craft is continuing to spread.

No reliable statistics exist as to the value of the domestic output of gem stones; in the rough it may approximate $400,000 to $500,000 and more than double that after cutting.

The many forms of quartz, chiefly the cryptocrystalline varieties, led the field, with jade second and turquoise third. Of the States, Oregon, Wyoming, Washington, and Texas were the leaders.

Agate.—Agate production, including all other varieties of chalcedony, such as jasper and petrified wood, is increasing as interest in the lapidary craft grows. "Thunder eggs" continued to be produced, chiefly in Oregon. The well-known Yellowstone River moss-agate locality in Montana is still producing but in ever decreasing quantity, with few if any full-time agate hunters.

It is estimated that over 50 tons of agate were produced in New Mexico, plus an additional unknown amount picked up by private collectors. Considerable agate was produced in west Texas, mostly near Alpine, in the Big Bend section, and near Laredo. South Dakota produced some agate, mined by Scott's Rose Quartz Co.

A relatively large amount of agatized wood was collected on the borders of the Petrified Forest National Monument, Ariz. New finds of petrified wood were reported from various localities in Oregon and Washington.

A small amount of chrysoprase was mined at Porterville, Calif.

Red jasper from Vermont was offered in ton lots, mined by the Burlington Gem Co.

Jade.—Allan Branham, Lander, Wyo., stated that the light-green jade (nephrite) in Wyoming is largely depleted but that new finds of dark green and black had been made. The year 1949 was the poorest in the past 13 for Wyoming jade; total sales were approximately $20,000, with the price of light green ranging from $10 to $15 per pound and dark green and black from $5 to $10 per pound.

A large deposit of black jade was found at Kortes Dam, Wyo. A single piece weighing 1,500 pounds was taken out. A newly discovered field at Daniel, Wyo., is reported to be of poor quality.

The American Jade Co., Denver, Colo., reportedly spent over $50,000 developing its jade deposit in the Sweetwater River area, Wyoming.

A new deposit of nephrite jade was discovered on Lewis Hill, 2 miles north of Porterville, Tulare County, Calif.; 1 ton was mined, with several more tons in sight. The jade is reported to vary in color from medium to dark green, with excellent translucency. Operators of the mine are Frank Janolco and F. V. Alston, Porterville.

Some nephrite jade was produced from the Monterey County, Calif., locality, chiefly by amateur collectors.

In November 1949 a deposit of jadeite jade was found on Clear Creek, San Benito County, Calif., by the late L. Ph. Bolander, K. J. Fritsch, and Buck Bleifus. The jadeite mined thus far has been dark green and not of gem quality. Considerable interest is being manifested in this deposit because it represents the first discovery of jadeite jade in the Western Hemisphere other than worked pieces in the tombs of ancient civilizations in Central America.

The Havenstrite Mining Co. (formerly Arctic Circle Exploration Co.) mined no jade in the Kobuk area, northwestern Alaska, during 1949, and reports no known mining by any other organization or individual in the Territory.

Turquoise.—Production of turquoise in the Southwest appears to be steadily diminishing. The Southwest Gem & Jewelry Co. mined 75 to 100 pounds at its Cerebrat ranch, Arizona, property. There was no production reported from New Mexico during the year. Some turquoise is mined in Lander County, Nev.

Diamond.—In October 1948 mining operations in the well-known diamond-bearing kimberlite pipes near Murfreesboro, Ark., were started once again, after a shut-down of many years, by a diamond corporation headed by Glenn L. Martin. Milling was carried on in a washing and recovery mill having a capacity of 1,000 tons a day. Surface-mining methods were used. After 120 thousand tons of various surface ores had been mined from numerous localities in the 60 acres showing peridotite, the enterprise was closed as of September 1949.

The company obtained approximately 840 diamonds, the largest a stone of 4½ carats. Ninety percent of the stones recovered were small industrials from one-tenth to 1 carat in size. Total diamonds produced weighed 246.15 carats. The indicated yield of the ground treated is 0.16 carat per 100 loads (16 cubic feet), compared with 24 carats per 100 loads for the Premier mine in South Africa. The production consisted of 10 percent very imperfect distorted pieces of mixed color, 5 percent seconds of dark-brown tint, 20 percent small-size mixed industrials, and 65 percent crushing boart. The appraised valuation was $984.60.

A 3.93-carat diamond was found near Peru, Miami County, Ind., in 1949.

Other Gem Stones.—Utah reported that about the normal amount (300 pounds) of variscite was produced, mostly from the Clay Canyon deposit.

Scott's Rose Quartz Co. mined about 100 pounds of rose quartz in South Dakota. The Bumpus quarry, Albany, Maine, reopened and produced about 50 tons of rose quartz, much of good color, including a single piece weighing 2,000 pounds.

Some transparent light-yellow labradorite was produced in Utah, probably not over 25 pounds in all.

No sapphires were produced at the Yogo sapphire mine, Montana. The mine has been taken over by a new company, the Yogo Sapphire Mining Co. It is reported that the mine will be reopened and worked during 1950.

Arkansas continued to produce some quartz crystals.

A number of good crystals of green tourmaline were produced in the Pala District, San Diego County, Calif., some of which were cut into stones of over 1 carat. Some golden and pale-pink beryl and a very small amount of kunzite were also produced.

A very fine gem-quality green beryl crystal, weighing 14½ ounces, was found in Riverside County, Calif. The exact locality has been withheld pending further exploration by the discoverers.

Other gem stones produced in small amounts in 1949 in the United States follow: Beryl, Mt. Antero, Colo.; amblygonite, beryl, and spodumene, Maine; idocrase ("californite"), Siskiyou County, Calif.; and topaz, Texas and Utah.

CANADIAN GEM STONES

Again in 1949 Canada produced very little in the way of gem stones. A few tons each of sodalite, peristerite, amazonite, and labradorite find their way each year to dealers in Canada and the United States. The annual value of Canada's gem-stone production probably does not exceed a few hundred dollars.

IMPORTS [2]

Imports of gem stones, exclusive of industrial diamonds, in 1949, as reported by the United States Department of Commerce, totaled $84,185,631, about 27 percent less than in 1948. Of the total, diamonds comprised 83 percent.

[2] Figures on imports and exports compiled by M. B. Price and E. D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1948–49

[U. S. Department of Commerce]

Commodity	1948		1949	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty-free	[1] 909,871	[1] $44,400,481	651,150	$28,299,799
Cut but unset, suitable for jewelry, dutiable	[1] 388,499	56,244,934	335,487	41,427,718
Emeralds:				
Rough or uncut, duty-free	4,937	28,054	80,231	226,233
Cut but not set, dutiable	11,213	286,565	13,723	284,578
Pearls and parts, not strung or set, dutiable:				
Natural		772,763		532,310
Cultured or cultivated		748,302		1,733,698
Other precious and semiprecious stones:				
Rough or uncut, duty-free		258,553		208,124
Cut but not set, dutiable		3,160,778		2,045,476
Imitation, except opaque, dutiable:				
Not cut or faceted		53,133		36,090
Cut or faceted:				
Synthetic		777,224		680,428
Other		8,904,941		8,495,151
Imitation, opaque, including imitation pearls, dutiable		59,610		37,819
Marcasite, dutiable:				
Real		[1] 225,638		170,405
Imitation		19,055		7,802
Total		[1] 115,940,031		84,185,631

[1] Revised figure.

DIAMOND

World production of diamonds was about 36 percent greater in 1949 than in 1948. Output for the Union of South Africa was approximately the same. The large increase came from the Belgian Congo, where production increased from a little less than 6,000,000 carats to over 9,600,000 carats. Tanganyika continued to show a steady rise.

Sales of rough by the principal distributors (Diamond Trading Co. for gem diamonds and Industrial Distributors (1946), Ltd., for industrial diamonds) were £28,446,000 for 1949 as compared with a little over £38,000,000 in 1948.

Cutting.—The number of employed cutters fluctuated throughout 1949 with the course of business, and there was considerable unemployment. The cost of cutting in the United States continues substantially higher than in other diamond-cutting centers of the world. Half the cutters are Belgians. Conditions in the Netherlands' cutting industry were fairly satisfactory, with about 1,500 to 1,600 workers employed. The Israel diamond-cutting industry was beset by many problems, chiefly lack of supply of rough from the Diamond Syndicate. Cutting in Germany caused other diamond-cutting centers considerable difficulty. An effort is being made to revive the diamond-cutting industry in Cuba.

Imports.—Imports of gem-grade diamonds into the United States decreased from $100,645,415 (revised figure) in 1948 to $69,727,517 in 1949, a decrease of 31 percent. The dollar value of both rough and cut decreased, as did the quantity of both. Belgium furnished 47 percent (value) of the cut in 1949.

Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1948–49, by countries

[U. S. Department of Commerce]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1948						
Austria				1	$215	$215.00
Belgian Congo	119	$3,870	$32.52			
Belgium				213,207	31,475,999	147.63
Brazil	[1] 12,987	[1] 235,410	[1] 18.13	4,762	578,774	121.54
British Guiana	786	29,219	37.17	116	12,535	108.06
Canada				21	13,388	637.52
China				328	67,032	204.37
Colombia				20	5,683	284.15
Cuba				4,790	657,520	137.27
Egypt				14	1,875	133.93
France				13,471	925,673	68.72
French Morocco				61	13,300	218.03
Germany				[1] 10,809	399,714	[1] 36.98
Hong Kong				324	83,282	257.04
Iran				113	12,724	112.60
Israel-Jordan	1,120	114,921	102.61	39,995	4,139,345	103.50
Italy				3	1,088	362.67
Jamaica				2	230	115.00
Japan				2	539	269.50
Lebanon				23	6,283	273.17
Mexico				80	9,954	124.43
Netherlands				34,246	5,109,945	149.21
Pakistan				1	488	488.00
Portugal				99	10,439	105.44
Sweden				1	450	450.00
Switzerland				18,298	3,044,693	166.39
Tangier				2	1,067	533.50
Thailand				1,049	197,868	188.63
Union of South Africa	832,022	42,379,244	50.94	33,060	7,974,210	241.20
U. S. S. R.				9,303	775,378	83.35
United Kingdom	6,112	310,098	50.74	4,297	724,968	168.71
Venezuela	56,725	1,327,719	23.41			
Yugoslavia				1	275	275.00
Total 1948	[1] 909,871	[1] 44,400,481	[1] 48.80	[1] 388,499	[1] 56,244,934	[1] 144.77
1949						
Argentina				3	1,009	336.33
Belgian Congo	3,100	6,096	1.97			
Belgium				159,189	19,581,847	123.01
Brazil	14,765	430,826	29.18	4,679	615,265	131.49
British Guiana	241	6,464	26.82	30	3,011	100.37
Canada				38	5,303	139.55
Chile				13	3,990	306.92
China				4	700	175.00
Cuba				580	71,099	122.58
Czechoslovakia				44	4,357	99.02
Denmark				139	11,300	81.29
France				2,843	355,899	125.18
French Morocco				63	15,091	239.54
Germany				3,528	283,903	80.47
Gold Coast	6,947	81,936	11.79			
Hong Kong				75	41,172	548.96
Iran				996	82,039	82.37
Israel-Jordan				70,485	5,402,074	76.64
Italy				27	134,933	4,997.52
Lebanon				103	13,829	134.26
Liberia	60	2,500	41.67			
Netherlands				24,789	3,202,227	129.18
Netherlands Antilles	11	3,534	321.27	15	3,689	245.93
Switzerland				14,465	1,932,944	133.63
Thailand				1,142	251,155	219.93
Union of South Africa	595,101	26,938,598	45.27	39,644	8,404,959	212.01
U. S. S. R.				8,663	539,412	62.27
United Kingdom	1,708	118,838	69.58	3,771	449,356	119.16
Venezuela	29,217	711,007	24.34	159	17,155	107.89
Total 1949	651,150	28,299,790	43.46	335,487	41,427,718	123.49

[1] Revised figure.

World Production.—Official figures on diamond production are not available for all countries, but the figures in the accompanying table are believed to be reasonably accurate as they have been compiled from Government reports, information supplied by officials of producing companies, and other authoritative sources. World production (gems and industrials) is estimated to have been 13,635,000 carats (3.01 short tons), which compares with 10,047,000 carats (2.21 short tons) for 1948, an increase for 1949 over 1948 of 36 percent.

Belgian Congo was the leading producer by weight but not by value since only about 7 percent of the Belgian Congo production is of gem quality. South Africa, on the other hand, although producing much less by weight led in terms of value.

Industrial Diamonds.—Sales of industrial diamonds in 1949 were very large, although considerably less than in 1948. Total sales in 1949 by Industrial Distributors (1946), Ltd., the industrial-diamond sales organization for the DeBeers group, were valued at £8,469,811. The United States purchased a large percentage of the total quantity, both for private industry and for the National Stockpile.

World production of diamonds, by countries, 1946–49, in metric carats

[Including industrial diamonds]

Country	1946	1947	1948	1949
Africa:				
Angola	806,961	799,210	795,509	769,981
Belgian Congo	6,033,452	5,474,469	5,824,567	9,649,896
French Equatorial Africa	87,381	107,076	118,800	123,000
French West Africa	51,834	53,749	77,970	94,906
Gold Coast	[1] 653,196	[1] 852,493	[2] 850,000	432,530
Sierra Leone	559,229	605,554	465,518	494,119
South-West Africa	163,611	179,554	200,691	280,134
Tanganyika	119,446	92,229	148,169	191,787
Union of South Africa:				
Lode	1,025,019	918,042	[2] 930,000	964,266
Alluvial	256,768	[3] 286,692	[2, 3] 270,000	[3] 289,756
Total Union of South Africa	1,281,787	1,204,734	[2] 1,200,000	1,254,022
Brazil (estimated)	325,000	275,000	250,000	250,000
British Guiana	30,958	24,669	36,562	34,790
Venezuela	20,912	61,634	75,513	56,362
Other countries (estimated)	1,600	3,500	3,500	3,000
Grand total	10,135,000	9,734,000	10,047,000	13,635,000

[1] Exports.
[2] Estimated.
[3] Includes an estimate of 100,000 carats for State Mines of Namaqualand.

The use of diamond drills for exploring and breaking ore is expanding, and the use of diamond-impregnated wheels is increasing. The only significant new use of industrial diamonds is for drilling in oil fields. Bits up to 12 inches in diameter have been used, although the common sizes are 6- and 8-inch. These bits are being used not for core recovery but for "making hole."

Figure 1 shows the increase in the quantity of industrial diamonds imported into the United States in the past 27 years, as contrasted with the price per carat.

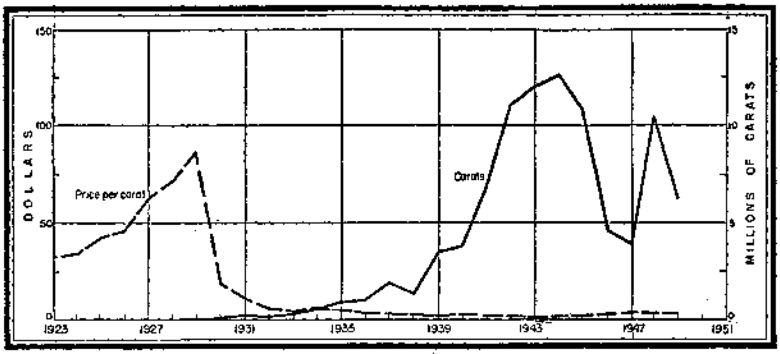

FIGURE 1.—United States imports and average price per carat of industrial diamonds, 1923–49.

Industrial diamonds (glaziers', engravers', and miners') imported for consumption in the United States, 1945–49

[U. S. Department of Commerce]

Year	Carats	Value		Year	Carats	Value	
		Total	Average			Total	Average
1945	10,733,411	$12,823,962	$1.19	1948 [1]	10,421,207	$32,581,385	$3.13
1946	4,625,282	14,297,536	3.09	1949	6,261,689	17,339,219	2.77
1947	3,999,119	13,312,668	3.33				

[1] Revised figures.

RUBY, SAPPHIRE, AND EMERALD

The precious stones, other than diamond, continued to increase in price owing to short supply of newly mined stones of fine quality.

A 2-ounce particolored sapphire was reported found along the bed of a gully near Tomahawk Creek, Central Queensland, Australia, a locality where gems had not been previously known to exist.

A star sapphire was found in a mine in the Ratnapura District, Ceylon, weighing nearly one-half pound. It is believed that two stones of about 400 carats each can be cut from it.

Mining has been resumed at the famous Chivor-Somondoco mines in Colombia according to reports. The old "terrace" type of mining has given way to conventional underground methods.[3] Production for 1949 was reported to be 91,656 carats compared with 82,370 carats for 1948.[4]

The emerald mines at Muzo, Colombia, have been closed by the Banco de la Republica, after operating for the year at a considerable loss.

Emeralds were mined in India, at Kaliguman, a small village in the Udaipur district in the State of Rajasthan. A small proportion of the production reportedly yielded stones of fine quality. Production of all qualities for 1948–49 was approximately 15,000 carats.

South Africa and Brazil continue to produce a few emeralds.

[3] Bureau of Mines, Mineral Trade Notes: Vol. 30, No. 1, January 1950, pp. 29–38.
[4] Bureau of Mines, Mineral Trade Notes: Vol. 31, No. 1, July 1950, pp. 31–32.

Ceylon produces not only ruby and sapphire but also alexandrite, cat's-eye, and a variety of less valuable gem stones. Most of these are recovered from gravels by placer mining. An estimated half million dollars' worth of gems is produced each year.

LESSER GEMS

The Australian opal-mining industry continues at a low ebb. Only about 100 miners are active. The once famous black-opal fields at Lightning Ridge, New South Wales, are almost exhausted.

Brazil continued to produce a large caratage of the lesser gems, principally amethyst, aquamarine, citrine quartz, and topaz.

TECHNOLOGY

Synthetic rutile (titania) was made in quantity by the Linde Air Products Co. and the National Lead Co. The material is grown in boules by a modification of the well-known Verneuil technique. No completely colorless material has been made, the nearest to this being tinged with yellow. Other shades such as red, blue, green, brown, and yellow have also been made. The refractive index of synthetic rutile is considerably higher than diamond, while its dispersion is approximately three times that of diamond.

Several experiments were reported in which the color of topaz, sapphire, and other gems was changed by exposure to radium radiation. The turning of yellow diamonds green and colorless quartz purple by bombardment in a cyclotron was also reported.

Education and Laboratories.—The Gem Trade Laboratory of New York consolidated with the Gemological Institute of America, the new laboratory to be known as the Gem Trade Laboratory of the Gemological Institute of America, 5 East Forty-seventh Street, New York, N. Y.

The Diamond Research Laboratory of Johannesburg, Union of South Africa, was established recently by the leading diamond companies of the world for two purposes: (1) To assist the mining companies in problems concerning their extraction processes and in investigations leading to increased output and reduced cost and (2) to act as a research and service center for all who use diamonds in any form.

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Gem Stones

By W. F. Foshag,[1] George Switzer,[1] and H. P. Chandler

GENERAL

DOMESTIC PRODUCTION

THE United States continues to be an unimportant factor in world gem production. Although a wide variety of gems is produced in small amount, gem mining probably will continue to be a minor mining industry.

There are no large gem-mining companies in the United States. A few small companies have been organized from time to time to work certain deposits, such as jade, turquoise, sapphire, and tourmaline. Some professional lapidary shops employ a few miners. Most gemstone production results from the efforts of thousands of amateur lapidaries ("rockhounds"), who spend their vacations and week ends searching for materials suitable for cutting and polishing. Chief objects of their search are such varieties of quartz as agate, jasper, and petrified wood. Much of what they collect is sold or exchanged to mineral dealers, local jewelers, or roadside curio shops, particularly in the Southwestern, Western, and Northwestern States. The hobby of lapidary work and gem and mineral collecting has grown phenomenally in the past 15 years. No reliable figures are available as to the number of persons engaged in this hobby, but the best estimates range from at least 200,000 to a million or more.

Since only a small percentage is mined by companies on a commercial scale, no statistics have been compiled as to the value of the domestic output of gem stones. In the rough, it may approximate $400,000 to $500,000.

The many forms of quartz, chiefly the cryptocrystalline varieties, led the field, with kunzite (pink spodumene) second, jade third, and turquoise fourth. Of the producing States, California, Texas, Oregon, Washington, and Wyoming were the leaders.

Agate.—Agate production, including all other varieties of chalcedony, continues to increase as interest grows in the lapidary hobby.

Greatest production in 1950 appears to have been from the Alpine-Big Bend area, Texas, where agates were recovered having a value variously estimated at $10,000 to $50,000.

Another relatively large producing area was Deming, N. Mex., with an estimated production of 30 tons, of which not more than 3 tons was of good quality.

Large quantities of agate were also found in California, Oregon, and Washington, with smaller amounts in Arizona, Montana, and Wyoming. Small quantities of various varieties of chalcedonic quartz, such as petrified wood and jasper, were collected in almost every other State.

[1] Smithsonian Institution; consulting mineralogist to Bureau of Mines.

Kunzite.—Kunzite, the pink gem variety of spodumene, figured in the gem-production picture owing to the discovery of a pocket containing 280 pounds of rough kunzite crystals in the San Pedro mine, Pala district, San Diego County, Calif. This is the first discovery of a large quantity of this gem in many years. The value of the find was estimated at $20,000 to $30,000. The largest crystal fragment, containing a large proportion of gem material, weighed 5 pounds. The material is reported to be of good quality but rather pale.

Jade.—The Wyoming jade (nephrite) industry is reported to be decreasing rapidly. The deposits of good green jade are nearly exhausted, with a 1950 production of not over 200 pounds. Prices for good-quality green have increased to as high as $30 per pound. Black jade is still plentiful at $2.00 to $5.00 per pound. Approximately 1,500 pounds of the black variety were sold in 1950, but a market is hard to find. Some black jade has been used as a substitute for black onyx; but, because it is harder to saw and polish, lapidaries prefer the onyx.

In California about 700 pounds of nephrite jade, valued at $700, was produced at Porterville. Smaller amounts were picked up by collectors at other localities, chiefly in Monterey County.

The jadeite jade deposit discovered in San Benito County, Calif., in 1949 has been visited by many collectors but has not been exploited commercially because of its poor color. Other finds of jadeite have been reported in Mendocino County, but so far no good gem material has been reported.

No production of nephrite jade was reported for the year from the Kobuk area, northwestern Alaska.

Turquoise.—Turquoise production in the Southwest continues to diminish. No output was reported from the Cerrillos mine in New Mexico. Some turquoise was mined by the Nevada Turquoise Co. near Battle Mountain, Nev., and the open-pit Castle Dome (copper) mine near Miami, Ariz., produced a small amount of turquoise of good quality.

Other Gem Stones.—No diamonds were produced from the Arkansas diamond mines in 1950, although the newly organized American Diamond Mining Co. indicated the possibility of renewing operations there.

The South Dakota inspector of mines reports 68.5 tons of rose quartz produced in that State in 1950 for ornamental and monumental purposes. Scott's Rose Quartz Co., Custer, S. Dak., mined no gem rose quartz in 1950, but produced 7½ tons, valued at $506.50, for ornamental purposes.

A small quantity of rock-crystal quartz from Arkansas and about 500 pounds of asteriated quartz from the Springfield, N. H. area were sold for gem use.

Some quartz colored blue by chrysocolla was produced from various localities in the Southwest, especially at the Inspiration (copper) mine near Miami, Ariz.

No sapphires were produced at the Yogo Sapphire mine, Montana.

An estimated $5,000 worth of colorless to pale-blue topaz was produced in Mason County, Tex., mostly by local collectors for private collections.

A small amount of peridot from near Deming, N. Mex., was sold. This material is reported to be abundant but will only cut 4- to 8-point stones. Peridot in small quantity was also found on the San Carlos Indian Reservation and sold by the Indians in small lots.

Some pyrope garnet was produced near Fort Defiance, Ariz., and sold by the Indians.

CONSUMPTION AND USES

For the first 6 months of the year jewelry sales were slow. The general attitude among retailers was one of depression but not panicky concern, for the early months of every year are traditionally dull in the jewelry stores. Diamonds were particularly slow, principally in higher-valued pieces, because of the anticipated reduction of the jewelry excise tax from 20 percent to 10 percent. The outbreak of the Korean War, however, killed any possibility of a tax reduction and had a strong effect on the sale of diamonds, for there was now nothing to be gained by further postponement of purchases. Actually, consumers saw higher prices in the immediate future because of inflationary influences, higher wages among diamond cutters, and greater demand. These factors, plus an increase in the marriage rate, caused a strong diamond market during the last 6 months of the year.

As usual, the United States again in 1950 was the principal world market for diamonds. There was substantial purchasing of diamonds as investments in several troubled areas of the world and considerable evidence of such type of purchasing of fine-quality diamonds in America during 1950.

The jewelers' Christmas business was good. It gained over 1949 and sufficed to raise the year's volume for the jewelry industry to $1,140,000,000 compared with $1,055,000,000 in 1949, a gain of 8 percent.

Fashions in Jewels.—Fashions in gems showed relatively little basic change during 1950. Jewelry was light, flexible, and mobile. Designed on the theory that diamonds in motion look bigger than diamonds in repose, mountings were made to move loosely.

In mountings, curved lines were the most popular, but with fewer naturalistic flowers and abstract objects. In forms of diamond jewelry, the necklace remained the most important single piece. Earrings changed from the long pendant type to large button clusters on the lobe. Diamond wrist watches became increasingly popular.

The cluster, a large center stone surrounded by one or more rows of stones of matched sizes, was the outstanding motif in 1950, especially in diamonds. The cluster mountings might be marquise, square, oval, or round. Most popular usage of these clusters was in dinner rings.

Toward the end of the year the metal restrictions imposed or on the horizon made new designs uncertain. Gold was being used extensively owing to the shortage of platinum.

More fancy-cut diamonds were used than since the 1920's. Such shapes as pentagon, kite, trapeze, triangle, and half-moon were used extensively. The bulk of the diamond jewelry sold in America, however, is mounted with the standard brilliant, the emerald cut, and occasionally the marquise and baguette.

IMPORTS[2]

Imports of gem stones, exclusive of industrial diamonds, in 1950, as reported by the United States Department of Commerce, totaled $119,641,457, an increase of 42 percent over 1949.

TABLE 1.—Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1949–50

[U. S. Department of Commerce]

Commodity	1949		1950	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty-free	[1] 633,731	[1] $28,216,634	819,083	$44,775,769
Cut but unset, suitable for jewelry, dutiable	335,487	41,427,718	492,671	58,524,902
Emeralds:				
Rough or uncut, duty-free	80,231	226,233	12,142	7,991
Cut but not set, dutiable	13,723	284,578	9,706	237,446
Pearls and parts, not strung or set, dutiable:				
Natural		532,310		410,970
Cultured or cultivated		1,733,698		3,192,334
Other precious and semiprecious stones:				
Rough or uncut, duty-free		208,124		324,089
Cut but not set, dutiable		2,045,476		2,429,992
Imitation, except opaque, dutiable:				
Not cut or faceted		36,090		19,088
Cut or faceted:				
Synthetic		680,428		811,372
Other		8,495,151		8,752,863
Imitation, opaque, including imitation pearls, dutiable		37,819		14,854
Marcasites, dutiable:				
Real		170,405		136,768
Imitation		7,802		3,019
Total		[1] 84,132,466		119,641,457

[1] Revised figure.

TECHNOLOGY

Additional experiments in the artificial coloration of diamonds in a cyclotron were carried out during the year.[3] Color changes noted were usually from pale brown to green, white to bluish green, and yellow to yellow green. Occasional changes from yellow to golden brown were observed. The induced color appears to be permanent but is only present as a surface skin. No permanent induced radioactivity was observed. Diamonds subjected to neutron bombardment in an atomic pile were said to have been quickly blackened after first passing through an intermediate green color.

Research on diamonds was carried out by the Diamond Research Laboratory of Johannesburg, Union of South Africa, sponsored and supported by the Industrial Distributors (1946), Ltd.

[2] Figures on imports and exports compiled by M. B. Price and E. D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.
[3] Gems and Gemology, Summer 1950, p. 295, and Spring 1951, p. 3.

DIAMONDS

The year 1950 was a record-breaking one in the diamond industry. Sales of diamonds effected through the Central Selling Organization on behalf of South African and other producers set a new record, as follows: Gem diamonds £38,357,698, industrial diamonds £12,609,343, total £50,967,041. The previous record was a total of £38,000,000 established in 1948. Whereas the quantity of diamonds sold in 1950 was approximately the same as the quantity sold in 1948, the proceeds realized in sterling in 1950 exceeded by nearly £13,000,000 (34 percent) the sterling proceeds in 1948. This increase was due to devaluation of the pound sterling in terms of the dollar in September 1949.

A new record was also set for world production of diamonds in 1950, with a total of 15,300,000 carats, compared with 14,175,000 carats in 1949.

Cutting.—The strong demand for gem diamonds in 1950 tended to alleviate somewhat the unemployment situation in the cutting centers. Both the Diamond Manufacturers Association and the World Federation of Diamond Workers passed resolutions at their annual conventions in Amsterdam urging uniform working conditions and hours throughout the industry.

Belgium continues to be the largest cutting center, followed by Germany, Netherlands, Israel, and the United States. Smaller cutting centers are well-established in South Africa, England, and Puerto Rico. Efforts to revive the Cuban diamond-cutting industry failed. In the United States there are about 300 diamond-cutting establishments, employing approximately 1,500 workers. High cutting costs in the United States, compared to other cutting centers, foreign currency manipulation, and other difficulties were only partly offset by greater efficiency and finer categories of cutting in the American industry.

Imports.—Imports of gem-grade diamonds into the United States amounted to $103,300,671 in 1950 compared to $69,674,352 in 1949, an increase of 48 percent. Percentagewise, rough or uncut stones showed the greatest increase in total value. Belgium furnished 50 percent (value) of the cut in 1950.

TABLE 2.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1949–50, by countries

[U. S. Department of Commerce]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1949						
Argentina				3	$1,009	$336.33
Belgian Congo	3,100	$6,096	$1.97			
Belgium-Luxembourg				159,180	19,581,847	123.01
Brazil	[1] 12,315	[1] 411,799	[1] 33.44	4,679	615,265	131.49
British Guiana	241	6,464	26.82	30	3,011	100.37
Canada				38	5,303	139.55
Chile				13	3,990	306.92
China				4	700	175.00
Cuba				580	71,099	122.58

[1] Revised figure.

TABLE 2.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1949–50, by countries—Continued

[U. S. Department of Commerce]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1949—Continued						
Czechoslovakia				44	$4,357	$99.02
Denmark				139	11,300	81.29
France				2,843	355,899	125.18
French Morocco				63	15,091	239.54
Germany				3,528	283,903	80.47
Gold Coast	6,947	$81,936	$11.79			
Hong Kong				75	41,172	548.96
Iran				996	82,039	82.37
Israel				70,485	5,402,074	76.64
Italy				27	134,933	4,997.52
Lebanon				103	13,829	134.26
Liberia	60	2,500	41.67			
Netherlands				24,789	3,202,227	129.18
Netherlands Antilles	11	3,534	321.27	15	3,689	245.93
Switzerland				14,465	1,932,944	133.63
Thailand				1,142	251,155	219.93
Union of South Africa	[1] 580,376	[1] 26,911,452	[1] 46.37	39,644	8,404,959	212.01
U. S. S. R.				8,663	539,412	62.27
United Kingdom	1,708	118,838	69.58	3,771	449,356	119.16
Venezuela	[1] 28,973	[1] 704,015	[1] 24.30	159	17,155	107.89
Total 1949	[1] 633,731	[1] 28,246,634	[1] 44.57	335,487	41,427,718	123.49
1950						
Argentina				109	11,847	108.69
Australia				12	6,500	541.67
Belgian Congo	400	11,059	27.65			
Belgium-Luxembourg	1,631	85,283	52.29	257,942	29,115,318	112.88
Brazil	43,043	955,922	22.21	2,125	190,562	89.68
British Guiana	821	25,078	30.55	1	148	148.00
British West Africa, n. e. s.	15,274	349,455	22.88			
Canada	1,415	6,413	4.53	657	98,343	149.68
China				90	12,738	141.53
Cuba				261	34,893	133.69
Denmark				104	7,118	68.44
France				4,497	517,574	115.09
French Equatorial Africa	215	14,009	65.16			
French Morocco				156	14,779	94.74
Germany	3	41	13.67	7,317	603,797	82.52
Hong Kong				321	64,126	199.77
Hungary				5	120	24.00
India				8	1,277	159.63
Iran				16	1,551	96.94
Israel	98	5,938	60.59	86,192	6,834,363	79.29
Italy				5	900	180.00
Kuwait				2	542	271.00
Lebanon				217	37,770	174.06
Netherlands	480	13,932	29.03	44,978	4,845,140	107.72
Philippines				30	8,500	283.33
Portuguese Asia				39	11,329	290.49
Southern-Southeastern Asia, n. e. s.				75	4,621	61.61
Switzerland				3,251	740,125	227.66
Thailand				418	81,596	195.21
Union of South Africa	703,520	41,956,932	59.64	74,476	14,313,316	192.19
U. S. S. R.				3,919	190,000	48.48
United Kingdom	9,349	380,338	40.68	5,448	776,009	142.44
Venezuela	42,834	971,309	22.68			
Total 1950	819,083	44,775,769	54.67	492,671	58,524,902	118.79

[1] Revised figure.

World Production.—Official figures on diamond production are not available for all countries, but the figures in the accompanying table are believed to be reasonably accurate, as they have been compiled from Government reports, information supplied by officials of producing companies, and other authoritative sources. World production (gems and industrials) is estimated to have been 15,300,000 metric carats, which compares with 14,175,000 (revised figure) carats for 1949, an increase of 8 percent.

Belgian Congo is the leading producer by weight, but only about 5 percent of the Belgian Congo production is of gem quality. South Africa, although producing much less by weight, leads in value owing to the high percentage of gem stones.

TABLE 3.—World production of diamonds, 1947–50, by countries, in metric carats

[Including Industrial Diamonds]

Country	1947	1948	1949	1950
Africa:				
Angola	799,210	795,509	769,981	638,867
Belgian Congo	5,474,469	5,824,567	9,649,896	10,147,471
French Equatorial Africa	107,076	[1] 118,300	[1] 122,928	111,460
French West Africa	53,749	77,970	94,996	126,346
Gold Coast	[2] 852,493	[3] 850,000	[1] [2] 972,976	[3] 950,000
Sierra Leone	605,554	465,518	494,119	655,474
South-West Africa	179,554	200,691	280,134	488,422
Tanganyika	92,229	148,169	191,787	195,274
Union of South Africa:				
Lode	918,042	[3] 930,000	964,266	1,516,194
Alluvial	[4] 286,692	[3] [4] 270,000	[4] 289,756	[4] 231,674
Total Union of South Africa	1,204,734	[3] 1,200,000	1,254,022	1,747,868
Brazil [3]	275,000	250,000	250,000	200,000
British Guiana	24,669	36,562	34,790	37,462
Venezuela	61,634	75,513	56,362	60,389
Other countries [3]	3,500	3,500	3,000	3,000
Grand total (round figures)	9,750,000	10,050,000	[1] 14,175,000	15,300,000

[1] Revised figure.
[2] Exports.
[3] Estimated.
[4] Includes an estimated 100,000 carats for State mines of Namaqualand.

Industrial Diamonds.—Details regarding imports, production, sales, and uses of industrial diamonds will be found in the Abrasive Materials chapter of this volume.

OTHER GEM STONES

The price of most gem stones other than diamonds continued to increase owing to short supply of newly mined stones of fine quality.

Again in 1950 Canada produced very little in the way of gem stones. A few tons each of sodalite, peristerite, and labradorite are produced each year, but the total value probably does not exceed a few hundred dollars.

Ceylon maintained its output of important quantities of a variety of gems, chiefly ruby, sapphire, chrysoberyl (including alexandrite), topaz, spinel, garnet, zircon, and tourmaline. The Ceylon gems come from the alluvial gravels of the Ratnapura district. The gem-mining industry is chiefly handled by villagers and minor concerns. Value of the annual production is believed to be about $500,000.

Emeralds were mined at the Chivor-Somondoco mines in Colombia. Production for 1949 was reported to be 91,656 carats. According to latest reports, the famous Muzo, Colombia, mines are still closed. Some good-quality emeralds were mined at Kaliguman, India, a small village in the Udaipur district, State of Rajasthan. South Africa and Brazil continued to produce a few emeralds.

Australian gem-sapphire production for 1948 had a reported value of £A 6,000.[4] In September 1948 a 1,958-carat (uncut weight) blue sapphire was discovered at Anakie, central Queensland.

Gem-stone production of Burma for 1949 was as follows: Ruby 100 carats, sapphire 2,500 carats, spinel 12,500 carats, jadeite 2,393 pounds, total value approximately $88,500.[5]

The Australian opal-mining industry continues at a low ebb. South Australia is now the largest producer, with the main fields lying in the Stuart Range north of Tarcoola. Only about 100 miners are now active, and the value of the annual production averages about $200,000.[6]

Madagascar gem-stone production for the first half of 1950, chiefly tourmaline, beryl, and garnet, was 9,004 grams.[7]

In Mozambique the pegmatites in the Alto Ligonho district produced some fine-quality rubellite, morganite, and aquamarine, some of which came into the United States.

The zircon mining and cutting industry of Thailand, which experienced a sudden boom immediately after World War II, is now in a depressed condition. Bangkok cutters predict that, if the present export volume is not increased soon, it may be impossible to keep the industry alive. The zircons are mined in the Provinces of Chantaburi and Ubonrajathani, in southeast Thailand along the Thai-Indochina border.

Brazil continued to produce a large caratage of amethyst, aquamarine, citrine, topaz, and tourmaline and smaller amounts of euclase, chrysoberyl, andalusite, and other stones.

SYNTHETIC GEM STONES

Corundum and Spinel.—The year 1950 witnessed further recapture of the American market by European producers of synthetic corundum and spinel. Chief production is in Germany, followed by France. India and Japan are other foreign producers.

The Idar-Oberstein district, in the French zone of West Germany, resumed its former position of importance as the chief cutting center for synthetics. Favored by low labor rates and devaluation of currency, most synthetic gems used in the American market are now cut in Idar-Oberstein. Toward the end of the year, as large orders piled up and European deliveries became slower, more business was placed in the United States.

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[4] Bureau of Mines, Mineral Trade Notes: Vol. 30, No. 6, June 1950, p. 36.
[5] Bureau of Mines, Mineral Trade Notes: Vol. 31, No. 6, December 1950, p. 31.
[6] Australian News and Information Bureau, New York: Vol. 8, No. 4.
[7] Bureau of Mines, Mineral Trade Notes: Vol. 31, No. 6, December 1950, p. 31.

Domestic synthetic corundum and spinel production for the year amounted to several million carats. Of this, approximately 70 percent was ruby-color synthetic corundum, 20 percent blue spinel, and the remainder corundum and spinel of other colors. Most of this material was used in educational ring stones, the buff-top, flat-back stones being the most popular style.

Synthetic Rutile (Titania).—During the year public acceptance of this relatively new synthetic gem material increased. When first introduced, the jewelry trade did not respond, but as a result of interest by the amateur lapidaries and direct-mail sales, public interest has been created to a point where the jewelry trade is now beginning to accept and promote titania.

Production has been largely on an experimental basis by the Linde Air Products Co. and the National Lead Co. Prices for boules are about 50 cents per carat for colorless and 75 cents per carat for colored (blue and red).

Synthetic Emerald.—This synthetic gem stone continues to be produced only by the Chatham Research Laboratories in San Francisco, Calif. Production in 1950 amounted to 50,000 carats of rough crystals, of which less than 10 percent was gem quality. No flawless stones of over 2 carats were produced. The retail price for top-quality synthetic emerald is $120 per carat.

Gem Stones

By W. F. Foshag,[1] George Switzer,[1] and Robert D. Thomson

GENERAL

DOMESTIC PRODUCTION

AS IN THE PAST, the United States continues to be an unimportant factor in world gem production. A wide variety of gems is produced but in small quantity. Gem mining is, and probably will continue to be, a minor industry.

Most gem-stone production in the United States results from the interest of thousands of amateur lapidaries, who pursue their hobby with great vigor and spend their vacations and weekends searching for materials suitable for cutting and polishing. Much of what they collect passes into the hands of numerous small mineral and lapidary supply dealers or roadside curio shops and changes hands through sale or exchange. The many varieties of quartz, such as agate, jasper, and petrified wood, are the chief materials produced in this way.

There are no large gem-mining companies in the United States. A few small companies operate certain deposits from time to time, such as turquoise, tourmaline, and jade, but they employ only a few miners. Since such a small percentage of the total gem production is mined on a commercial scale, no reliable statistics of the value of the domestic output of gems can be compiled. The value may approximate $400,000 to $500,000.

The many forms of quartz—chiefly the crypto-crystalline varieties—were produced in greatest quantity and value in 1951. Other gems produced, but in very much smaller quantity, were jade, kunzite, and turquoise, and a number of others in almost insignificant quantity. Of the producing States, California, Oregon, Texas, Washington, and Wyoming were the leaders.

Agate.—As far as could be ascertained, there was no appreciable change in agate production (including all varities of chalcedony) from that of 1950.

The Alpine-Big Bend area in Texas was one of the leading producers. A single locality near Alpine was reported to have yielded approximately 6,000 pounds of agate during the year, with an average value of 25 cents per pound.

Production from New Mexico was reported as essentially unchanged from the previous year.

[1] Smithsonian Institution, consulting mineralogist to Bureau of Mines.

Large quantities of agate also were found in California, Oregon, and Washington, with smaller quantities in Arizona, Montana, and Wyoming. Small quantities of all forms of chalcedonic quartz, such as agate, jasper, petrified wood, and chert, were collected in nearly every State. A small quantity of chrysoprase was said to have been recovered at Porterville, Calif.

Kunzite.—Renewed mining activity in the Pala district, San Diego County, Calif., in the years 1949–51 yielded important quantities of kunzite. In the Vandenberg mine pockets were struck in July and October 1951 which yielded about 150 pounds of kunzite, of which about 10 percent was fine gem quality. The larger of these two pockets contained material of exceptionally good color. The value of this find was estimated at about $16,000.

Jade.—The available supply of Wyoming nephrite jade continued to diminish. Material of good color was reportedly selling for $30 to $60 per pound. A new find was reported in Shirley Basin, north of Medicine Bow, yielding some material of good medium-green color, selling at $5 to $10 per pound.

In California some jade (nephrite) was found along the coast near Monterey, and some jadeite jade was collected at Clear Creek, San Benito County. No production was reported from the Porterville locality. Reports published in 1951 described the jade deposits in Marin, Monterey, and San Benito Counties, Calif.[2]

No production of nephrite jade was reported for the year from the Kobuk area, northwestern Alaska.

Turquoise.—Turquoise production continued to decline in the Southwest. There was no large-scale activity in any turquoise localities, although undoubtedly small quantities were produced from various mines in Nevada, Arizona, and Colorado.

Other Gem Stones.—No diamonds were produced from the Arkansas diamond mines in 1951.

The Barton Mines Corp., North Creek, N. Y., reported a 1951 production of 60 pounds of gem-quality garnet, valued at $85.

No sapphire was produced in Montana from the Yogo Gulch area. The Yogo Sapphire Mining Corp. was negotiating to buy all the properties of the British-owned New Mine Sapphire Syndicate and planned to open the mines if negotiations were successful.

No variscite was produced from the Fairfield, Utah, locality during 1951 because of litigation. A small quantity was obtained by collectors at Grantsville and Lucin, Utah, and a new variscite deposit was reported near Snowville, Box Elder County, Utah.

A number of good-size pieces (single pieces up to several hundred carats) of pale-blue topaz were recovered by collectors in Mason County, Tex. The Thomas Mountains, Utah, topaz locality was visited by many collectors, but no important production resulted.

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[2] Chesterman, Charles W., Nephrite in Marin County, Calif.: California Div. of Mines Spec. Rept. 10-B, 1951, 11 pp.
Crippen, Richard A., Jr., Nephrite Jade and Associated Rocks of the Cape San Martin Region, Monterey County, Calif.: California Div. of Mines Spec. Rept. 10-A, 1951, 14 pp.
Yoder, H. S. and Chesterman, C. W., Jadeite of San Benito County, Calif.: California Div. of Mines Spec. Rept. 10-C, 1951, 8 pp.

Small quantities of tourmaline and morganite were produced in San Diego County, Calif., and some tourmaline and aquamarine in the various New England pegmatite localities, chiefly in Maine and New Hampshire.

Rose-quartz production from South Dakota was small. Some of the rock-crystal quartz from Arkansas undoubtedly went into the gem trade.

The total value of these miscellaneous gems probably was not more than a few hundred dollars.

CONSUMPTION AND USES

Business conditions in the jewelry industry remained essentially the same as in 1950. In general, sales were slow, particularly in the early months of the year, and even the traditional Christmas rush did not come up to the expectations of most retailers. Continuation of the Korean War eliminated any immediate chance of a reduction in the 20-percent excise tax on jewelry. This, plus continually rising living costs, caused a slump in the jewelry industry.

Again in 1951, the United States was the principal world market for diamonds. There was no significant change in the volume of diamonds sold by jewelers. Diamond jewelry sales represented about one-quarter of total jewelry sales of the typical dealer in 1951. Most jewelers had no trouble in obtaining an adequate supply of diamonds, although fine-quality stones in the larger sizes were said to be in short supply.

Fashion in Jewels.—During 1951 women continued to wear a large quantity of jewelry of conspicuous sizes. There was a steady rise in the production and use of baguette diamonds, as well as other fancy cuts, such as the pear and marquise. Large, emerald-cut diamonds were the most coveted solitaires, but because of their high price few could afford them.

Paris jewelry went to no extremes and made no radical departure in style. Leaf forms from many trees and shrubs inspired the designers. The scale continued large, but forms were light and airy.

Paris continued to set trends for the world of fashion in 1951, but three Italian cities—Rome, Florence, and Milan—also emerged as sources of inspiration. Since the Italian jewelry designers sometimes come from the ranks of painters, sculptors, and even architects, great diversity of artistic creation may be expected from this source.

IMPORTS [3]

Imports of gem stones, exclusive of industrial diamonds, in 1951, as reported by the United States Department of Commerce, totaled $129.3 million, compared with $118.5 million in 1950, an increase of about 9 percent. Diamonds were the more important, totaling $110.6 million (86 percent) of the total value of imports, with "cut but unset" representing 56 percent of the diamond imports.

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[3] Figures on imports and exports compiled by M. B. Price and E. D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 1.—Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1950–51

[U. S. Department of Commerce]

Commodity	1950		1951	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty-free	[1] 673,699	[1] $43,655,706	697,981	$48,704,819
Cut but unset, suitable for jewelry, dutiable	[1] 492,741	[1] 58,531,035	480,516	61,858,003
Emeralds:				
Rough or uncut, duty-free	12,142	7,991	2,706	2,698
Cut but not set, dutiable	9,706	237,446	20,148	264,527
Pearls and parts, not strung or set, dutiable:				
Natural		410,970		449,379
Cultured or cultivated		3,192,334		2,747,653
Other precious and semiprecious stones:				
Rough or uncut, duty-free		[1] 304,167		160,609
Cut but not set, dutiable		2,429,992		2,686,137
Imitation, except opaque, dutiable:				
Not cut or faceted		19,088		87,162
Cut or faceted:				
Synthetic		811,372		888,629
Other		[1] 8,753,307		11,307,401
Imitation, opaque, including imitation pearls, dutiable		14,854		26,394
Marcasites, dutiable:				
Real		136,768		88,395
Imitation		3,019		3,836
Total		[1] 118,508,049		129,275,642

[1] Revised figure.

TECHNOLOGY

The emphasis in gem-stone research was on diamonds. The Diamond Research Laboratory of Johannesburg, Union of South Africa, sponsored and supported by Industrial Distributors (1946), Ltd., investigated many problems in mining and utilization of diamonds.

Articles published recently dealt with the investigation of the Slipper diamond, a 7.25-carat octahedron with a small included octahedron [4] and the luminescence of polished cleavage plates of diamond; [5] description of the unusual twinned tetrahedral diamonds from the Belgian Congo; [6] a fractographic study of the cleavage face of a 34½-carat diamond from the Premier mine, South Africa, which had a cleavage pattern partly characteristic of type I and partly of type II diamond; [7] description of the effects of treating diamonds in a cyclotron; [8] and measurement of the thermo conductivity of diamond, sapphire, and quartz.[9]

An excellent summary of the chief scientific and industrial development regarding diamonds that took place during 1951 was prepared by

[4] Kohn, J. A., Observations on the Slipper Diamond: Gems and Gemology, vol. 6, No. 11, Fall 1950, pp. 347–348.

[5] Raman, C. V., The Luminiscence of Diamond–II: Curr. Sci. (India), vol. 20, No. 1, January 1951, pp. 1–7.

[6] Polinard, E., Sur une forme tétraédrique du diamant: Bull. soc. geol. Belg., vol. 74, No. 3, 1950, pp. 59–63.

[7] Custers, J. F. H., Laminations in Type II Diamonds: Research, vol. 4, No. 3, March 1951, pp. 131–136.

[8] Ehrmann, M., Bombarded Diamonds: Gems and Gemology, vol. 6, No. 10, summer 1950, p. 295.
Pough, F. H. and Schulke, A. A., The Recognition of Surface Irradiated Diamonds: Gems and Gemology, vol. 7, No. 1, Spring 1951, pp. 3–11.

[9] Berman, R., Simon, F. E., and Wilks, J., Thermal Conductivity of Dielectric Crystals; the "Umklapp" Process: Nature, vol. 168, No. 4268, Aug. 18, 1951, pp. 277–280.

P. Grodzinski and his associates and distributed by the Industrial Diamond Information Bureau, 32–34 Holborn Viaduct, London, E. C. 1.

In the field of colored gem stones, taaffeite, a pale mauve gem resembling spinel but chemically a beryllium magnesium-aluminum oxide, was described.[10]

DIAMONDS[11]

The year 1951 was another record-breaking year in the diamond industry. The value of diamonds sold through the Central Selling Organization, on behalf of South African and other producers, amounted to £65 million. Sale of diamonds produced in Brazil, British Guiana, and Venezuela raised the overall total to approximately £68 million, an increase of about 30 percent over 1950. A 15-percent increase in diamond prices in March 1951 brought sterling prices to full parity with dollar prices, which were in effect before the devaluation of sterling in 1949. The increased sales for 1951, however, are only partly attributable to this cause, also being influenced by increased production of rough diamonds through increased mining activity and better milling practices.

A sharp increase in sales of industrial diamonds featured the 1951 market. Sales by the Central Selling Organization were divided as follows:

Gem diamonds	£46, 780, 632
Industrial diamonds	18, 277, 333
	65, 057, 965

A new record also was set for world production of diamonds in 1951, with a total of 16,800,000 carats, compared with 15,250,000 carats in 1950.

Cutting.—The strong demand for gem diamonds continued unabated during 1951.

In spite of this high level of activity, the cutting industry continued to be plagued with unemployment, indicating a surplus of workers in the industry.

Means to eliminate the disparity in cutting costs, wages, and working hours in the various cutting centers was widely considered, but no uniform wage basis could be determined. Neither the efforts of the Netherlands and Belgian cutters and manufacturers to arrive at some satisfactory arrangement, nor the efforts of the Universal Alliance of Diamond Workers to work out an agreement with the German diamond workers' organization on time, tariffs, and apprenticeships, were successful.

Belgium continued to be the largest cutting center, followed by Germany, Netherlands, Israel, and the United States. Smaller cutting centers were in England, South Africa, France, India, Brazil, and Puerto Rico.

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[10] Anderson, B. W., A Rare New Gem Stone: Gemologist, vol. 20, No. 237, April 1951, pp. 75–77.
[11] Foshag, W. F. and Switzer, G., The Diamond Industry in 1951: Jewelers' Circular-Keystone, vol. 122, No. 10, July 1952, pp. 88, 90, 116–117, and 118; No. 11, August 1952, pp. 130, 132, and 168–169; and No. 12, September 1952, pp. 126, 128, and 149.

TABLE 2.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1950–51, by countries

[U. S. Department of Commerce]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1950						
Argentina	----	----	----	109	$11,847	$108.69
Australia	----	----	----	12	6,500	541.67
Belgian Congo	[1] 200	[1] $10,000	[1] $50.00	----	----	----
Belgium-Luxembourg	[1] 336	[1] 43,454	[1] 129.33	257,942	29,115,318	112.88
Brazil	[1] 28,096	[1] 777,164	[1] 27.66	2,125	190,562	89.68
British Guiana	[1] 375	[1] 22,378	[1] 59.67	1	148	148.00
British West Africa, n. e. s	[1] 9,955	[1] 317,412	[1] 31.88	----	----	----
Canada	(2)	(2)	(2)	657	98,343	149.68
China	----	----	----	90	12,738	141.53
Cuba	----	----	----	261	34,893	133.69
Denmark	----	----	----	104	7,118	68.44
France	----	----	----	4,497	517,574	115.09
French Equatorial Africa	215	14,009	65.16	----	----	----
French Morocco	----	----	----	156	14,779	94.74
Germany	3	41	13.67	7,317	603,797	82.52
Hong Kong	----	----	----	321	64,126	199.77
Hungary	----	----	----	5	120	24.00
India	----	----	----	8	1,277	159.63
Iran	----	----	----	16	1,551	96.94
Israel and Palestine	98	5,938	60.59	[1] 86,262	[1] 6,840,496	[1] 79.30
Italy	----	----	----	5	900	180.00
Kuwait	----	----	----	2	542	271.00
Lebanon	----	----	----	217	37,770	174.06
Netherlands	480	13,932	29.03	44,978	4,845,140	107.72
Philippines	----	----	----	30	8,500	283.33
Portuguese Asia	----	----	----	39	11,329	290.49
Southern-Southeastern Asia, n. e. s	----	----	----	75	4,621	61.61
Switzerland	[1] 151	[1] 7,324	[1] 48.50	3,251	740,125	227.66
Thailand	----	----	----	418	81,596	195.21
Union of South Africa	[1] 588,551	[1] 41,149,102	[1] 69.92	74,476	14,313,316	192.19
U. S. S. R	----	----	----	3,919	190,000	48.48
United Kingdom	[1] 5,117	[1] 350,706	[1] 68.54	5,448	776,009	142.44
Venezuela	[1] 40,122	[1] 944,246	[1] 23.53	----	----	----
Total 1950	[1] 673,699	[1] 3,655,706	[1] 64.80	[1] 492,741	[1] 58,531,035	118.79
1951						
Australia	765	97,086	126.91	12	1,200	100.00
Bahrein	50	20,878	417.56	----	----	----
Belgian Congo	2,645	215,173	81.35	----	----	----
Blegium-Luxembourg	4,582	409,071	89.28	251,617	31,317,834	124.47
Brazil	7,749	523,453	67.55	452	79,078	174.95
British Guiana	1,563	55,513	35.52	6	646	107.67
British Malaya	----	----	----	161	26,700	165.84
Canada	6,112	174,167	28.50	7	1,751	250.14
Ceylon	----	----	----	9	121	13.44
Czechoslovakia	----	----	----	10	1,150	115.00
Denmark	----	----	----	17	2,348	138.12
France	286	13,990	48.92	3,208	425,507	132.64
Germany	----	----	----	9,691	789,720	81.49
India	----	----	----	2	260	130.00
Iran	----	----	----	30	3,600	120.00
Israel and Palestine	207	1,656	8.00	104,194	9,128,630	87.61
Italy	----	----	----	62	12,372	199.55
Japan	----	----	----	50	5,670	113.40
Kuwait	----	----	----	1	800	800.00
Liberia	180	10,000	55.56	----	----	----
Mexico	----	----	----	6	1,871	311.83
Netherlands	19,329	1,481,908	76.67	35,940	4,398,388	122.38
Southern British Africa	----	----	----	154	27,853	180.86
Switzerland	85,110	5,533,669	65.02	7,229	1,259,918	174.29
Union of South Africa	66,930	1,856,217	27.73	64,537	13,835,217	214.38
United Kingdom	475,927	37,557,682	78.91	3,120	536,944	172.10
Uruguay	----	----	----	1	425	425.00
Venezuela	26,546	754,356	28.42	----	----	----
Total 1951	697,981	48,704,819	69.78	480,516	61,858,003	128.73

[1] Revised figure.
[2] Revised to none.

In the United States employment in the diamond-cutting industry reached a low level in 1951. During the year less than 50 percent of the enrolled members of the Diamond Workers Protective Union had steady employment, and work in the non-union shops was seasonal. High labor costs in the United States permitted only cutting of the larger and finer grade stones.

Imports.—Imports of gem-grade diamonds into the United States amounted to $110,563,000 in 1951 compared with $102,187,000 (revised) in 1950, an increase of slightly less than 1 percent. The United Kingdom furnished most of the rough or uncut and Belgium-Luxembourg most of the cut in 1951.

World Production.—Official figures on diamond production are not available for all countries, but the figures in the accompanying table are believed to be reasonably accurate. World production in 1951 (gems and industrials) is estimated to have been 16,800,000 metric carats, which compares with 15,250,000 carats for 1950, an increase of nearly 10 percent.

Belgian Congo was again the leading producer by weight, but only about 5 percent of the Belgian Congo production was of gem quality. South Africa, although producing much less by weight, lead in value owing to a higher percentage of gem stones.

TABLE 3.—World production of diamonds, 1948–51, by countries, in metric carats

[Including industrial diamonds]

Country	1948	1949	1950	1951
Africa:				
Angola	795,509	769,981	538,867	751,447
Belgian Congo	5,824,567	9,649,896	10,147,471	10,564,667
French Equatorial Africa	118,300	122,928	[4] 111,407	[2] 136,000
French West Africa	77,970	94,996	126,346	101,000
Gold Coast	[2] 850,000	[1] 972,976	[2] 950,000	[2] 1,600,000
Sierra Leone	465,518	494,119	655,474	475,759
Southwest Africa	200,691	280,134	488,422	478,075
Tanganyika	148,169	191,787	195,274	108,625
Union of South Africa:				
Lode	[2] 930,000	964,266	1,516,194	1,967,272
Alluvial	[2,3] 270,000	[3] 289,756	[3] 231,674	[3] 289,063
Brazil [2]	250,000	250,000	200,000	200,000
British Guiana	36,562	34,790	37,462	43,260
Venezuela	75,513	56,362	60,389	63,226
Other countries [2]	3,500	3,000	3,000	3,000
Grand total (round figures)	10,050,000	14,175,000	[4] 15,250,000	16,800,000

[1] Exports.
[2] Estimated.
[3] Includes an estimated 100,000 carats for State mines of Namaqualand.
[4] Revised.

Industrial Diamonds.—Details regarding imports, production, sales, and uses of industrial diamonds will be found in the Abrasive Materials chapter of this volume.

OTHER GEM STONES

The price of most gem stones other than diamonds continued to hold steady owing to a short supply of newly mined stones of fine quality.

Ceylon maintained its output of important quantities of a variety of gems, chiefly ruby, sapphire, chrysoberyl, spinel, garnet, zircon, topaz, and tourmaline. The gems came from the alluvial gravels of the Ratnapura district. The gem mining was done by individuals or small companies, and no official production figures are available.

Australian opal production[12] for 1951 was valued at £65,474, an increase of £9,255 over that produced in 1950. Good-quality material was scarce. The Andamooka and Coober Pedy fields in South Australia were the main producing centers. The Hayricks mine in the Quilpie district was the only one operating in Queensland, and a few men worked intermittently at Lightning Ridge, New South Wales. The value of opal exports in 1951 amounted to £79,972, as compared with £40,040 in 1950. The United States was the largest buyer in both years.

Australian sapphire production[12] during 1951 was valued at £1,135, compared with £3,181 in 1950. Production, which amounted to 63 ounces, was chiefly from the areas of Rubyvale and Sapphire, Queensland. Three cutting plants were operated at the fields, and lapidaries in Brisbane and other cities cut Queensland sapphires for the local market and export. No export statistics are available.

Cultured-pearl production in Japan during 1951 amounted to 3,375 kilograms. Production had risen steadily from none in 1945 to 938 kilograms in 1948 and 2,625 kilograms in 1950. The 1951 export value of cultured pearls was $4,354,000. An interesting change took place in the export market after World War II. In 1938, 40 percent of the cultured-pearl exports went to the United States, while in 1951 the corresponding figure was 61 percent.

Production of emeralds in Colombia was reported by the Ministry of Development to be about 68,000 carats in 1951. This represents only the production of the Government-owned Muzo and Cosquez mines, which had been closed the last quarter of 1949 but were opened again during the latter part of 1951; production was, however, erratic. Production of the privately owned Chivor mine is not known. The Chivor Emerald Mines, Inc., the owner, went into bankruptcy in April 1951. Some production was continued by the workers, but all of the stones went into the black market. Despite this trouble, it was reported that a new vein was found at Chivor, and the emeralds produced were said to be the best quality ever taken from the mine.

Brazil continued to produce a large quantity of amethyst, aquamarine, citrine, topaz, and tourmaline and smaller quantities of chrysoberyl, andalusite, euclase, and other gems.

Gem-stone production in other well-known districts, such as Burma, Thailand, Mozambique, Madagascar, and India, apparently was small, and no official figures are available.

SYNTHETIC GEM STONES

Synthetic Emerald.—This synthetic gem, so far as known, is produced only by the Chatham Research Laboratories in San Francisco, Calif. Production in 1951 averaged 5,000 carats per month in crystals averaging 40 carats each. The total production of 60,000

[12] Australian Bureau of Mineral Resources, Geology and Geophysics, Australian Mineral Industry—1951: 1952, p. 165.

carats for the year was an increase of about 20 percent over 1950. Production was broken down as follows: 50 percent very low grade (opaque) but good color, 40 percent medium grade, and 10 percent fine gem quality. Retail prices of top-quality stones remained about the same at $90 to $120 per carat. Flawless stones over 2 carats in size were not produced.

Corundum and Spinel.—The year 1951 found conditions in the American synthetic gem industry at a very low ebb owing to recovery of the European industry after World War II, chiefly in Germany and France.

It was reported that one shop in the United States continued to cut synthetics on a large scale, by offering well-cut and well-sized stones at higher prices than the European goods but with the added advantage of good deliveries. Most of the material cut from American sources was for educational jewelry (for example, class rings), the most popular style being the buff-top flat back. Ruby-colored corundum predominated, the distribution being 70 percent ruby corundum and 30 percent blue spinel.

The sales of rough synthetic gem stones manufactured in the United States virtually vanished. European manufactured synthetic gem stones—principally from Germany—reached manufacturing jewelers directly rather than through the normal channels of gem-stone dealers. Thus, by obtaining their gem stones directly from Europe the manufacturing jewelers bypassed wholesalers and realized some price advantage.

There was some increase in the use of synthetic star rubies and sapphires in 1951 over 1950. Also, some synthetic stars of European manufacture were seen and at much lower prices than those made in the United States.

Synthetic Rutile (Titania).—During 1951 titania sales increased somewhat, with a greater number of manufacturing jewelers incorporating this stone in their designs. However, there had not been great popular acceptance of this material, and it had not become a serious threat to the diamond trade, as was at first feared by some.

Gem Stones

By George Switzer[1] and Robert D. Thomson[2]

AS in the past, the United States continued to be an unimportant factor in world gem production. A wide variety of gems was produced but in small quantity.

DOMESTIC PRODUCTION

The efforts of thousands of amateur lapidaries, who spend their vacations and weekends searching for gem materials, yield most of the gem materials produced in the United States. The many varieties of quartz, such as agate, jasper, and petrified wood, are the chief materials recovered in this way. The demand for cuttable rough gem stones by these hobbyists also supports a few small gem-mining companies, which operate deposits from time to time, chiefly for turquoise, tourmaline, kunzite, and jade. Since only a small percentage of the total is produced on a commercial scale, no accurate statistics can be compiled on the value of the domestic output of gems; an estimate may approximate $400,000 to $500,000.

The many forms of quartz, chiefly the cryptocrystalline varieties, represented the greatest quantity and value of gem stones produced in 1952. Other gems included were turquoise, topaz, garnet, jade, tourmaline, onyx, chrysocolla, opal, variscite, idocrase, and spinel. Of the producing States, California, Oregon, Texas, Nevada, Washington, Wyoming, and Arizona, in decreasing order, were the leaders.

Agate.—The Marfa-Alpine area in the northern part of Presidio and Brewster Counties, Big Bend area, in Brewster County, and Laredo-Zapata area in Webb and Zapata Counties, Texas, were among the leading producers of agate in 1952, with an estimated output of 50,000 pounds valued at $0.50 to $60.00 per pound and a total value exceeding $35,000.

In Arizona the Saddle Mountain area, covering parts of Maricopa, Pinal, and Graham Counties, reportedly produced 8 to 10 tons of agate valued at $7,000–$8,000, and total production from this State may have been as much as 100 tons.

Production of agate in California in 1952, largely from the Mohave Desert region, had an estimated value of about $100,000.

Over 10 tons of agate valued at $10,500 were reported produced in the Bend area, Deschutes County, Oreg. Production at the Fulton agate beds (formerly the Priday ranch, Jefferson County) was not reported. However, each visitor was charged a fee and was permitted

[1] Smithsonian Institution; consulting mineralogist to the Bureau of Mines.
[2] Commodity-industry analyst, Bureau of Mines.

to gather up to 30 pounds of agate. Hundreds of visitors collected from the Fulton agate beds during the year, and some nodules reportedly sold for as much as several hundred dollars.

The famous moss-agate deposits along the Upper Yellowstone River in Wyoming produced an estimated 6,000 to 8,000 pounds of agate, valued at $1 to $6 per pound and averaging $2.50 per pound, for a total value of about $20,000.

New Mexico production was reported as essentially unchanged from 1951.

Considerable quantities of agate were produced also in Utah, Michigan, Colorado, and Florida, and almost every State yielded small quantities of cuttable forms of chalcedonic quartz.

Information on agates in the Lake Superior area and the history of the use of agates was published in 1952.[3]

Topaz.—The Streeter-Kotempsie area of Mason County, Tex., known to have produced sizable quantities of gem-quality topaz at various times for over 50 years, produced during all of 1952, largely as the result of the efforts of amateur hobbyists or "diggers" whose findings later were sold to amateurs. Both white and blue topaz were found by washing or sifting stream gravels in small creeks. The 1952 production totaled about 10,000 grams, of which approximately 65 percent was white topaz with a commercial value of about $0.35 per gram. Twenty-five percent of the topaz found was blue-white valued at $0.75 per gram, and about 1,000 grams of high-quality blue material was produced, valued at $1.25 per gram. Estimated value of the 1952 production ranged from $5,400 to $25,000.

A small quantity of fine-quality gem topaz was reported from a locality near Boise, Idaho.

Turquoise.—Turquoise production continued essentially unchanged from 1951. Lee F. Hand, operating a lease near Battle Mountain, Nev., produced about $12,000 worth of turquoise. The Miami-Globe district of Gila County, Ariz., reportedly produced about 3,000 pounds valued at $3 to $15 per pound. Arizona turquoise was stated to be soft and of inferior quality, but a method of oiling it was discovered, which greatly improved its color. Some of the old mines in the vicinity of Mineral Park, Mohave County, Ariz., were opened, and about 2,000 pounds of oiling grade (chalk) turquoise was produced, valued at $2.50 to $3.00 per pound.

A small quantity of turquoise was produced near Villa Grove, Saguache County, Colo.

The famous turquoise mine near Cerrillos, Santa Fe County, N. Mex., was described in an article.[4]

Opal.—During 1952 the famous Rainbow Ridge mine of Virgin Valley, Humboldt County, Nev., produced what is perhaps the world's largest precious opal, weighing 6 pounds. This opal was described as being of exceptional quality and beauty and was valued at $50,000. In addition to this unusual find, several additional pounds of opal was produced. Unfortunately, the Virgin Valley opal is not durable, and for this reason it is not used in the jewelry trade.

[3] Vanasse, T. C., Lake Superior Agate: The Sun, Spring Valley, Wis., 2d. ed., 1952, 66 pp.
Pratt, Ethel M., Agate-Gemstone of the Ancients: Mineralogist, vol. 20, No. 11, November 1952, pp. 394, 396.

[4] Foster, E. E., Famous Turquoise Mine: Mineralogist, vol. 20, No. 12, December 1952, pp. 452, 454.

Jade.—There was a great decline in jade mining in Wyoming owing to depletion of the known deposits. The 1952 production was estimated at 3 tons of black jade, a few tons of dark-green and gray jade, and about 300 pounds of good apple-green material. The price ranged from $1 to $2 per pound up to as much as $60 per pound for the best quality.

In California a small quantity of jade, none of fine quality, was produced in Mendocino, Monterey, and San Benito Counties.

Some black jade with green streaks was reported from near Tonopah, Nev.

Other Natural Gem Stones.—Some rock-crystal quartz was produced in California, Arkansas, and Idaho, but very little was of gem quality. A small quantity of star-rose quartz was reported from the Bumpus quarry, Albany, Maine. No rose quartz was produced in South Dakota during 1952.

The Barton Mines Corp., North Creek, N. Y., reported a 1952 production of 76 pounds of gem-quality garnet valued at $132.20.

Tourmaline valued at approximately $2,000 was produced in San Diego County, Calif. Three mines in San Diego County—the Himalaya at Mesa Grande and the Reynolds and Ashley mines at Pala—were operated part time.

About 5 tons of chrysocolla reportedly was produced at the Inspiration mine, Gila County, Ariz. Only a small proportion of this was good cutting-grade material that sold for $5 to $100 per pound.

Three hundred pounds of californite (idocrase) valued at $0.50 per pound was produced at the Happy Camp, Siskiyou County, Calif., locality.

The Onyx ranch, Murray, Salt Lake County, Utah, reported a production of 20 tons of onyx valued at $2,400, all used in the lapidary trade. Near Salida, Chaffee County, Colo., 500 pounds of black onyx valued at $500 was produced.

A small quantity of variscite was mined in Utah.

No sapphire was produced during 1952 from the Yogo Gulch area in Fergus, Judith Basin, and Meagher Counties, Mont., and no diamonds were mined in Arkansas.

Synthetic Gems.—Synthetic emerald was produced only by the Chatham Research Laboratories in San Francisco, Calif. Production in 1952 was about 60,000 carats, of which 50 percent was very low quality, 40 percent medium quality, and 10 percent fine gem quality. Retail prices of fine-quality stones remained at $90 to $120 per carat. Flawless stones of more than 2 carats are not produced.

Diamonds colored by exposure to bombardment of alpha particles in a cyclotron, or to neutron bombardment in an atomic pile to produce green stones, were made before 1952. A quantity of green diamonds produced in this manner appeared on the market in 1952. One dealer reported that he produced and sold about 500 carats of green cyclotron-treated diamonds in 1952, in sizes ranging from ½ carat to 30 carats each.

Literature.—Articles on gem stones appearing in the press in 1952 discussed amber, beryl, meteorites, obsidian, opal, pearl, peridot, sinhalite, thunder eggs, tourmaline, quartz, and gem stones in California, Connecticut, and Maine.[5]

CONSUMPTION AND USES

Total sales of gem stones by retail jewelers rose slightly in 1952 as a result of greater than usual Christmas buying, which partly offset slow sales in the early months of the year. The greatest consumption of gems was for decorative purposes, mainly in jewelry. Bracelets, brooches, hair ornaments, necklaces, and earrings were very popular.

An outstanding use of gem stones during the year was for gem collections. Enthusiasm of collecting gem stones by thousands of amateur gem collectors for hobby collections or commercial use continued to increase. Supply houses, trading posts, and lapidaries required sizable quantities for resale.

A unique use of jade in 1952 was in the construction of a church window in Chicago by J. L. Kraft. About 446 pieces of beautifully cut and polished jade from his private collection were used. Kraft stated, "From the beginning of time, jade has symbolized truth, goodness, and beauty," and estimated the jade and labor would have come to about $1,500,000.[6]

For the third consecutive year a new high record was established, when the value of diamonds sold in 1952 totaled an estimated £72,000,000, an increase of about 6 percent above 1951. Sales effected through the Central Selling Organization on behalf of South African and other producers amounted to £69,662,000, an increase of £4,604,000 over 1951. The remainder was divided principally between Brazil, Venezuela, and British Guiana. As in previous years, the United States was the principal world market for diamonds. There was no significant change in sales volume of diamond jewelry or diamond engagement rings between 1951 and 1952. Jewelers had no difficulty in obtaining enough diamonds, although some reported a short supply of certain sizes and qualities. Diamond engagement rings continued to produce as much revenue for the typical jeweler as all other diamond jewelry combined.

The outstanding feature of diamond sales in 1952 was the strong advance in industrial diamonds. Sales of industrial diamonds

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[5] Blakemore, Jean, Treasure Hunting in Maine—Gems and Minerals: Smiling Cow Shop, Boothbay, Maine, 1st ed., 1952, 118 pp.
California Journal of Mines and Geology, Gem Stones: Vol. 48, No. 1, January 1952, pp. 111–112.
Dake, H. C., California Gem Trails: Mineralogist Pub. Co., Portland, Oreg., 1952, 80 pp.
Claringbull, G. F., and Hey, M. H., Sinhalite ($MgAlBO_4$), a New Mineral: Mineralogist Mag., (London), vol. 24, No. 217, June 1952, pp. 841–849.
Mihelcic, Lillian, Story of Amber: Mineralogist, vol. 20, No. 9, September 1952, pp. 333–334.
Mineralogist, California Obsidian Deposits: Vol. 20, No. 2, February 1952, pp. 85–90.
Nininger, H. H., Out of the Sky: Univ. of Denver Press, Denver, Colo., 1952, 336 pp.
Patchick, P. F., Mineral Collecting at Crestmore, Calif.: Rocks and Minerals, vol. 27, No. 3–4, March–April 1952, pp. 130–135.
Paugh, F. H., A Short Course in Gemology: Jewelers' Circular—Keystone, vol. 122, No. 7, April 1952, pp. 126, 144–148; No. 8, May 1952, pp. 116, 142–146; No. 9, June 1952, pp. 92, 108–109; No. 10, July 1952, pp. 100, 102, 126–127; No. 11, August 1952, pp. 118, 153; and No. 12, September 1952, pp. 122, 161–162; vol. 123, No. 1, October 1952, pp. 132, 148–151; and No. 2, November 1952, pp. 118, 164–168.
Roots, Robert D., Thunder Eggs: Rocks and Minerals, vol. 27, No. 5–6, May–June 1952, pp. 234–236.
Smith, G. F. H., Gem Stones: Methuen & Co., Ltd., London, 12th ed., 1952, 537 pp.
Sohon, J. A., Connecticut Minerals, Their Properties and Occurrence: Connecticut State Geological and Natural History Survey, Bull. 77, 1952, 133 pp.
Walton, James, Physical Gemology: Sir Isaac Pitman & Sons, Ltd., London, 1952, 304 pp.
Wescott, I. P., Some Beryl-Family Gems: Mineralogist, vol. 20, No. 1, January 1952, pp. 3–7.

[6] Time, Jade in Church: Vol. 60, No. 14, Oct. 6, 1952, p. 76.

amounted to £23,892,000, an advance of more than £5,000,000 over 1951. Sales of gem diamonds amounted to £45,770,000 in 1952, about £1,000,000 less than in 1951.

Although the diamond industry was at a high level, diamond cutting was still troubled by shortage of rough material and some unemployment.

The announcement of the date for Queen Elizabeth's coronation had an impact on fashion at all levels. Precious jewelry responded conservatively with revivals of diamond-set crown brooches, small baskets of jeweled flowers, increased demand for amethyst (the royal purple) and the Tudor rose as a motif. Tiaras and crownlike ornaments of all kinds were heavily promoted.

In engagement rings, there was a revival of the use of cushion-cut diamonds mounted in platinum. In lower priced engagement rings baguette solitaires were used set with an extension rim to increase their apparent size. Eighty percent of diamond engagement rings sold were set with center stones of 55 points or less, and the price reported by the typical dealer for engagement rings sold in 1952 was $167, exclusive of Federal tax.

The so-called "baroque" jewelry, made by tumbling rough fragments of various gem stones to polish them while maintaining their irregular shape, continued to grow in popularity.

Conditions in the American synthetic corundum and spinel industry continued at low ebb as a result of recovery of the European industry. Sales of synthetic corundum boules manufactured in the United States were very small. There was some sale of synthetic star sapphires and rubies made in the United States, but even this market was impaired by imports of less expensive synthetic star stones made in Europe.

Sales of synthetic rutile remained essentially unchanged. There was no popular acceptance of this material, and it was not a serious threat to the diamond trade.

FOREIGN TRADE [7]

Imports of gem stones, exclusive of industrial diamonds, in 1952 totaled $124,807,761, compared with $128,953,866 in 1951, a decrease of 3 percent (table 1).

Imports of gem-quality diamonds into the United States in 1952 totaled $103,972,623, compared with $110,169,603 in 1951. A distribution of these figures into rough or uncut and cut but unset for the past 2 years is shown in table 2.

TECHNOLOGY

The expanding need for industrial diamonds and the present outlook for only a limited increasein production stimulated a great interest in the synthesis of diamonds. Several research programs concerned with this problem were underway, but no successful synthesis so far had been announced. A more than usual number of dubious claims were publicized, the one receiving the most press

[7] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 1.—Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1951–52

[U. S. Department of Commerce]

Commodity	1951		1952	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty-free	[1] 654, 235	[1] $48,256,746	725, 422	$52, 300, 980
Cut but unset, suitable for jewelry, dutiable	[1] 480, 602	[1] 61, 912, 857	438, 546	51, 671, 643
Emeralds:				
Rough or uncut, duty-free	2, 706	2, 698	8, 790	22, 213
Cut but not set, dutiable	20, 148	264, 527	11, 162	449, 726
Pearls and parts, not strung or set, dutiable:				
Natural		449, 379		465, 165
Cultured or cultivated		2, 747, 653		3, 373, 383
Other precious and semiprecious stones:				
Rough or uncut, duty-free		160, 609		226, 632
Cut but not set, dutiable		2, 686, 137		2, 125, 456
Imitation, except opaque, dutiable:				
Not cut or faceted		87, 162		97, 602
Cut or faceted:				
Synthetic		888, 629		536, 659
Other		[1] 11, 378, 844		13, 412, 914
Imitation, opaque, including imitation pearls, dutiable		26, 394		39, 142
Marcasites, dutiable:				
Real		88, 395		75, 285
Imitation		3, 836		11, 061
Total		[1] 128,953,866		124, 807, 761

[1] Revised figure.

notices being that of Herman Meincke and associates working under the auspices of the German Economic Ministry. The method of production, when carried out under the eyes of Government investigators, produced no diamonds.

Methods for producing synthetic sapphires, rubies, and emeralds were described, and distinguishing facts were emphasized.[8] The thermal conductivity of synthetic sapphire was investigated and found at 100° C. to be about 0.07 calorie per second per centimeter per ° C.[9]

Experiments reportedly showed that no gem, either natural or synthetic, has more dispersion or fire than synthetic rutile.[10]

Procedures used in cutting a rough diamond into a finished gem and the stages of development of the brilliant cut since the 15th century were described during the year.[11] Details of the index of refraction, angle of total reflection, and inclination of main facets for diamond, zircon, corundum, topaz, and quartz were compiled in 1952.[12]

Various standard sizes and shapes for cabochons and methods of drilling holes in cabochons using hollow tubes and silicon carbide and diamond abrasives were described.[13]

[8] Webster, R., Synthetic Gem Stones: Gemologist, vol. 21, No. 249, 1952, pp. 66–70.
[9] Weeks, J. L., and Seifert, R. L., Thermal Conductivity of Synthetic Sapphire: Jour. Am. Ceram. Soc., vol. 35, No. 1, January 1952, p. 15.
[10] Field, D. S. M., Synthetic Rutile: Mineralogist, vol. 20, No. 10, October 1952, p. 378, 380.
[11] Jewelers' Circular—Keystone, How a Diamond Is Cut: Vol. 123, No. 2, November 1952, pp. 112, 114. Dake, H. C., Development of the Brilliant Cut: Mineralogist, vol. 20, No. 10, October 1952, pp. 373–374, 376.
[12] Dake, H. C., Some Facet Cuts: Mineralogist, vol. 20, No. 11, November, 1952 pp. 421–422.
[13] Sinkankas, John, The Size and Shape of Cabochons: Rocks and Minerals, vol. 27, No. 5–6, May-June 1952, pp. 264–269.
Dake, H. C., Drilling Cabochons: Mineralogist, vol. 20, No. 1, January 1952, pp. 42, 44.

TABLE 2.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1951–52, by countries

[U. S. Department of Commerce

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1951 [1]						
Australia	765	$97,086	$126.91	12	$1,200	$100.00
Belgian Congo	2,645	215,173	81.35			
Belgium-Luxembourg	4,582	409,071	89.28	[2] 251,703	[2] 31,331,704	[2] 124.48
Brazil	[2] 6,827	[2] 497,726	[2] 72.91	452	79,078	174.95
British Guiana	1,563	55,513	35.52	6	646	107.67
British Malaya				161	26,700	165.84
Canada	[2] 1,371	[2] 154,728	[2] 112.86	7	1,751	250.14
Ceylon				9	121	13.44
Czechoslovakia				10	1,150	115.00
Denmark				17	2,348	138.12
France	286	13,990	48.92	3,208	425,507	132.64
Germany				9,691	789,720	81.49
India				2	260	130.00
Iran				30	3,600	120.00
Israel and Palestine	207	1,656	8.00	104,194	[2] 9,169,614	[2] 88.01
Italy				62	12,372	199.55
Japan				50	5,670	113.40
Kuwait				1	800	800.00
Liberia	180	10,000	55.56			
Mexico				6	1,871	311.83
Netherlands	19,329	1,481,908	76.67	35,940	4,398,388	122.38
Switzerland	[2] 62,328	[2] 5,325,332	[2] 85.44	7,229	1,259,918	174.29
Union of South Africa	[2] 58,541	[2] 1,810,483	[2] 30.93	[2] 64,691	[2] 13,863,070	[2] 214.30
United Kingdom	[2] 470,698	[2] 37,461,206	[2] 79.60	3,120	536,944	172.10
Uruguay				1	425	425.00
Venezuela	[2] 25,013	[2] 722,874	[2] 28.90			
Total 1951	[2] 654,235	[2] 48,256,746	[2] 73.76	[2] 490,602	[2] 61,912,857	[2] 128.82
1952						
Australia				142	41,882	294.94
Belgium-Luxembourg	4,852	430,417	88.71	186,682	22,956,814	122.97
Bermuda	9,545	300,102	31.44			
Bolivia	71	2,119	29.85			
Brazil	9,719	479,114	49.30	2,056	242,763	118.08
British Guiana	1,061	53,855	50.76	22	3,349	152.23
British Malaya	1,723	115,367	66.96			
Canada	3,847	383,463	99.68	169	36,694	217.12
Denmark				15	2,528	168.53
France	50,490	1,075,560	21.30	784	321,310	409.83
French Equatorial Africa	13,976	396,924	28.40			
French Morocco				6	602	100.33
India				2,821	25,539	9.05
Indonesia				14	2,532	180.86
Israel and Palestine	1	47	47.00	128,206	10,017,374	78.13
Italy	359	60,808	169.38	187	29,641	158.51
Japan				5	1,250	250.00
Lebanon				7	1,573	224.71
Mexico				111	13,143	118.41
Netherlands	2,271	219,467	96.64	33,636	4,246,138	126.24
Portuguese Asia, n. e. s.				1,021	7,476	7.32
Surinam	135	8,999	66.66			
Switzerland	103,447	7,050,320	68.15	3,319	582,130	175.39
Thailand	1,338	153,564	114.77	968	134,883	139.34
Union of South Africa	53,593	1,300,987	24.28	54,011	10,737,727	198.81
United Kingdom	442,068	39,418,835	89.17	6,706	902,044	134.51
Venezuela	26,926	851,032	31.61			
West Germany				17,658	1,364,251	77.26
Total 1952	725,422	52,300,980	72.10	438,546	51,671,643	117.82

[1] Changes in Minerals Yearbook 1951 are as follows: Bahrein and Southern British Africa revised to none.
[2] Revised figure.

Information on different abrasives and wheels used in polishing gem stones by lapidaries was given in an article.[14] A very high polish can be obtained on an onyx by using oxalic acid and tin oxide.[15]

A book on gem cutting was published in 1952.[16]

WORLD REVIEW

A new record was set for world production of diamonds in 1952, with a total of 18,694,000 metric carats, compared with 16,917,000 in 1951. Details are given in table 3. Belgian Congo was again the leading producer by weight, but 95 percent of the Belgian Congo production was industrial quality. South Africa, although producing less by weight, led in value owing to a higher percentage of gem stones.

Angola.—A comprehensive report on the diamond industry in Angola was published in 1952. Geology, tenor, character of the diamonds, reserves, production from 1916 to 1950, and other detailed information, were discussed.[17]

TABLE 3.—World production of diamonds, 1949–52, by countries, in metric carats

[Including industrial diamonds]

Country	1949	1950	1951	1952
Africa:				
Angola	769,981	538,867	[1] 734,324	743,302
Belgian Congo	9,649,896	10,147,471	10,564,667	11,608,763
French Equatorial Africa	122,928	111,407	[2] 136,000	163,400
French West Africa	94,996	126,346	101,000	136,080
Gold Coast	[3] 972,976	[2] 950,000	[1] 1,752,878	2,189,657
Sierra Leone	494,119	655,474	475,759	451,426
Southwest Africa	280,134	488,422	478,075	541,027
Tanganyika	191,787	[1] 164,996	108,625	143,023
Union of South Africa:				
Lode	964,266	1,516,194	1,967,272	2,093,138
Alluvial	[4] 289,756	[4] 231,674	[4] 289,063	[4] 282,681
Brazil [2]	250,000	200,000	200,000	200,000
British Guiana	34,790	37,462	43,260	38,305
Venezuela	56,362	60,389	63,226	98,291
Other countries [2]	3,000	3,000	3,000	5,000
Total	14,175,000	15,232,000	16,917,000	18,694,000

[1] Revised.
[2] Estimate.
[3] Exports.
[4] Includes an estimated 100,000 carats for State Mines of Namaqualand.

Australia.—Australian opal production continued to diminish. The Lightning Ridge and White Cliffs fields were shut down, and only the Andamooka and Coober Pedy areas were supplying any opal. The number of miners working these deposits becomes smaller each year.

Some Australian sapphires were produced during the year, but they were not of fine quality and did not compete well with Ceylon stones in the world market.

Belgian Congo.—In addition to the productive area around Bakwanga and Tskikapa, Kasai Province, diamonds are known to occur in Katanga Province and along the Lomami, Ituri, Ubangi, and Uele

[14] Mineralogist, Lapidary Hints: Vol. 20, No. 6-8, June-August 1952, pp. 277-278.
[15] Mineralogist, Polishing Onyx: Vol. 20, No. 9, September 1952, p. 330.
[16] Willems, J. D., Gem Cutting: Chas. A. Bennett Co., Inc., Peoria, Ill., 1952, 224 pp.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 4, April 1952, pp. 32-46.

Rivers, but these localities are regarded to have no economic importance.[18] In Kivu Province, some small concentrations of rubies, white zircons, sapphires, and pink and green tourmalines are known to have been found. Garnets occur around Boma, in the Leopoldville Province, and in the District du Kibali-Ituri. Amethyst is known to occur in the Bas Congo of Leopoldville Province and in Kasai and Kivu Provinces. Agate has been found at Tshala on the Bushimaie River, and often in the alluvials along the rivers of Kasai, Kwango, and Moyen-Congo.[19]

Data on diamond production in the Belgian Congo by individual companies in 1951 was published during the year.[20]

Brazil.—Brazil continued to produce a large caratage of amethyst, aquamarine, citrine, topaz, and tourmaline, and smaller quantities of chrysoberyl, andalusite, euclase, and other gems.

Canada.—Properties and localities of gem stones, such as zircon, cat's-eye, tremolite, and scapolite, were discussed in an article.[21]

Gem-quality serpentine occurs at Kilmar, Quebec, associated with magnesite. The material ranges in color from dark green through pea green to citron yellow. Some of the stones have been made into ornamental objects, such as book ends.[22]

Ceylon.—Ceylon continued to be the principal world producer of ruby, sapphire, chrysoberyl, spinel, and zircon, and produced lesser quantities of garnet, topaz, and tourmaline. The gems came from the alluvial gravels of the Ratnapura district. Mining was done mostly by individuals, and no official production figures were available.[23]

Colombia.—Operations at the famous Chivor emerald mine, owned by Chivor Emerald Mines, Inc., were suspended. The Government-owned Muzo and Cosquez mines produced some emeralds, but output was erratic.[24]

French Equatorial Africa.—According to reports of Grivar Exploration Development Corp., the United States and France agreed to develop jointly a new diamond mine in this country. The mine is near the Ubangi River, about 220 miles southeast of Berberati.[25]

Madagascar.—Garnet was produced by Syndicat Minier Carlo Borsa near the village of Miary.[26] A small quantity of opaque black tourmaline for industrial uses was produced on the island.

Portuguese West Africa.—Harry Winston, Inc., a New York diamond dealer, was reported to have negotiated for distributor's rights for rough diamonds from Portuguese West Africa. The diamonds are mined by Angola Diamond Co.[27]

Tanganyika.—It was announced in 1952 that the diamond production from the Williamson mine at Mwadui, Shinyanga, would be sold

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[18] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 5, November 1952, p. 48.
[19] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 5, November 1952, p. 50.
[20] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 5, November 1952, pp. 31–37.
[21] Field, D. S. M., Miscellaneous Gem Stones in Canada: Canadian Min. Jour., vol. 73, No. 5, May 1952, pp. 78–80.
Field, D. S. M., More Canadian Gem Stones: Canadian Min. Jour., vol. 73, No. 11, November 1952, pp. 86–88.
[22] Canadian Mining Journal, vol. 73, No. 11, November 1952, p. 87.
[23] Seymour, John, Gem Mining in Ceylon: Mine and Quarry Eng. (London), vol. 18, No. 11, November 1952, p. 349.
[24] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 1, July 1952, p. 35. Mining World, vol. 14, No. 2, February 1952, p. 62.
[25] Mining World, vol. 14, No. 1, January 1952, p. 70.
[26] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 3, September 1952, p. 40.
[27] Mining World, vol. 14, No. 10, October 1952, p. 75.

on the open market. John T. Williamson stated he refused to agree to new terms to sell the diamonds through the Diamond Trading Corp. controlled by DeBeers diamond interests. Production from this mine has averaged about $8,400,000 per year.[28]

Venezuela.—The Minister of Mines and Hydrocarbons of Venezuela announced that the Government would grant a concession to the Compania Venezolana de Diamantes to exploit diamonds at Perantepuy. These deposits are in the southeastern part of the State of Bolivar near the Brazilian border.[29]

[28] Mining World, vol. 14, No. 2, February 1952, p. 56.
[29] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 5, October 1952, p. 29. Foreign Commerce Weekly, vol. 47, No. 12, June 23, 1952, p. 30.

Gem Stones

By Robert D. Thomson,[1] George Switzer,[2] and Eleanor V. Blankenbaker[3]

AS IN past years, gem production in the United States resulted largely from the efforts of amateur lapidaries who spent their leisure time searching for cuttable material. The many varieties of quartz, such as agate, jasper, and petrified wood, were the chief materials recovered in this way.

A few small gem-mining companies operated deposits chiefly for turquois, opal, tourmaline, and jade. Because only a small percentage of the total was produced on a commercial scale, precise statistics on the value of the domestic output of gems cannot be compiled. The value was estimated at $500,000 to $600,000.

The popularity of gem cutting as a hobby has increased tremendously in the past 10 years. An editor of one of the leading magazines in this field estimated that there were perhaps 50,000 home gem-cutting shops, and the total value of gems produced was millions of dollars. Almost all such production remained in private collections without passing through trade channels.

DOMESTIC PRODUCTION

In the following section the principal gems produced domestically in 1953 and areas for which information was obtained are given in detail. Materials produced in small quantities and their sources are listed in table 1.

Agate.—There was no significant change in agate production in the United States in 1953 compared with 1952.

In Oregon an estimated 15 tons of agate was recovered, with a total value of about $12,000. The Fulton agate beds, Jefferson County, reportedly produced about 7 tons valued at $1,000 per ton. An area in Crook County northeast of Prineville, reportedly yielded 11,500 pounds of agate valued at 10 cents per pound, while 2,000 pounds was reported found in the Crooked River area.

Production of agate in Montana was reported to have been about 2,000 tons; from the quantity worked stones valued at perhaps $15,000 were cut.

In Texas the Marfa-Alpine area in Presidio and Brewster Counties and the Big Bend area in Brewster County were the chief sources, with a reported production valued at about $8,000.

[1] Commodity-industry analyst.
[2] Smithsonian Institution; consulting mineralogist to the Bureau of Mines.
[3] Statistical clerk.

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1953

State, county, and locality	Gem material
Alabama: Jackson County: Bridgeport	Chalcedony.
Alaska:	
Homer	Black petrified wood.
Jade Mountain, north of Kobuk River	Jade (nephrite).
Sequoia (southeast Alaska)	Petrified wood.
Arizona:	
Apache County: Apache Indian Reservation	Obsidian and peridot.
Cochise County: Mule Mountain	Agate and amethyst.
Gila County:	
Globe-Miami area	Azurite, chrysocolla, epidote, garnet, obsidian, opal, amethyst, carnelian, bloodstone, agate, agatized wood, crocidolite, serpentine, turquois, and peridot.
Rice	Peridot.
Roosevelt Dam	Amethyst.
Graham County:	
Ash Spring Canyon, San Francisco River	Petrified wood, banded agate (blue and green), and obsidian.
Moonshine Canyon, San Francisco River	Opal, opalized wood, onyx, and chalcedony.
Potter Canyon, San Francisco River	Turquois, azurite, malachite, agate, and opalized wood.
Greenlee County:	
Clifton	Agate.
Coronado Trail, Metcalf	Turquois, malachite, azurite, variscite, chalcedony, amethyst, garnet, agate (blue banded), and chrysocolla.
Granville	Onyx.
Guthrie, York, and Sheldon	Chalcedony, turquois, azurite, opal, onyx, petrified and opalized wood, agate (black banded, orchid), quartz (rose and white).
Morenci	Turquois and agate.
Maricopa County:	
Bronco Canyon	Agate and jasper.
Cavecreek	Onyx, agate, petrified wood.
Fish Creek	Agate.
Gila Bend Mountains	Chalcedony.
Lake Pleasant—Slow Springs	Agate.
New River	Agate, opal, and jasper.
Phoenix	Amethyst and agate.
Saddle and Fourth of July Mountains	Agate and chalcedony.
Seven Springs	Jasper.
Wickenburg	Agate.
Wintersburg	Do.
Navajo County:	
Holbrook	Agatized wood.
Navajo Indian Reservation	Garnet.
Pinal County: Perlite	Obsidian.
Yavapai County:	
Bradshaw Range	Agate.
Castle Hot Springs	Do.
Limestone Canyon—	
Cottonwood Springs	Agate (purple banded); petrified, opalized, and agatized wood; chalcedony; limonite; jasper (red and green); carnelian; and moonstone.
Rock Springs	Agate.
Yuma County:	
Bouse	Jasper and agate.
Castle Dome district	Agate, jasper, opal, and petrified wood.
Arkansas:	
Garland County	Rock quartz.
Hot Spring County: Magnet	Smoky quartz.
Montgomery County	Rock quartz.
California:	
Alameda County: Berkeley Hill	Agate.
Calaveras County	Chrysoprase.
Del Norte County: Crescent City	Agate, jasper, and petrified wood.
El Dorado County: Placerville	Petrified and opalized wood, jasper, and agate.
Fresno County: Coalinga district	Jasper, chert, and petrified wood.
Humboldt County: Eel River and Van Duzen River.	Jasper and jade.
Imperial County:	
Black Mesa	Petrified wood and dumortierite.
Picacho district	Agate.
Winterhaven	Agate and fossil wood.
Inyo County:	
Bishop area	Garnet, epidote, clear and smoky quartz crystal, obsidian, petrified wood, agate, and jasper.
Owl Springs	Agate.

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1953—Continued

State, county, and locality	Gem material
California—Continued	
Kern County:	
Horse Canyon	Agate and jade.
Rosamond	Rhodonite.
Mendocino County: Northern part	Jade, jasper, opal, and quartz.
Monterey County:	
Monterey Coast	Agate, nephrite, and jadeite.
Monterey	Jade, rhodonite, jasper, and agate.
Plumas County	Rose quartz.
Riverside County:	
Banning	Corundum.
Beaumont	Garnet, epidote, and tourmaline.
Cabazon	Chalcedony and agate.
Hemet	Rose quartz, tourmaline, topaz, and beryl.
Juniper Flats (between Lakeview and Hemet).	Aquamarine.
Near Wiley Well	Agate.
Nuevo	Asteriated rose quartz.
Thomas Mountain (between Hemet and Palm Springs).	Rose quartz and amazonstone.
San Benito County: Dallas gem mine	Benitoite, nephrite, and jadeite.
San Bernardino County:	
Mojave and Needles district	Jasper, agate, and bloodstone.
Yucaipa and Mentone district	Rhodonite.
San Diego County:	
George Ashley mine, Pala	Kunzite, beryl, tourmaline, and quartz.
Himalaya and Herriot Mines	Tourmaline, beryl, topaz, and quartz.
Mesa Grande district	Tourmaline.
Pala	Kunzite.
Ramona	Tourmaline and garnet.
Rincon	Tourmaline and kunzite.
San Diego	Do.
San Luis Obispo County:	
Cayucos	Quartz.
Morro Bay	Jasper and jade.
Nipomo area	Agate, jasper, and moss agate.
Northern part of county	Jasper.
Shell Beach	Onyx (travertine).
Santa Clara County: Morgan Hill and Stone Canyon.	Jasper.
Siskiyou County: Happy Camp district	Nephrite, jade, and idocrase.
Trinity County	Agate, jasper, and rhodonite
Colorado:	
Chaffee County:	
Brown Canyon	Petrified wood and agate.
Salida	Jasper.
Delta County: Roubideau Canyon	Do.
Elbert County: Bijou Basin (near Elbert)	Opalized wood.
El Paso County:	
Cheyenne Canon	Garnet and tourmaline.
Colorado Springs	Topaz.
Tarryall Mountains	Do.
Fremont County:	
Canon City	Agate.
Garden Park	Do.
Larimer County:	
Red Feather Lakes	Amethyst.
Wellington	Amazonstone.
Mesa County:	
Fruita	Agate.
Unaweep Canyon	Amethyst.
Whitewater	Flint and petrified wood.
Montrose County: Crystal	Amazonstone, phenacite, smoky quartz, and topaz.
Saguache County:	
Poncho Pass	Agate.
Villa Grove	Turquois.
Teller County:	
Clyde	Topaz.
Cripple Creek	Zircon.
Divide	Amethyst.
Florissant	Petrified wood.
Pike's Peak	Agate.
Florida: Hillsborough County: Tampa Bay (Ballast Point).	Agatized coral.
Georgia:	
Cobb County: Kennesaw Mountain (near Marietta).	Topaz.
Morgan County: Buckland	Amethyst.
Paulding County: Dallas	Garnet.
Rabun County: Clayton area	Ruby, garnet, amethyst, and smoky quartz

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1953—Continued

State, county, and locality	Gem material
Georgia—Continued	
Troup County: La Grange	Rose quartz, aquamarine, and amethyst.
Wilkes County: Graves Mountain (11 miles from Washington).	Rutile, kyanite, and lazulite.
Idaho:	
Benewah County: Emerald and Ruby Creeks	Star garnet.
Blaine County: Muldoon location	Agate and petrified wood.
Butte County: Craters of the Moon	Do.
Canyon County: Caldwell	Agate and agatized wood.
Lemhi County: Salmon	Opalized wood.
Nez Perce County: Lewiston	Opal, star garnet, petrified wood, agate, jasper, and sapphire.
Owyhee County: Bruneau Dester location	Petrified wood, jasper, opalized wood, and agate.
Indiana: Elkhart County: Goshen	Agate and jasper.
Iowa:	
Lee County: Fort Madison	Jasper.
Page County: Clarinda	Agate.
Kansas:	
Franklin County: Ottawa	Petrified wood.
Wallace County: Wallace	Opal.
Louisiana:	
Ouachita County: West Monroe	Agate, jasper, and petrified wood.
Vernon County: Leesville	Petrified wood.
Maine: Androscoggin County: Minot	Garnet.
Maryland:	
Baltimore County:	
Baltimore Harbor	Flint.
Butler	Garnet.
Dyer Quarry	Serpentine.
Calvert County: Calvert Cliffs	Jasper.
Carroll County: New Windsor	Azurite and malachite.
Cecil County: State Line Chrome Pits	Serpentine.
Frederick County: Libertytown	Malachite.
Harford County: Cardiff	Serpentine.
Washington County: Camp Ritchie	Cuprite.
Michigan:	
Emmet County: Petoskey	Fossil coral ("Petoskey stone").
Keweenaw County:	
Ahmeek	Agate and thomsonite.
Delaware mines	Chlorastrolite.
Isle Royale beaches	Agate and thomsonite.
Minnesota:	
Carlton County: Moose Lake	Agate and jasper.
Cook County:	
North shore of Lake Superior	Thomsonite and agate.
Tom Lake	Do.
Lake County: Grand Marais	Do.
Mississippi:	
Harrison County: Biloxi	Jasper.
Wayne County: Waynesboro	Petrified wood.
Missouri: Cape Girardeau County: Ozark Mountains (west of Cape Girardeau).	Agate and jasper.
Montana:	
Custer County: Miles City	Agate and sapphire.
Fergus County: Lewistown	Sapphire.
Granite County:	
Anaconda and Meyers Gulches	Do.
West fork of Rock Creek	Do.
Lewis and Clark County: Helena	Sapphire, garnet, ruby, and spinel.
Madison County	Tourmaline.
Missoula County: Lola Creek district	Smoky and colorless quartz.
Park County to Dawson County: Yellowstone River.	Agate.
Powell County: Dry Cottonwood Creek Gulch	Sapphire.
Prairie County: Terry	Agate and petrified wood.
Silver Bow County: Butte	Sapphire.
Yellowstone County: Billings	Moss agate.
Nebraska:	
Jefferson County:	
Fairbury	Jasper, agate, and petrified wood.
Steele City	Do.
Sioux County: Orella	Agate, chalcedony, and petrified wood.
Nevada:	
Clark County: Las Vegas Wash	Amethyst.
Douglas County	Topaz.
Humboldt County: Virgin Valley, Thousand Creek.	Opal and rhodonite.
Lander County: Battle Mountain area	Turquois.

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1953—Continued

State, county, and locality	Gem material
Nevada—Continued	
Lincoln County:	
Acoma district	Chalcedony.
Bristol silver-mining district	Chrysocolla and malachite.
Hiko district	Jasper.
Washoe County: Sparks	Petrified wood, agate, jasper, idocrase, garnet, and obsidian.
New Hampshire:	
Cheshire County:	
Alstead	Aquamarine.
Marlow	Green tourmaline.
Surry	Amethyst.
Walpole	Blue tourmaline.
Westmoreland	Amethyst.
Coos County	
Milan	Topaz.
Stark	Amethyst and smoky quartz.
Grafton County: Plymouth	Aquamarine.
Rockingham County: Raymond (Chandler feldspar mine).	Spodumene.
Sullivan County: Tempster	Aquamarine.
New Jersey:	
Morris County: Stirling	Carnelian.
Passaic County: New Street quarry in Paterson.	Prehnite.
Sussex County: Franklin	Friedelite.
New Mexico:	
Luna County: Deming	Agate.
Santa Fe County: Santa Fe	Beryl.
New York:	
Erie County: Buffalo	Satin-spar (calcite)
Orange County: Forest of Dean magnetite mine.	Sunstone.
North Carolina:	
Ashe County	Garnet, moonstone, rutile, aquamarine, and golden beryl.
Avery County: Cranberry	Unakite.
Macon County: Caler Fork of Cowee Creek	Corundum.
Orange County: Hillsboro	Moss agate.
North Dakota: McLean County: Coleharbor	Petrified wood.
Oklahoma:	
Canadian County: El Reno	Jasper, petrified wood, and agate.
Comanche County: Zircon mine, Wichita Mountain.	Zircon.
Dewey County: Taloga	Jasper, petrified wood, and agate.
Greer County: Mangum	Alabaste.
Jackson County: Altus	Smoky quartz.
Ottawa County: Miami-Oklahoma district	Sphalerite.
Pushmataha County: Antlers	Green quartz.
Oregon:	
Baker County: Greenhorn	Agatized fern.
Crook County:	
Carey Ranch	Agate.
Crooked River country	Moss agate.
Eagle Rock	Agate.
Ochoco Mountains, Lucky Strike bed	Moss agate and carnelian.
Powell Butte	Agate.
Prineville	Do.
View Point beds	Do.
Curry County: Brookings	Jade.
Deschutes County	Moss agate and carnelian.
Harney County:	
Glass Butte obsidian field	Obsidian.
Steens Mountains	Agate.
Jackson County: Medford	Agate, jasper, and petrified wood.
Jefferson County:	
Fulton agate beds	Agate.
Madras	Amethyst.
Pony Butte-Friday Ranch	Agate.
Lane County: Bear Creek	Do.
Malheur County: Sucker Creek	Agate, jasper, and petrified wood.
Polk County: Dallas	Jasper, agate, and petrified wood.
Union and Wallowa Counties: Wallowa Mountains.	Agate.
Wheeler County: Fossil district	Do.
Pennsylvania:	
Adams County: Greenstone	Cuprite.
Lancaster County: Woods mine	Serpentine.

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1953—Continued

State, county, and locality	Gem material
South Carolina:	
Anderson County: Pelzer	Tourmaline.
Chesterfield County: Chesterfield (Old Brewer gold mine).	Topaz.
Florence County: High Hill Creek	Petrified wood.
South Dakota:	
Custer County:	
Black Hills and Bad Lands	Rose quartz, star beryl, jasper, jade, chert, and agate.
Custer	Beryl, rose and star quartz, and agate.
Pennington County: Keystone	Beryl, rose and star quartz, and tourmaline.
Tennessee: Carter County: Roan Mountain	Unakite.
Texas:	
Brewster County:	
Alpine	Agate.
Rio Grande River and Big Bend area	Agate and jasper.
DeWitt County	Agate, agatized and opalized wood, and jasper.
Duval County	Do.
Fayette County: Muldoon	Opalized and petrified wood.
Gonzales County:	
Gonzales	Do.
Nixon	Do.
Hidalgo County: Mission	Agate.
Lee County: Giddings	Opalized and petrified wood.
Llano County: Llano	Amethyst, garnet, smoky quartz, quartz, and black tourmaline.
Mason County: Streeter	Topaz.
Potter County: Amarillo	Petrified wood.
Presidio County: Marfa	Agate and jasper.
Trinity County: Trinity	Opalized and petrified wood.
Walker County: Huntsville	Do.
Webb County: Laredo	Agate.
Zapata County: Zapata and Falcon Dam on Rio Grande River.	Do.
Utah:	
Box Elder County: Lucin	Variscite.
Garfield County: Escalante	Agate, dinosaur bone, and petrified wood.
Kane County: Orderville	Agate.
Millard County: Black Rock	Obsidian.
Salt Lake County: Murray	Onyx.
Sevier County: Salina	Agate.
Tooele County: Dugway Pass	Quartz.
Washington County: Hurricane	Agate.
Wayne County:	
Hanksville	Agate and petrified wood.
Torrey	Petrified wood, dinosaur bone, jasper, and agate.
Vermont: Windsor County: Chester	Pyrite.
Virginia: Rockbridge County: Vesuvius	Unakite.
Washington:	
Cowlitz County: Kalama	Carnelian and sardonyx.
Kittitas County:	
Cle Elum	Agate.
Ellensburg	Do.
Horse Canyon	Chalcedony.
Lewis County:	
Chehalis	Carnelian and sardonyx.
Toledo	Do.
Yakima County: Toppenish	Do.
Wisconsin:	
Ashland County: Chippewa River	Jasper.
Clark County: Owen	Agate and jasper.
Wyoming:	
Carbon County: Kortes Dam	Jade (nephrite).
Fremont County:	
"Cottonwood-Haypress" and Warm Springs	Do.
Dubois	Agate.
Lander	Jade (nephrite) and agate.
North side Beaver Divide and Green Mountains.	Jade (nephrite), iris agate, moss agate, jasper, agatized wood, sapphire, garnet, aventurine, hematite, and serpentine.
Sweetwater County:	
Agate fields	Agate.
Eden Valley	Petrified wood.
Between Liman and Little America	Agate.

Agate valued at $2,200 was found in San Bernardino County, Calif., principally in the Mojave Desert region. The value of gem stones from other areas in California, as shown in table 1, is not known.

The total production of agate in Arizona was reported to be 12 tons, valued at about $12,000. The principal localities were the Saddle Mountain area, in Maricopa, Pinal, and Graham Counties, in the Bradshaw Range east of Wickenburg, Maricopa County, and near Holbrook, Navajo County, from areas just outside the Petrified Forest National Monument.

The agate fields near Deming, Luna County, N. Mex., reportedly yielded about 50 tons of material (value not reported). Production from the Salida and Pike's Peak area, Chaffee County, Colo., was valued at $2,000. In Florida production of agatized coral from Tampa, Hillsborough County, was reported as 1,000 pounds, valued at $3,000.

The Iris and Fairburn agate were described in 1953.[4]

Jade.—The decline in jade mining in Wyoming, noted in the past several years, continued in 1953 owing to depletion of known deposits. There was virtually no production of good-quality material worth $30 to $100 per pound. Production was reported as follows: Apple green, 100 pounds at $30 per pound; black, olive, etc., 2,000 pounds at $1 per pound; snowflake, 1,500 pounds at $2 per pound.

A jade boulder (possibly idocrase) weighing 1,350 pounds was found in Shasta County, Calif., and it was estimated that after cutting it may be worth about $25,000.[5] A small quantity of jade, none of fine quality, was produced in Mendocino, Monterey, and San Benito Counties, Calif.

The Empire Jade Co. and the Shungnak Jade Products Co. produced a small quantity of nephrite jade from the Shungnak district, Northwestern Alaska region, in 1953. By careful selection and cutting gem-quality jade was obtained and made into jewelry. Scraps from the cutting and inferior-quality grade, unsuitable for cutting, were cut into blocks and sold to tourists as souvenirs.

Three articles were published in 1953 on jade.[6]

Opal.—The opal mines in Virgin Valley, Humboldt County, Nev., produced opal valued at approximately $60,000.

Topaz.—Topaz continued to be produced from the Streeter-Kotempsie area of Mason County, Tex. Both white and blue topaz were found by amateur gem collectors by washing and sifting stream gravels in the area. The 1953 production was reported as 10,000 grams, with an estimated value ranging from $4,000 to $10,000.

Tourmaline.—Operations in the famous gem-producing area of Mesa Grande, San Diego County, Calif., produced more tourmaline than in the past several years. Production from the Himalaya mine, operated by R. R. Potter, was reported as 168 pounds, valued at $6,000. Morganite (pink beryl) also was produced, at a value of $3,000.

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[4] Jones, F. T., The Iris Agate Described: Mineralogist, vol. 21, No. 1, January 1953, pp. 3-10.
Putnam, G. G., Fairburn Agate: Mineral Notes and News, No. 187, April 1953, pp. 8, 43.

[5] California Mining Journal, vol, 23, No. 2, October 1953, p. 30.

[6] Webster, Robert, Jade and Jadelike Minerals :Mineralogist, vol. 21, No. 12, December 1953, pp. 435-438.
Long, F. W., Some Alaska Jade Trails: Mineralogist, vol. 21, Nos. 6-7-8, June-August 1953, pp. 243-249, 258, 260, 262, 264, 266, 268, 270.
Halphern, J. M., Arctic Jade: Rocks and Minerals, vol. 28, No. 5-6, May-June 1953, pp. 237-242.

Turquois.—Principal production of turquois during 1953 was from mines in the vicinity of Battle Mountain, Humboldt County, Nev. The Royal Blue Mines Co., operated by Lee F. Hand of Battle Mountain, reported producing turquois valued at more than $110,000. About 2,000 pounds of good grade turquois and 3,000 pounds of lighter colored material was produced in Arizona from the Miami-Globe district, Gila County. A small quantity of fine-quality turquois was produced from Villagrove Turquoise Lode, near Villagrove, Saguache County, Colo.

SYNTHETIC GEMS

Synthetic star sapphire and ruby gem stones were produced in Europe and the United States in 1953. Production by domestic industry declined sharply in 1953 compared with 1952 because of increased imports of foreign synthetic stones, which were sold at lower prices than similar stones produced in the United States. Linde Air Products Co., Division of Union Carbide & Carbon Corp., a producer of synthetic star stones, petitioned the United States Tariff Commission to ban imports on these products originating in Europe.[7]

Synthetic emerald was produced only by the Chatham Research Laboratories in San Francisco, Calif. Production in 1953 was essentially the same as in 1952—about 60,000 carats, of which 50 percent was low-quality, 40 percent medium-quality, and 10 percent fine gem quality.

A small production of titania (synthetic rutile) was reported by two United States manufacturers.

The cultured-pearl industry in Japan, which had nearly regained its prewar status, was set back by a typhoon which destroyed much of the crop that was to have been harvested in late 1953. In some areas losses as high as 60 percent of the crop were reported. The damage was expected to cause a 20-percent rise in cultured-pearl prices. Major purchasers of cultured pearls urged the Japanese Government to establish marketing quotas to prevent flooding of the market with inferior quality material.

CONSUMPTION

Total sales of diamonds and other gem stones by retail jewelers in the United States declined slightly in 1953 compared with 1952. Total sales of diamonds, including both gem and industrial, by the Central Selling Organization on behalf of all major producers amounted to $176,500,000 compared with $201,600,000 in 1952. Sales of gem diamonds by the Diamond Trading Co. during 1953 were $121,-341,000, a small decrease compared with 1952.

Large quantities of semiprecious gem stones were collected in the United States by gem-stone enthusiasts. The stones were cut and polished in home lapidary shops for handmade jewelry or private collections or by commercial lapidary shops. Activity in this field has been increasing through the efforts of several technical journals and local gem societies.

[7] Chemical and Engineering News, vol. 31, No. 35, Aug. 31, 1953, pp. 3552–3553.

FOREIGN TRADE [8]

Imports of gem stones into the United States increased 4 percent in 1953 compared with 1952 (table 2). Diamonds ranked first, with 83 percent of the imports, based on value, followed by imitation stones (synthetic and other), 12 percent; and pearls (natural and cultured), 3 percent, as shown in table 2.

TABLE 2.—Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1952–53

[U. S. Department of Commerce]

Commodity	1952 Carats	1952 Value	1953 Carats	1953 Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty-free	[1] 709,043	[1] $52,192,621	733,630	$57,010,629
Cut but unset, suitable for jewelry, dutiable	438,546	51,671,643	444,247	50,549,942
Emeralds:				
Rough or uncut, duty-free	8,790	22,213	15,561	27,987
Cut but not set, dutiable	11,162	449,726	26,952	320,739
Pearls and parts, not strung or set, dutiable:				
Natural		465,165		264,873
Cultured or cultivated		3,373,383		3,769,758
Other precious and semiprecious stones:				
Rough or uncut, duty-free		226,632		203,667
Cut but not set, dutiable		2,125,456		2,218,868
Imitation, except opaque, dutiable:				
Not cut or faceted		97,502		40,720
Cut or faceted:				
Synthetic		[1] 536,047		677,029
Other		[1] 13,413,526		14,872,795
Imitation, opaque, including imitation pearls, dutiable		39,142		127,641
Marcasites, dutiable:				
Real		75,285		94,813
Imitation		11,061		2,589
Total		[1] 124,699,402		130,182,050

[1] Revised figure.

TABLE 3.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1952–53, by countries

[U. S. Department of Commerce]

C untry	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1952						
Australia				142	$41,882	$294.94
Belgium-Luxembourg	4,852	$430,417	$88.71	186,682	22,956,814	122.97
Bermuda	9,545	300,102	31.44			
Bolivia	71	2,119	29.85			
Brazil	9,719	479,114	49.30	2,056	242,763	118.08
British Guiana	1,061	53,855	50.76	22	3,349	152.23
British Malaya	1,723	115,367	66.96			
Canada	3,847	383,463	99.68	169	36,694	217.12
Denmark				15	2,528	168.53
France	50,490	1,075,560	21.30	784	321,310	409.83
French Equatorial Africa	13,976	396,924	28.40			
French Morocco				6	602	100.33
Germany, West				17,658	1,364,251	77.26
India				2,821	25,539	9.05
Indonesia				14	2,532	180.86

[8] Figures on imports and exports compiled by Mae. B. Price and Elise D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 3.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1952–53, by countries—Continued

[U. S. Department of Commerce]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
Israel and Palestine	1	$47	$47.00	128,206	$10,017,374	$78.13
Italy	359	60,808	169.38	187	29,641	158.51
Japan				5	1,250	250.00
Lebanon				7	1,573	224.71
Mexico				111	13,143	118.41
Netherlands	2,271	219,467	96.64	33,636	4,246,138	126.24
Portuguese Asia, n. e. s				1,021	7,476	7.32
Surinam	135	8,999	66.66			
Switzerland	[1] 94,052	[1] 6,997,845	[1] 74.40	3,319	582,130	175.39
Thailand	1,338	153,564	114.77	968	134,883	139.34
Union of South Africa	[1] 48,515	[1] 1,276,049	[1] 26.30	54,011	10,737,727	198.81
United Kingdom	[1] 440,162	[1] 39,387,869	[1] 89.48	6,706	902,044	134.51
Venezuela	26,926	851,032	31.61			
Total 1952	[1] 709,043	[1] 52,192,621	[1] 73.61	438,546	51,671,643	117.82
1953						
Argentina				18	4,263	236.83
Australia				3	1,771	590.33
Belgian Congo				300	63,603	212.01
Belgium-Luxembourg	19,116	1,818,663	95.14	215,438	25,554,634	118.62
Bermuda	8,985	502,677	55.95			
Brazil	398	99,448	249.87	34	8,722	256.53
British Guiana	2,307	83,958	36.39	30	2,847	94.90
British Malaya	560	65,162	116.36			
British West Africa	121	726	6.00			
Canada	4,744	448,338	94.51	95	88,241	928.85
Dominican Republic				1	235	235.00
France	11,631	280,922	24.15	1,098	170,306	155.11
French Equatorial Africa	39,963	940,002	23.52			
Germany, West	167	1,667	9.98	22,196	1,633,341	73.59
Gold Coast	450	4,219	9.38			
Hong Kong				1	93	93.00
India				2,974	52,853	17.77
Israel and Palestine				122,218	10,276,874	84.09
Italy				48	30,647	638.48
Japan				55	4,919	89.44
Mexico				165	10,239	62.05
Netherlands	4,171	374,437	89.77	29,365	3,491,370	118.90
Switzerland	7,820	841,026	107.55	493	171,765	348.41
Union of South Africa	56,592	2,336,405	41.29	46,441	8,455,833	182.08
United Kingdom	524,826	47,625,107	90.74	3,271	526,641	161.00
Venezuela	51,779	1,587,872	30.67	3	745	248.33
Total 1953	733,630	57,010,629	77.71	444,247	50,549,942	113.79

[1] Revised figure.

TECHNOLOGY

Descriptions of lapidary equipment, the general principles of construction, and applications of the various cabochon and facet machines were described in magazine articles to guide amateur lapidaries.[9]

The merits of cutting certain gem stones by the freeform method were emphasized.[10]

The procedure for cutting and grading diamonds involves intricate steps and requires skills developed through years of painstaking work.

[9] Morrow, I. L., Gem-Cutting Equipment to Make in the School Shop: Industrial Arts and Vocational Education, vol. 42, October 1953, pp. 285–286.
Sinkankas, John, Lapidary Machinery, part I—Cabochon Machinery: Rocks and Minerals, vol. 28, No. 1–2, January-February 1953, pp. 44–48; part II—Faceting Machinery, No. 3–4, March–April 1953, pp. 147–153.
Walker, D. B., A Horizontal Lap Wheel: Mineralogist, vol. 21, No. 10, October 1953, pp. 373–374, 376, 378.
[10] Sanger, Lucille, Cutting the Freeform: Rocks and Minerals, vol. 28, No. 9–10, September-October 1953, pp. 493–494.

The history of diamond polishing and present-day methods for cutting and polishing diamonds for market were described.[11]

On the basis of end use diamonds are classified as (1) gem and (2) industrial. Diamonds of good color and perfection are used for gem purposes, and the remainder are used in industry because of their hardness.[12] Studies were conducted to determine, by microscopic techniques, the growth features of diamonds, phenomena produced by etching, limitations of polishing, and the rate of abrasive resistance.[13]

Further work was done on coloring diamonds by irradiation in a cyclotron or nuclear reactor. Green was the main color obtained, but brown and other colors also were obtained. Formation of blue diamonds from yellow by exposure to high-energy electrons was described.[14]

Investigations of natural and synthetic emerald showed that synthetic stones had a greater transparency to short-wave ultraviolet light. Results of the experiments present a possible method for distinguishing natural from synthetic emerald.[15]

The history of gem-stone synthesis and methods used for producing synthetic sapphire, ruby, and emerald were discussed.[16]

Tumbling gems for polishing rough gem materials has been known for more than 100 years, but just recently the technique has become popular with amateur lapidaries. Mechanics and use of a tumbling barrel were described.[17]

A discussion to aid the layman, to clarify the meaning of brilliance and fire and the factors that influence each, was published in 1953.[18]

Patents were issued on methods for growing synthetic corundum and spinel gems on a seed [19] and for growing synthetic rutile.[20]

Absorption spectra of pink and green tourmaline were measured by a Hilger-medium quartz spectograph. Absorption curves showed that color was unaffected by heating at less than 800° C., and between 800°–1,000° C. the pink crystals were decolorized, with loss in weight and partial destruction of the lattice. Green tourmaline turned

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[11] Industrial Diamond Review, Early Diamond Polishing in London: Vol. 13, No. 149, April 1953, p. 80.
Grodzinski, P., The History of Diamond Polishing: Industrial Diamond Rev., vol. 13, No. 147, suppl. 1, February 1953, pp. 1–13. Diamond Technology; Production Methods for Diamond and Gem Stones: N. A. G. Press, Ltd., London, 2d rev., 1953, 784 pp.
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[12] Kraus, E. H., Classification and Description of Varieties of Diamond: Ind. Diamond Rev., vol. 13, No. 149, April 1953, p. 86.

[13] Tolansky, S., The Surfaces of Diamonds: Ind. Diamond Rev., vol. 13, No. 157, December 1953, pp. 271–276.

[14] Custers, J. F. H., Artificial Coloration of Diamonds: Optima, vol. 3, 1953, pp. 8–12.

[15] Anderson, R. W., A New Test for Synthetic Emerald: Gemmologist (London), vol. 22, No. 264, July, 1953, pp. 115–117.

[16] Davids, E. B. and Tindula, R. W., Synthetic Gemstones: Off. Tech. Services, Tech. Div. Rept. IR–11392, May 1953, 7 pp.
Frondel, C., Commercial Synthesis of Star Sapphires and Star Rubies: Econ. Geol., vol. 48, No. 4, June–July 1953, p. 325.
Kaspar, J., Synthetic Corundum, part II: Ind. Diamond Rev., vol. 13, No. 149, April 1953, pp. 81–84. Synthetic Corundum, part III: Ind. Diamond Rev., vol. 13, No. 150, May 1953, pp. 102–104.
Miles, Joel, Man-Made Gem Stones: Mineralogist, vol. 21, No. 9, September 1953, pp. 325–326, 328, 330, 332.
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Weyl, W. A., Synthetic Minerals: Econ. Geol., vol. 48, No. 4, June–July 1953, pp. 288–305.

[17] Leeson, Bert, The Tumbling Barrel, How Does It Work: Min. Notes and News, No. 187, April 1953, pp. 9, 52.
Mitchell, R. C., How to Tumble Gems: Lapidary Jour., vol. 6, No. 6, February 1953, pp. 442–446.

[18] Pough, F. H., Brilliance and Fire as Gemstone Properties, part I: Jewelers' Circ.–Keystone, vol. 123, No. 11, August 1953, pp. 140, 187–190; part II, No. 12, September 1953, pp. 112, 136–138, 140.

[19] Barnes, M. H. (assigned to Union Carbide & Carbon Corp.), Synthetic Gem Production: U. S. Patent 2,634,554, Apr. 14, 1953.

[20] Eversole, W. G. and Drost, Wilfred (assigned to Union Carbide & Carbon Corp.), Synthetic Rutile and Method of Making: U. S. Patent 2,610,129, Sept. 9, 1952.

386902—56——32

brownish at lower temperatures. Results of experiments to determine the relationship between color and either lattice structure or chemical composition were reported.[21]

A polariscope consisting of a cylindrical shell with polaroid plates can be used to determine whether a gem is singly or doubly refractive. Details were given for building a handmade instrument.[22]

Certain gem stones, when exposed to ultraviolet rays, will glow or luminesce. Selected gem stones were subjected to ultraviolet and X-ray radiation and their reactions were recorded.[23]

A historical survey of the spectroscope and its application in gemmology was published in a technical journal.[24]

WORLD REVIEW

Production of diamonds (including industrial diamonds) in 1953 increased 7 percent compared with 1952, as shown in table 4. Belgian Congo ranked first, with 63 percent, principally industrial diamonds, and Union of South Africa second, with 13 percent, mainly gem-quality diamonds. A detailed review of the world diamond industry in 1952 was published in 1953.[25]

Australia.—The value of opal production in 1953 was $174,000—an increase of $31,000 over the 1952 figure and the highest annual value recorded since 1907. The increase was probably due to a rise in average quality rather than to the quantity of material produced. Most of the opal produced in 1953 was from the Coober Pedy and Andamooka fields in South Australia.[26]

A book describing the Lightning Ridge opal area was published in 1953.[27]

The Anakie field in Central Queensland is the only Australian producer of sapphires. Production has been declining in recent years. Production for 1953 was valued at $1,617. A geological report on the Anakie field published during the year stated that 21 men were engaged in mining sapphires in April 1953.[28]

Belgian Congo.—The most important diamond fields are in the Kasai, Bushimae, and Kundelungu districts. Some sporadic deposits occur in Aruwimi, Izuri, and Itimbiri districts.[29] Tshikapa is considered the focal point for the diamond industry in Belgian Congo and was described in an article.[30]

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[21] Bradley, J. E. S., and Bradley, Olive, The Coloring of Pink- and Green-Zoned Tourmaline: Mineral. Mag. (London), vol. 30, No. 220, March 1953, pp. 26–32.

[22] Gems and Minerals, How to Make a Polariscope: No. 194, November 1953, pp. 10–12.

[23] Gemmologist (London), Luminescence in the Service of Gemmology: Vol. 22, No. 260, March 1953, pp. 46–49; No. 261, April 1953, pp. 74–76.

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Anderson, B. W., Crossed Filters for the Study of Fluorescence: Gemmologist (London), vol. 22, No. 260, March 1953, pp. 39–46.

[24] Anderson, B. W., The Spectroscope and Its Applications to Gemmology: Gemmologist (London), vol. 22, No. 266, September 1953, pp. 153–158; No. 267, October 1953, pp. 173–176; No. 268, November 1953, pp. 198–201; No. 269, December 1953, pp. 218–222.

[25] Foshag, W. F. and Switzer, George, Diamond Industry, 1952: Jewelers' Circ.-Keystone, vol. 123, No. 10, July 1953, pp. 98–100, 108–110, 142–144; No. 11, August 1953, pp. 142, 144, 238, 240, 243, 245; No. 12, September 1953, pp. 108, 110, 153.

[26] J. A. Dunn, chief mineral economist, Bureau of Mineral Resources, Department of National Development, Commonwealth of Australia, letter to Bureau of Mines.

[27] Idriess, I. L., Lightning Ridge, the Land of Black Opals: Anglobooks, New York, N. Y., 1953, 238 pp.

[28] Queensland Government Mining Journal (Australia), vol. 54, No. 622, August 1953, pp. 570–571.

[29] Fieremans, C. [Geology and Geochemistry of the Diamond Fields of Belgian Congo]: Tech. Wetensch. Tijdschr, vol. 22, 1953, pp. 71–82.

[30] Gemmologist (London), Diamond City of the Congo: Vol. 22, No. 267, October 1953, pp. 182–187; No. 268, November 1953, pp. 202–207.

TABLE 4.—World production of diamonds, 1950–53, by countries, in metric carats

(Including industrial diamonds)

	1950	1951	1952	1953
Africa:				
Angola	538,867	734,324	743,302	729,377
Belgian Congo	10,147,471	10,564,667	11,608,763	12,580,256
French Equatorial Africa	111,407	136,000	163,400	140,144
French West Africa	126,346	101,000	136,080	180,000
Gold Coast	[1] 950,000	1,752,878	2,189,557	2,167,364
Sierra Leone	655,474	475,759	451,426	472,934
South-West Africa	488,422	478,075	541,027	617,411
Tanganyika	164,996	108,625	143,023	170,679
Union of South Africa:				
Lode	1,516,194	1,967,272	2,093,138	[2] 2,397,755
Alluvial	[3] 231,674	[3] 289,063	[3] 282,681	[4] 300,000
Brazil [1]	200,000	200,000	200,000	200,000
British Guiana	37,462	43,260	38,305	36,306
Venezuela	60,389	63,226	98,291	84,790
Other countries	3,000	3,000	5,000	5,000
Grand total	15,232,000	16,917,000	18,694,000	20,081,000

[1] Estimate.
[2] Pipe mines under De Beers control.
[3] Includes an estimated 100,000 carats for State mines of Namaqualand.
[4] Includes: (1) Approximately 117,000 carats for pipe mines outside De Beers control and (2) an estimated 100,000 carats for State mines of Namaqualand.

British Guiana.—The Government increased its royalty on diamonds in 1953 to $0.50 per carat.

There were several independent diamond buyers and cutters in Georgetown, but the domestic diamond market was controlled by a local syndicate, comprised of Krakowsky & Correia Co. and Morabisi Mining Co. There was considerable prospecting in the Kurupung area and Anaborong River area, as well as in the vicinity of Kurashi Creek, a tributary of the Cuyuni River.[31] The Kurupung Placers Co. early in the year finished prospecting in the Kurupung area and found that the deposits were not large enough for commercial exploitation. The company began investigation in the Eping Basin.[32]

Burma.—A book on the geology and gem stones of the Mogok Stone Tract was published.[33]

Canada.—Several large diamonds were found along the banks of the Rainy River near Fort Francis, Ontario, and prospectors were lured to the area in expectation of finding more.[34]

A supplementary list of gem materials found in Canada was compiled.[35]

Ceylon.—Corundum gems produced in Ceylon include ruby and white and yellow sapphire; gem-quality alexandrite, amethyst, aquamarine, garnet, spinel, and zircon also are produced.[36] Production in 1953 was estimated to be worth $420,000.

Colombia.—The Government-owned Muzo and Cosquez emerald mines were opened in 1953 on a full-time production basis after 4 years of sporadic production. The principal reason for production

[31] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, p. 33.
[32] Mining Journal (London), vol. 241, No. 6172, December 1953, p. 656.
[33] Iyer, L. A. N., The Geology and Gem Stones of the Mogok Stone Tract, Burma: Mem. Geol. Survey India, vol. 82, 1953, 100 pp.
[34] California Mining Journal, Diamond Discovery in Canada Starts Prospecting: Vol. 22, No. 11, July 1953, p. 28.
[35] Field, D. S. M., List of Canadian Gems and Ornamental Minerals: Canadian Min. Jour., vol. 74, No. 4, April 1953, pp. 82–83.
[36] Parkinson Kenneth, Ceylon; the Island of Gems: Gemmologist (London), vol. 22, No. 258, January 1953, pp. 5–7.

being suspended was the guerilla activities in the area. With the change of government in July, the new administration was able to renew production.

French Equatorial Africa.—It was reported in 1953 that the Government expected to double its diamond production within the next 4 years. It was planned to increase output gradually until it reaches 400,000 carats per year.[37]

India.—New gem-quality emerald occurrences were reported near Rajnagar near Deogarh in Kishangarh and in southwest Jaipur. The important deposits in Rajasthan are at Kalaguman. The emeralds are marketed at auctions held periodically under supervision of the Rajasthan State authorities at Jaipur.[38]

As a result of a field examination in 1953, it was reported that profitable production could be increased from the diamond deposits in the Panna area, Vindhya Pradesh. It was recommended that accurate quantitative information be obtained regarding the extent and location of the reserves and that investment of greater capital in mining and milling equipment be considered in an effort to increase the production.[39]

Japan.—Most of Japan's cultured-pearl fisheries are along the coast of the Ku Peninsula. The industry is based on the fact that a grain of sand put into the oyster irritates it and causes the particle to be coated with a secretion, which in 7 to 8 years will harden and form a gem pearl. Artificially cultivated pearls can be marketed at a much lower price than those that occur naturally. Japan is the most important producer of cultured pearls.[40]

Union of South Africa.—De Beers Consolidated Mines recently divided the Diamond Corp. into two companies by forming a new company called De Beers Investment Trust, Ltd. Diamond Corp. will confine its activities to the diamond trade, and the new company will handle the financial affairs of Diamond Corp.

Descriptions of diamond mining and recovery at Kimberley [41] and of the early diamond industry [42] were published.

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[37] Mining World, vol. 15, No. 10, September 1953, p. 75.

[38] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, pp. 36–37.

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[39] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, pp. 33–36.

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[40] Messmer, Jacqueline, S–H–H Pearls: Deco Trefoil, vol. 17, No. 3, May-June 1953.

[41] Daniel, R., Diamond-Mining Practice in Kimberley, South Africa: Bull. Inst. Min. Met., vol. 62, 1953, pp. 201–228.

[42] Kisch, T. B., South Africa's First Diamonds: Gemmologist (London), vol. 22, No. 258, January 1953, pp. 9–13.

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Gem Stones

By John D. McLenegan,[1] George Switzer,[2] and Eleanor V. Blankenbaker[3]

GEM-STONE production in the United States in 1954 continued to depend upon the efforts of amateur collectors to provide cuttable material. A few small companies operated deposits, chiefly for turquois, opal, tourmaline, and jade.

Because only a small percentage was mined on a commercial scale, complete statistics were not compiled on the value of the domestic output of gem stones. The value of the crude uncut stone was estimated at $600,000 to $700,000.

The many forms of quartz, such as agate, jasper, and petrified wood, composed the largest output, with kunzite second, jade third, and turquois fourth. California, Texas, Oregon, Washington, and Wyoming were the chief producing States.

The gem-stone collecting and cutting hobby continued to increase in 1954, particularly in central and eastern United States. An increased number of amateur rock collectors was in the field in the Western States; however, many focused their attention on uranium prospecting instead of the collection of gem stones.

DOMESTIC PRODUCTION

The reported sources of gem materials in the United States in 1954 are listed in table 1. The principal gem-stone production, in areas where more detailed information was obtained, is given as follows:

Agate.—Production of agate in Montana increased in 1954. Of the reported $20,000 production, about half was scenic and banded agate from the Yellowstone River. The remainder was moss agate and lower grade banded material.

The value of Oregon agate produced in 1954 approximated $12,000. Plume thunder-egg agate from 20 miles north of Madras, Oreg., ranged in price from $0.50 to $10 per square inch of slab material.

Agate production valued at $5,000 was reported from the Alpine area of Brewster County, Tex., in 1954. The total agate production in the State was considered to be greater in 1954 than in any previous year.

Gravels in Imperial County, Calif., produced several varieties of agate. The value of this material, combined with that from the Hauser geode beds in the northern part of the county, was about $5,000 in 1954. Riverside County production was reported to be approximately 1 ton of rough agate valued at $400.

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[1] Commodity-industry analyst.
[2] Smithsonian Institution; consulting mineralogist to the Bureau of Mines.
[3] Literature-research clerk.

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1954

State	County	Locality	Gem material
Alaska	1st Judicial division	Baranof (southeast Alaska)	Petrified wood and agate.
Do	4th Judicial division	Circle	Jade.
Do	2d Judicial division	Kobuk River on the north	Do.
Do	do	Noatak River	Jasper.
Arizona	Apache		Petrified wood.
Do	do	Fort Defiance	Pyrope garnet.
Do	Gila		Obsidian.
Do	do	Globe (Salt River Canyon)	Serpentine.
Do	do	Globe-Miami area	Chalcedony, turquois, garnet, amethyst, agate, and apache tears (volcanic glass).
Do	do	Miami	Turquois.
Do	do	San Carlos Reservation	Peridot.
Do	Greenlee		Obsidian.
Do	do	Morenci	Shattuckite and turquois.
Do	Maricopa	Cave Creek	Plume agate and jasper.
Do	do	Four Peak Mountain	Amethyst.
Do	do	New River	Plume agate.
Do	do	Saddle Mountain	Fire agate.
Do	Maricopa and Yavapai.	Agua Fria River	Jasper.
Do	Maricopa and Yuma	Gila River	Agate.
Do	Pima	Ajo	Shattuckite.
Do	Pinal	Florence	Chalcedony.
Do	do	Superior	Obsidian.
Do	Yavapai	Mayer	Calcite onyx.
Do	Yuma		Dumortierite and shattuckite.
Do	do	Yuma	Garnet, petrified wood, jasper, agate, chalcedony (desert roses) and turquois.
Arkansas	Garland	Hot Springs	Quartz crystal and novaculite.
Do	Montgomery		Quartz crystal.
California	Alameda	Berkeley hills	Agate.
Do	Alpine	Markleeville	Do.
Do	Calaveras	Valley Springs	Chalcedony.
Do	El Dorado	Placerville	Idocrase, vesuvianite, and garnet.
Do	Humboldt	Along ocean	Agate, petrified wood, jasper, and jade.
Do	Imperial	Midway Well	Opal.
Do	do	Ogilby	Petrified palm root.
Do	do	Picacho Peak	Agate.
Do	do	Salton Sea area	Desert roses.
Do	Inyo	Bigpine	Quartz crystal.
Do	do	Bishop	Garnet.
Do	do	Death Valley (Wingate Pass).	Agate.
Do	do	Independence	Turquois.
Do	Kern	Boron	Agatized wood.
Do	do	Mojave	Petrified palm and agate.
Do	do	Rosamond	Rhodonite.
Do	Los Angeles	Los Angeles	Agate.
Do	do	Newhall	Do.
Do	do	Randsburg area	Agate and rhodonite.
Do	do	Rosemead (Gem Hill)	Do.
Do	Marin	Bolinas Bay	Agatized whalebone.
Do	Mendocino	Covelo	Jade.
Do	do	Eel River (Round Valley)	Jasper and jade.
Do	Monterey	Monterey	Jade (nephrite), serpentine, and rhodonite.
Do	Nevada	Nevada City	Opalized wood.
Do	do	North Bloomfield	Opal.
Do	Riverside	Coon Hollow (Wiley Well)	Agate.
Do	do	Hemet	Agate and jasper.
Do	do	Midland	Rhodonite crystals and spinel.
Do	do	Sage	Rubellite.
Do	Sacramento	Folsom	Opal and agate.
Do	do	Sacramento	Jade (nephrite).
Do	San Benito		Benitoite crystals.
Do	do	New Idria	Jadeite.
Do	San Bernardino	Needles	Agatized wood.
Do	do	San Bernardino	Rhodonite.
Do	do	Yermo (Calico Mountains or Mule Canyon).	Agatized palm.
Do	San Diego	Himalaya mine (Mesa Grande).	Tourmaline.
Do	do	Pala	Kunzite, spodumene, tourmaline and lepidolite.
Do	San Luis Obispo	Nipomo	Sagenite and agate.
Do	Siskiyou	Happy Camp	Jade (nephrite) and californite.
Do	Solano	Fairfield	Travertine onyx.

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1954—Continued

State	County	Locality	Gem material
California	Trinity	Trinity River	Jade.
Do	Tulare	Porterville	Jade and chrysoprase.
Colorado	Fremont	Canon City	Agate and onyx.
Do	Mineral		Jasper and petrified wood.
Do	Rio Grande		Agate and petrified wood.
Do	Saguache	Villa Grove-Turquoise mine.	Turquois and lazulite.
Do	Teller	Florissant	Jade.
Do	Weld	Stoneham	Petrified wood, barite crystals, and agate.
Connecticut	Middlesex	Gillette Quarry (Haddam Neck).	Tourmaline.
Florida	Hillsborough	Tampa Bay (Ballast Point).	Agatized coral.
Do	Pinellas	St. Petersburg	Agatized ancient shark bone.
Georgia	Troup	La Grange	Aquamarine.
Idaho	Benewah	Emerald Creek	Garnet.
Do	Owyhee	Homedale	Agate and jasper.
Illinois	Hancock	Hamilton	Geodes.
Do	do	Nauvoo	Do.
Iowa	De Moines	Burlington	Do.
Do	Fremont		Fossils.
Do	Henry	New Lincoln	Agate, jasper, and petrified wood.
Do	Lee	Keokuk	Geodes.
Do	Page	Clarinda	Agate.
Kansas	Cherokee	Galena	Marcasite and sphalerite.
Do	Wyandotte	Kansas City	Agate.
Louisiana	Vernon (Parish)	Hornbeck	Opalized and petrified wood.
Maine	Androscoggin	Livermore	Cinnamon garnet.
Do	Oxford	Albany	Rose quartz.
Do	do	Kezar Lake	Amethyst.
Do	do	Newry	Rose quartz.
Do	do	Norway	Tourmaline.
Do	do	Stoneham	Smoky quartz.
Do	do	Stow	Amethyst.
Maryland	Allegany	Frostburg	Siderite and barite crystals.
Do	Baltimore	Powder Mill Conversion Tunnel (Baltimore City).	Quartz, garnet, tourmaline, and serpentine.
Do	do	Texas	Calcite crystals.
Do	do	White Marsh	Jasper and quartz.
Do	Garrett	State Line	Williamsite, rhodochrome, picrolite, and serpentine.
Do	Montgomery	Chain Bridge vicinity	Placer gold.
Michigan	Emmet	Petoskey	Agate, devonion fossils, and Petoskey stones (coral fossils).
Do	Houghton	Houghton	Agate.
Do	Keweenaw	Ahmeek	Domeykite (metal with quartz).
Do	do	Eagle Harbor	Agate, datolite, and thomsonite.
Do	do	Five Mile Point to Keweenaw.	Agate, thomsonite, and chlorastrolites.
Do	do	Mohawk	Domeykite (metal with quartz)
Do	Marquette	Ishpeming	Jasper and jaspilite.
Do	do	Marquette	Jasper.
Do	do	Negaunee	Do.
Do	do	Republic	Jasper and jaspilite.
Do	Ontonagon	Mass	Datolite, malachite, and tenorite
Do	do	Silver City	Agate.
Minnesota	Cook	North shore of Lake Superior.	Thomsonite.
Do	do	Paradise Beach	Agate.
Do	Lake	Beaver Bay	Agate and thomsonite.
Do	St. Louis	Duluth	Agate.
Missouri	Bollinger		Agate and jasper.
Do	Cape Girardeau		Do.
Do	Clark	Wayland	Geodes.
Do	Crawford	Cherry Valley mine (near Steelville).	Amethyst.
Do	Franklin	Ruepple mine (near Stanton).	Do.
Do	Jackson		Do.
Do	Lewis	La Grange	Agate.
Do	Madison		Agate and jasper.
Do	St. Louis	St. Louis	Geodes, agate, barite, and galena.
Do	Wayne		Agate and jasper.
Montana	Beaverhead		Quartz.
Do	do	Camp Creek	Corundum.
Do	Custer	Miles City	Agate.
Do	Dawson	Glendive	Do.
Do	Deer Lodge	Oro Fino-Dry Cottonwood district.	Sapphire.
Do	Gallatin	Boseman	Corundum.

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1954—Continued

State	County	Locality	Gem material
Montana	Granite	Phillipsburg	Sapphire.
Do	do	Rock Creek	Do.
Do	Jefferson	Bernice	Barite.
Do	do	Boulder Basin district	Tourmaline.
Do	do	Toll Mountain, R. S.	Amethyst.
Do	Judith Basin	Yogo Gulch	Sapphire.
Do	Lewis and Clark	Helena	Do.
Do	Madison	Cliff Lake	Serpentine.
Do	do	Ennis	Garnet.
Do	do	Granite Creek	Pegmatite.
Do	do	Mill Canyon	Tourmaline.
Do	do	Renova	Orthoclase crystal.
Do	do	Rochester	Quartz crystal.
Do	do	Sheridan	Pegmatite.
Do	do	Silver Star	Jasper.
Do	do	South Boulder Creek	Quartz.
Do	do	Sweetwater Creek	"Montana onyx."
Do	do	Virginia City	Garnet.
Do	Park	Carbella	Petrified wood, amethyst, and fairy stones.
Do	do	Clyde Park	Iceland spar.
Do	do	Gardiner	Petrified wood and travertine
Do	do	Jardine	Arsenopyrite.
Do	do	Livingston	Petrified wood.
Do	do	Springdale	Iceland spar.
Do	do	Yellowstone Valley	Garnets.
Do	Powell	Elliston	Agate.
Do	do	Lost Creek Falls	Amazonstone.
Do	Prairie	Fallon	Agate.
Do	Ravalli	Rye Creek	Fluorite.
Do	Rosebud	Forsyth west to Sidney	Agate.
Do	Silver Bow	Browns Gulch	Sapphire.
Do	do	Butte	Amethyst.
Do	do	Highlands	Epidote and garnet.
Do	do	Nissler	Fluorite.
Do	Yellowstone	Billings	Agate.
Do	do	Custer	Agate and jasper.
Nebraska	Sioux	Orella	Chert.
Nevada	Humboldt	Rainbow Ridge mine (Virgin Valley).	Opal and rhodonite.
Do	Lander	Battle Mountain	Turquois.
Do	Lincoln	Fish Lake Valley	Agatized wood.
Do	White Pine	Ely	Garnet.
New Hampshire	Carroll	Conway	Topaz, smoky quartz, and amethyst crystals.
Do	do	Passaconaway	Topaz and smoky quartz.
Do	Coos	Stark	Smoky quartz and amethyst.
New Jersey	Morris	Montville	Serpentine.
Do	do	Stirling	Carnelian.
Do	Passaic	Paterson	Prehnite.
Do	do	Prospect Park	Prehnite, agate, and amethyst.
Do	Sussex	Franklin	Willemite, garnet, rhodonite, and friedelite.
Do	do	Sparta	Ruby corundum.
New Mexico	Luna	Deming	Agate.
Do	Rio Arriba	La Madera	Dumortierite, pink and green feldspar, and blue-green beryl.
Do	Sierra	Elephant Butte Lake	Petrified wood.
Do	do	Engle	Petrified wood and agate.
New York	Warren	Barton mine (North River)	Garnet.
Do	do	North Creek	Do.
North Carolina	Alexander		Hiddenite.
Do	Avery	Cranberry Iron mine	Epidote.
Do	Buncombe	Goldsmith mine (Democrat)	Moonstone.
Do	Burke		Amethyst.
Do	Haywood	Emerald mine (Crabtree Mountain).	Emerald.
Do	Macon	Corundum Hill	Ruby and sapphire.
Do	Mitchell	Geo. Howell mine	Oligoclase.
Do	do	McKinney mine	"Moonglo" and "sunstone."
Do	do	Roan Mountain	Moonstone, epidote, and unakite.
Do	Rutherford		Emerald.
Do	Warren		Amethyst.
Do	Yancey	Little Gibbs mine	Oligoclase.
Do	do	Ray mine	Emerald.
North Dakota	Adams		Agatized wood.
Oklahoma	Dewey	Seiling	Jasper, agatized wood, jasp-agate, agate, denderite, chalcedony, and jadite.
Do	do	Taloga	Do.
Do	Major	Fairview	Do.

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1954—Continued

State	County	Locality	Gem material
Oregon	Baker	Greenhorn	Tempskya (agatized fern).
Do	do	Huntington	Agate and jasper.
Do	Coos	Bandon	Fossil wood.
Do	Crook	Eagle Rock bed	Agate.
Do	do	Lucky Strike bed	Moss agate.
Do	do	Ochoco bed	Agate.
Do	do	Post	Do.
Do	Deschutes	Hampton	Jasp-agate.
Do	do	Terrebonne	Thunder eggs and agate.
Do	Douglas	Sutherlin	Agate.
Do	do	Yoncalla	Do.
Do	Grant	Galena	Agate and petrified wood.
Do	do	Meadow Creek	Agate, petrified wood, and jasp-agate.
Do	Harney	Burns	Agate.
Do	Jackson	Eagle Point and Butte Falls.	Petrified wood, opalized and agatized wood, jasper, jasp-agate, bloodstone, and rhodonite.
Do	Jefferson	Ashwood	Opal.
Do	do	Gateway	Agate.
Do	do	Madras	Agate and thunder eggs.
Do	do	Pony Butte bed	Agate.
Do	Lake	Glass Buttes bed	Obsidian.
Do	do	Lakeview	Thunder eggs.
Do	do	Plush (Hart Mountain)	Opal.
Do	Lane	Crooked River at Bear Creek.	Agatized petrified wood.
Do	Lincoln	Agate Beach	Agate, bloodstone, sardonyx, jasper, jasp-agate, agatized coral, petrified wood, and fossil bone.
Do	do	Yachats	Agate, jasper agatized wood, and sagenite.
Do	Malheur	Nyssa	Thunder eggs.
Do	do	Sucker Creek	Agate.
Do	Morrow	Peter's Butte (Opal Butte).	Thunder eggs and agate.
Do	Wasco	Antelope	Chalcedony, jade, sagenite, agate, jasper, bloodstone, geodes, amethyst crystals, and quartz.
Do	Wheeler	Clarno bed (fossil)	Agate.
Pennsylvania	Adams	Greenstone	Cuprite.
Do	Bedford		Quartz, calcite, and spar.
Do	do	New Enterprise	Quartz, calcite, and flint.
Do	do	Salemville	Quartz.
Do	do	Waterside	Spar, quartz, calcite, and flint.
Do	Somerset	Confluence	Smoky quartz.
Do	Westmoreland		Petrified wood and flint.
South Carolina	Chesterfield	Jefferson (Old Brewer gold mine).	Topaz.
South Dakota	Custer	Black Hills	Rose quartz.
Do	do	Custer	Agate, tourmaline, and rose quartz.
Do	do	Fairburn	Breccia and agate.
Do	Fall River	Minnekahta	Agatized wood.
Do	Lawrence	Deadwood area	Garnet and rose quartz.
Do	Pennington	Quinn	Jasp-agate, chert, chalcedony, and agate.
Do	do	Scenic	Chalcedony.
Do	do	Sheep Mountain	Do.
Do	Pennington and Shannon.	Bad Lands	Agate, jasper, and petrified wood.
Do	Shannon	Pine Ridge	Chert.
Tennessee	Carter	Shell Creek	Unakite.
Texas	Brewster	Alpine	Jasper, agate, labradorite, opal, and amethyst.
Do	do	Marathon	Agate and novaculite.
Do	do	Terlingua	Agate, jasper, agatized and jasperized wood.
Do	Burnet	Marble Falls	Garnet and topaz.
Do	Culberson	Van Horn	Agate.
Do	Duvall	Freer	Do.
Do	Fayette	Carmine	Petrified, agatized, and opalized wood.
Do	do	Flatonia	Do.
Do	Gillespie	Fredericksburg	Petrified, agatized, and opalized wood, garnet, and topaz.
Do	Hudspeth	Sierra Blanca	Agate.
Do	Jeff Davis	Fort Davis	Agate and adularia (moonstone).
Do	Live Oak	George West	Agate and petrified wood.
Do	Llano	Llano	Garnet and topaz.

TABLE 1.—Localities in the United States where gem materials were reported to have been found in 1954—Continued

State	County	Locality	Gem material
Texas	Mason		Topaz, smoky quartz, amazonite, and cassiterite.
Do	do	Streeter	Topaz.
Do	McMullen	Tilden	Petrified, agatized, and opalized wood.
Do	Presidio	María	Agate.
Do	Reeves	Balmorhea	Agate, onyx, and sardonyx.
Do	Terrell	Sanderson	Agate.
Do	Walker	Huntsville	Petrified, agatized, and opalized wood.
Do	Webb	Laredo	Agate and jasper.
Do	Zapata	Zapata	Do.
Do	Brewster, Presidio, Jeff Davis, Pecos, and Reeves.	Big Bend area	Agate, carnelian, petrified wood, jasper, jasp-agate, moonstone, chalcedony, opal, amethyst, and citrine.
Utah	Beaver		Petrified wood.
Do	do	Blue Valley (Beaver)	Agate.
Do	do	Milford	Quartz crystals.
Do	Emery		Petrified wood.
Do	do	Green River	Agate.
Do	Garfield	Escalante	Agatized wood.
Do	do	Henry Mountains	Barite nodules.
Do	Grand		Petrified wood and agate.
Do	Juab	Jericho	Agate.
Do	do	Levan	Do.
Do	do	Thomas Range	Topaz.
Do	Millard	Black Rock	Obsidian.
Do	do	Kanosh	Do.
Do	Salt Lake	Murray	Onyx.
Do	Sevier	Salina	Agate.
Do	Washington	Hurricane	Do.
Do	do	St. George	Do.
Do	Wayne	Fruita	Barite nodules.
Virginia	Amelia	Amelia Court House	Amazonite.
Do	Madison	Syria	Unikite.
Do	Page	Ida	Jasper.
Do	Rockbridge	Vesuvius	Unikite.
Washington	Chelan	Wenatchee	Thulite.
Do	Douglas	Bridgeport	Thulite and jadeite.
Do	Kittitas	Ellensburg	Petrified wood and jasper.
Do	do	Vantage	Petrified wood.
Do	Klickitat	Lyle	Agatized and opalized wood, jasper, and agate.
Do	Snohomish	Roosevelt	Petrified, agatized, and opalized wood.
Do	Yakima	Saddle Mountain area	Do.
Do	do	Sunnyside	Do.
Do	do	Yakima	Petrified wood.
Wisconsin	Clark		Agate and jasper.
Do	Ashland, Bayfield, Douglas, and Iron.	Lake Superior area	Agate.
Wyoming	Albany	Marshall area	Petrified, agatized, and opalized wood, and agate.
Do	Carbon	Leo	Jade.
Do	do	Medicine Bow	Do.
Do	do	Rawlins	Do.
Do	Fremont		Rhodonite.
Do	do	Lander	Agate, jade, and jade (nephrite).
Do	Natrona		Amazon stone.
Do	do	Casper	Agate.
Do	Sweetwater	Eden Valley	Territilla (agatized snails), jade, agate, and petrified wood.
Do	do	Farson	Petrified and agatized wood, jade, jasper, agate, and chalcedony.
Do	do	Granger	Agate.
Do	do	Green River	Agatized wood, agate, jasper and corundum.
Do	do	Wamsutter	Territilla (agatized snails) and agate.

Several tons of plume agate, worth $5 a pound in some instances, was produced in Maricopa County, Ariz. Production from the Saddle Mountain area, Pinal and Graham Counties, in 1954, was estimated to be somewhat larger than in 1953.

About 100 tons of rough agate of undetermined value was produced from the agate fields near Deming, Luna County, N. Mex. Agatized fossils, valued at about $2,000, were found on the shores of Lake Superior, Mich.

Jade.—Production of jade in Wyoming was about 50 tons in 1954. It was mostly dark olive but included pink and green, pink, and some dark green varieties. Gem-quality, apple-green and black jade were scarce and high priced. Apple-green jade retailed at $40 to $100 per pound, good black at $10 per pound, and other varieties at $5 per pound.

Alaskan jade production in 1954 amounted to an estimated value of about $10,000, mostly from the Shungnak district in the Northwestern Alaskan region. There was increased interest in the jade industry, due to the success of the Indian Arts and Crafts Board, which utilized jade from the deposits near Shungnak to produce finished jewelry.

Topaz.—Production of topaz from the Streeter-Kotempsie area of Mason County, Tex., continued in 1954. An estimated 8,000 grams of this gem material, valued at $4,200, was found, principally by amateur lapidarists.

Tourmaline.—A pocket of gem-green tourmaline containing an estimated 10,000 carats valued at $20 to $100 a caret was discovered at Norway, Maine. A 23-carat emerald-green stone was the largest cut from the material.

Turquois.—Two hundred pounds of turquois from the Villa Grove area, Saguache County, Colo., was produced in 1954. This was mostly high-grade material valued at $20 to $100 per pound. The Royal Blue Mines Co., formerly operated by Lee F. Hand of Battle Mountain, Nev., was operated by the new owner, Wendall King. Production in 1954 was not reported, although it was estimated to be about the same as in 1953. Gila County, Ariz., reported about the same production of chalk-grade turquois as in 1953. Total Arizona production of turquois in 1954 was valued at about $13,000.

Other Natural Gem Stones.—About 600 tons of opalized wood was produced in Yakima County, Wash., from the prehistoric shoreline of Lake Bonneville. Limb sections ½ inch to 3 inches in diameter and up to 6 inches long retailed for about $2 per pound. Minnesota reported the production of thomsonite valued at $3,000 in 1954. The use of gem material in the St. Paul-Minneapolis area increased about 200 percent during the year owing in part to the increased use of tumblers to polish rough stone, which previously was unused because of slow methods of finishing. The polished stone was marketed in baroque form. Production of 1,300 pounds of aquamarine was reported from Troup County, Ga., mostly for markets in Ohio. The Idaho production of moss agate, opal, thunder eggs, and garnet had a retail value of about $3,000. About 500 pounds of gem quality and over 2 tons of specimen quartz crystal was reported mined at Crystal Springs, Ark. About 5 tons of onyx valued at $1,500 in the rough was mined in Utah County, Utah.

A deposit in Arizona of serpentine containing chrysolite was discussed as to location and occurrence in the Mineralogist.[4]

Details on a deposit of onyx in California were published in the Mineralogist.[5]

The use of tempskya, a petrified palm root, as a gem material was reported from Pasco, Wash. The only reported occurrence of this material in the United States is the old "Chinese diggings" near the former town of Greenhorn in the southwestern part of Baker County, Oreg. Total production through 1954 was estimated at 8 tons and valued up to $2 per pound.[6]

Synthetic Gems.—Diamonds were synthesized in 1954 by the General Electric Co., Schenectady, N. Y., although the accomplishment was not announced until February 15, 1955.

Of fundamental importance to success of the project was development of a vessel that could be operated at pressures up to at least 1,500,000 pounds per square inch and temperatures about 5,000° F. and the ability to maintain these pressure-temperature conditions simultaneously for long periods. Details of the design of the pressure vessel were not revealed.[7]

A new synthetic spinel closely resembling lapis lazuli was produced in Idar-Oberstein, Germany. The stones could be differentiated from natural lapis lazuli by X-ray powder photographs or observation under a Chelsea color filter. Genuine lapis lazuli has specks of iron pyrite that usually can be detected at some point on the surface. The makers of lapis-colored spinel can provide the stones with specks of gold if so desired, in which instance pyrites (fool's gold) would indicate the genuine stone and gold would represent the imitation.[8]

The world's second largest synthetic emerald, weighing 1,014 carats, was added to the Smithsonian Institution's mineralogical collection. The crystal was produced by the Chatham Research Laboratories in San Francisco, Calif.[9]

CONSUMPTION

Total sales of diamonds and gem stones by retail dealers increased slightly in 1954 compared with 1953. Sales of gem and industrial diamonds during 1954 totaled approximately $182 million compared with $176 million in 1953. The proceeds realized from sales of diamonds effected through the Central Selling Organization on behalf of South African and other producers and diamonds drawn from stocks held by the Diamond Corp. were as follows: Gem diamonds, $127.6 million; industrial diamonds, $46.4 million; total, $174 million. Corresponding figures in 1953 were: Gem, $121 million; industrials, $49.9 million; total, $171 million.[10]

The rise in the sales of gem diamonds in 1954 more than offset the decline in sales of industrial diamonds.

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[4] Mineralogist, Arizona's Chrysolite Asbestos: Vol. 22, No. 6, September 1954, pp. 297–300.
[5] Mineralogist, California Onyx Location: Vol. 22, No. 3, March 1954, pp. 99–100.
[6] Gentzler, Joseph S., letter to Bureau of Mines, Mar. 16, 1955.
[7] Switzer, George, 30th Annual Report on the Diamond Industry, 1954: Jewelers' Circ.-Keystone, 1955, pp. 12–13.
[8] Anderson, B. W., A New Substitute for Lapis Lazuli: Gems and Gemology, vol. 8, No. 3, Fall 1954, pp. 88–89.
[9] Mineralogist, vol. 29, No. 5–6, May–June 1954, p. 244.
[10] Switzer, George, 30th Annual Report on the Diamond Industry, 1954: Jewelers' Circ.-Keystone, 1955, p. 3.

The consumption of semiprecious gem stones by amateur lapidarists increased in 1954. The chief factor in the increase was continued development of mechanical tumbling and faceting equipment. Commercial semiprecious gem cutters considered that the larger volume of their sales came from gem collectors rather than jewelry manufacturers.

PRICES

The first appreciable change in diamond prices since 1945 occurred in December 1954, when the Diamond Corp. announced a 2½-percent increase in the price of rough diamonds. This price increase was attributed to the unexpected high demand for gem stones in the United States.

United States excise tax on jewelry was reduced from 20 to 10 percent in April 1954.

FOREIGN TRADE [11]

Imports of gem stones into the United States increased in 1954 compared with 1953 (table 2). Because of changes in tabulating procedures by the United States Department of Commerce, the 1954 data were not comparable to those for earlier years. Diamonds ranked first, with 85 percent of the imports, based on value, followed by other precious and semiprecious stones, 12 percent; and pearls (natural and cultured), 3 percent.

TABLE 2.—Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1953–54

[U. S. Department of Commerce]

Item	1953		1954	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty-free	[1] 730,350	[1] $57,001,329	887,273	$59,428,708
Cut but unset, suitable for jewelry, dutiable	[1] 444,362	[1] 50,571,535	594,772	62,758,349
Emeralds:				
Rough or uncut, duty-free	15,561	27,987	(2)	(2)
Cut but not set, dutiable	26,952	320,739	24,460	385,063
Pearls and parts, not strung or set, dutiable:				
Natural		264,873		503,753
Cultured or cultivated		3,769,758		[3] 4,333,890
Other precious and semiprecious stones:				
Rough or uncut, duty-free		203,667		[3,4] 265,837
Cut but not set, dutiable		2,218,868		[3] 1,848,989
Imitation, except opaque, dutiable:				
Not cut or faceted		40,720		[3] 37,902
Cut or faceted:				
Synthetic		677,029		[3] 283,302
Other		14,872,795		[3] 13,651,937
Imitation, opaque, including imitation pearls, dutiable		127,641		[3,4] 35,014
Marcasites, dutiable:				
Real		94,813		61,073
Imitation		2,589		
Total		[1] 130,194,343		[3] 143,593,877

[1] Revised figure.
[2] Effective January 1, 1954, not separately classified; included with precious and semiprecious stones, rough or uncut.
[3] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to earlier years.
[4] Due to changes in classifications data not strictly comparable to earlier years.

[11] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 3.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1953–54, by countries

[U. S. Department of Commerce]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1953						
North America:						
Bermuda	8,985	$502,677	$55.95			
Canada	4,744	448,338	94.51	95	$88,241	$928.85
Dominican Republic				1	235	235.00
Mexico				165	10,239	62.05
Total	13,729	951,015	69.27	261	98,715	378.22
South America:						
Argentina				18	4,263	236.83
Brazil	398	99,448	249.87	34	8,722	256.53
British Guiana	2,307	83,958	36.39	30	2,847	94.90
Venezuela	51,779	1,587,872	30.67	3	745	248.33
Total	54,484	1,771,278	32.51	85	16,577	195.02
Europe:						
Belgium-Luxembourg	19,116	1,818,663	95.14	215,438	25,554,634	118.62
France	11,631	280,922	24.15	1,098	170,306	155.11
Germay, West	167	1,667	9.98	22,196	1,633,341	73.59
Italy				48	30,647	638.48
Netherlands	4,171	374,437	89.77	29,365	3,491,370	118.90
Switzerland	7,820	841,026	107.55	493	171,765	348.41
United Kingdom	524,826	47,625,107	90.74	3,271	526,641	161.00
Total	567,731	50,941,822	89.73	271,909	31,578,704	116.14
Asia:						
Hong Kong				1	93	93.00
India				2,974	52,853	17.77
Israel and Palestine				122,218	10,276,874	84.09
Japan				55	4,919	89.44
Malaya	560	65,162	116.36			
Total	560	65,162	116.36	125,248	10,334,739	82.51
Africa:						
Belgian Congo				300	63,603	212.01
British West Africa	121	726	6.00			
French Equatorial Africa	39,963	940,002	23.52			
Gold Coast	450	4,219	9.38			
Union of South Africa	[1] 53,312	[1] 2,327,105	[1] 43.65	[1] 46,556	[1] 8,477,426	[1] 182.09
Total	93,846	3,272,052	34.87	46,856	8,541,029	182.28
Oceania: Australia				3	1,771	590.33
Grand total 1953	[1] 730,350	[1] 57,001,329	[1] 78.05	[1] 444,362	[1] 50,571,535	[1] 113.81
1954						
North America:						
Bermuda	6,231	118,899	19.08			
Canada	4,984	514,120	103.15	275	59,487	216.32
Mexico	100	750	7.50			
Total	11,315	633,769	56.01	275	59,487	216.32
South America:						
Brazil	6,890	161,606	23.46	350	28,985	82.81
British Guiana	2,064	63,591	30.81			
Venezuela	81,442	2,421,299	29.73			
Total	90,396	2,646,496	29.28	350	28,985	82.81

Revised figure.

TABLE 3.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1953–54, by countries—Continued

[U. S. Department of Commerce]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1954—Continued						
Europe:						
Belgium-Luxembourg	67,969	$7,232,086	$106.40	335,173	$35,110,962	$104.75
France	14,563	346,162	23.77	4,405	594,543	134.97
Germany, West				38,724	2,645,535	68.32
Netherlands	11,673	802,417	68.74	25,866	2,973,356	114.95
Switzerland	1,455	82,314	56.57	208	124,199	597.11
United Kingdom	632,394	44,923,762	71.04	4,732	1,267,999	267.96
Total	728,054	53,386,741	73.33	409,108	42,716,594	104.41
Asia:						
Ceylon				12	1,717	143.08
India				1,156	216,743	187.49
Israel	4,066	42,836	10.54	137,073	11,620,417	84.78
Japan	186	2,779	14.94	398	34,751	87.31
Lebanon	1,325	146,867	110.84	53	22,271	420.21
Malaya	453	55,351	122.19			
Total	6,030	247,833	41.10	138,692	11,895,899	85.77
Africa:						
Belgian Congo	204	24,717	121.16			
French Equatorial Africa	16,812	731,630	43.52			
Liberia	2,843	35,729	12.57			
Union of South Africa	31,619	1,721,853	54.46	46,347	8,057,384	173.85
Total	51,478	2,513,929	48.84	46,347	8,057,384	173.85
Grand total 1954	887,273	59,428,768	66.98	594,772	62,758,349	105.52

TECHNOLOGY

H. C. Dake described methods for calculating the potential value of large masses of gem materials.[12] The techniques of sawing, grinding, sanding, polishing, and setting malachite were published.[13] The art of cabochon making was described.[14] The techniques, equipment, knowledge, and tools required for the amateur to collect mineral specimens in various parts of the United States were listed.[15]

A new gem stone, sinhalite, has been found and identified by the British Museum and the Smithsonian Institution.[16]

A historical and technical article, Turquois in Nevada, was published.[17]

The historical and technical properties of jade were reviewed.[18]

An exhaustive list of gem stones that are luminescent under ultraviolet light was published.[19]

A new pearl weight estimation chart and table for drilled and undrilled pearls was developed that provided the weight of pearls of any size in pearl grains, mommes, carats, and grams. Momme is a

[12] Dake, H. C., Calculating Rough Gem Values: Mineralogist, vol. 22, No. 2, February 1954, pp. 57–62.
[13] Sinkankas, John, The Treatment of Malachite: Rocks and Minerals, vol. 29, No. 11–12, November–December 1954, pp. 599–601.
[14] Bingham, W. J., Cabochons: Earth Science, vol. 7, No. 4, January–February 1954, pp. 34–38.
[15] Dake, H. C., Where to Collect Minerals: Mineralogist, vol. 22, No. 11, November 1954, pp. 400, 406.
[16] Rocks and Minerals, Sinhalite, A New Gem Stone: Vol. 29, No. 5–6, May–June 1954, p. 251.
[17] California Mining Journal, Turquois in Nevada: Vol. 23, No. 8, April 1954, p. 23.
[18] Parker, R. J., The Nature of Jade: Gems and Gemology, vol. 8, No. 2, Summer 1954, pp. 38–46.
[19] Webster, Robert, Gemstone Luminescence: Gemmologist, vol. 23, No. 273, April 1954, pp. 77–78.

Japanese term used in cultered-pearl wholesaling. One momme equals to 0.0132 ounce.[20]

Three methods were devised to distinguish naturally colored diamonds from those colored by nuclear bombardment.[21]

A new brilliant cut was calculated that has a light output improvement of 21 to 28 percent. In addition, the cut enabled smaller stones to be utilized because of its lower height.[22]

A modified electrostatic separation process was developed at the Diamond Research Laboratory, Johannesburg, South Africa, to treat the finer sizes of gravity concentrate at various alluvial diamond mines. The new electrostatic separator recovered diamonds too small for satisfactory recovery by grease belts.[23]

WORLD REVIEW

Total world diamond production in 1954 was the highest on record and slightly higher than in 1953. Most of the increase came from the Union of South Africa and Tanganyika.

Table 4 shows world production of diamonds, with accurate figures from most countries. The total world production was estimated to be 1 to 2 percent higher than the figures given in the table.

Angola.—A report on the 1954 operation of the Companhia de Diamantes de Angola was published.[24]

TABLE 4.—World production of diamonds, 1951–54, by countries, in metric carats

(Including industrial diamonds)

	1951	1952	1953	1954
Africa:				
Angola	734, 324	743, 302	729, 337	721, 607
Belgian Congo	10, 564, 667	11, 608, 763	12, 580, 256	12, 619, 378
French Equatorial Africa	136, 000	163, 400	140, 144	152, 529
French West Africa	101, 000	136, 080	180, 000	216, 000
Gold Coast	1, 752, 878	2, 189, 557	[4] 2, 180, 728	2, 135, 141
Sierra Leone	475, 759	451, 426	472, 934	398, 608
South West Africa	478, 075	541, 027	617, 411	683, 536
Tanganyika	108, 625	143, 023	[4] 172, 304	326, 009
Union of South Africa:				
Lode	1, 967, 272	2, 093, 138	2, 397, 755	[1] 2, 544, 305
Alluvial	[2] 289, 063	[2] 282, 681	[2] 300, 000	[2] 314, 000
South America:				
Brazil	200, 000	200, 000	200, 000	[3] 200, 000
British Guiana	43, 260	38, 305	35, 306	30, 073
Venezuela	63, 226	98, 291	84, 790	96, 983
Other countries	3, 000	5, 000	5, 000	[3] 5, 000
Grand total	16, 917, 000	18, 694, 000	[4] 20, 096, 000	20, 440, 000

[1] Pipe mines under De Beers control but including 75,225 carats from alluvial diggings at Kleinzee.
[2] Includes an estimated 100,000 carats from the State mines of Namaqualand.
[3] Estimate.
[4] Revised figure.

SOURCE: Jewelers' Circ.-Keystone, 30th Annual Report on the Diamond Industry, 1954: 1955, p. 7.

[20] Small, J., Weight Estimations of Pearls: Gems and Gemology, vol. 8, No. 4, Winter 1954–55, pp. 99–105.
[21] Custer, J. F. H., and Dwyer, H. B., Discrimination Between Natural Blue Diamonds, and Diamonds Colored Blue Artificially: Gems and Gemology, vol. 8, No. 2, Summer 1954, pp. 35–37.
[22] Parker, R. L., Suggestion for a New Brilliant Cut: Gemmologist, vol. 23, No. 279, October 1954, pp. 177–179.
[23] Optima, Recovery of Small Diamonds: Vol. 4, No. 1, March 1955, pp. 33–34.
[24] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 2, February 1955, pp. 46–49.

Brazil.—Increased prices for industrial diamonds in Brazil encouraged expansion of diamond mining in 1954.[25]

There was a minor diamond rush in the Diamantino area, in the State of Mato Grosso, where the population was reported to be increasing at the rate of 1,000 a month. Miners found it more profitable to search for alluvial diamonds than to recover quartz crystals, which had been their chief mainstay before the diamond rush.

British Guiana.—Diamond production in British Guiana during 1954 amounted to 27,400 metric carats, a decrease of 8,000 carats from 1953.[26]

Canada.—In 1954 a substantial deposit of garnet was discovered in Dana township, 25 miles north of Sturgeon Falls, Ontario. The garnet, of alamandite type, was found in a zone of soft mica schist suitable for opencut mining.[27]

Ceylon.—Gem-stone mining in Ceylon was limited to small-scale open pits operated by 5 to 10 men. The pits, usually rectangular, were limited to a depth of 10 to 15 feet by ground-water conditions. Usual operations consisted of two men bailing while the other men dig and pile the gravel on the surface. When a pit was completed, the gravel was washed in cone-shaped baskets of bamboo or cane, and the gem stones were picked out.[28]

No production statistics were available, but it is estimated that the value of annual output was approximately $400,000 in 1954.[29]

Principal gem-stone localities in Ceylon follow:

Sabaragamuwa Province

Ratnapura	Kotamulla	Marapona
Balangoda	Karangoda	Pathakada
Pelmadulla	Hangomuwa	Elapatha
Adandawela	Urupollalawn	Modduwa

Southern Province

Ambalangoda Meethiyagoda Karandeniya	There were several moonstone and amethyst mines near these villages. The most precious moonstones are found here (dark sky-blue).

Central Province

Matale Rattota Gammaduwa East and West Matale	Fine color amethysts have been mined near these villages.

Colombia.—It was announced that the Muzo emerald mine, operated by the Banco de la Republica, had reopened in November 1953. The operations were being expanded gradually, and production was expected to equal that of 1949. The mine was closed in 1949 because of internal disorders throughout Colombia.[30]

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[25] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, pp. 41, 42.
[26] Mining Journal (London), Annual Review, May 1955, p. 178.
[27] Engineering and Mining Journal, vol. 155, No. 11, November 1954, p. 160.
[28] Jayasinghe, W. D. S., Communication to E. R. Ruhlman, dated Oct. 27, 1955.
[29] Mining Journal (London), Annual Review, May 1955, p. 198.
[30] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, p. 51.

India.—The Indian Bureau of Mines investigated the area near Ramaelakota (Andhra), and found evidence of a once-flourishing diamond-mining industry. It recommended a careful search for volcanic plugs; the original source of diamonds in Andhra.[31]

Japan.—The Japanese pearl-shell expedition that had been operating in the Arafura Sea under the terms of an interim agreement between the Governments of Australia and Japan discontinued diving in October 1954, when its quota was reached. The limit of shells agreed upon was 975 tons.[32]

Madagascar.—Production of precious and semiprecious gem stones in Madagascar was valued at $30,000 in 1954, about the same as in 1953. Among the stones produced were beryl, tourmaline, topaz, opal, sapphire, garnet, and amethyst.[33]

A comprehensive report of the gem stones of Madagascar was published.[34]

South-West Africa.—Industrial Diamonds of South Africa, Ltd., discovered a raised diamond-bearing marine terrace near Luderitz. The diamonds were similar in quality to those mined at the Saddle Hill Terrace.[35]

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[31] Chemical Age (London), vol. 71, Aug. 21, 1954, p. 368.
[32] Bureau of Mines, Mineral Trade Notes: Vol. 39, No. 4, October 1954, p. 56.
[33] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 6, June 1954, pp. 56-57.
[34] Jeannelle, H. F., Mineralogist: Vol. 22, No. 2, February 1954, pp. 85-90.
[35] Mining World, vol. 16, No. 12, November 1954, p. 37.

Gem Stones

By John W. Hartwell [1] and Eleanor V. Blankenbaker [2]

GEM-STONE production in the United States during 1955 increased 17 percent in value over 1954 and reached an alltime high exceeding $800,000. This was due largely to the increased number of collectors, lapidaries, and "rockhounds." It was estimated that 150,000 to 300,000 individuals were engaged, full or part time, in this field. Some of the added interest was created by the increase in articles on gem stones published in nationally distributed magazines and newspapers. Many retired individuals supplemented their income by collecting, cutting and polishing, and selling gem stones in small shops throughout the United States. These small businesses increased the demand for gem materials, and prices rose as the quantity of good gem material decreased; however, as prices increased, new locations of gem material were found, and old areas were reworked.

DOMESTIC PRODUCTION

In 1955, approximately 65 percent of the total value of gem-stone production was credited to quartz, jade, and turquois, in decreasing order. Eight States—Oregon, Texas, California, Arizona, Nevada, Washington, Wyoming, and Colorado—produced 88 percent of the total value. Oregon was the leading producing State, with an estimated $150,000.

Agate.—As in previous years, agate was the principal gem material produced in the United States. The price varied with the quality of the material, and only estimates could be made on the value of production. The areas near Roosevelt, Klickitat County, Wash., and Miles City, Custer County, Mont., were the most productive, and the price of agate from these localities ranged from $0.50 to $3.50 per pound.

Oregon was the leading producer, with an estimated value of $25,000, more than double the 1954 figure. Owners of about 20 agate-bearing properties in central and eastern Oregon charged fees to collectors, based on the quantity of agate removed.

Agate from New Mexico was produced from a locality near Deming, Luna County, with reported sales exceeding $12,000.

Over 20 tons of agate was produced in Wyoming, mainly from Sweetwater and Fremont Counties.

Other States with a reported agate-production value of over $3,000 were Arizona, California, Colorado, South Dakota, and Texas.

The Yellowstone River Valley in Montana was a good source of moss agate, but more work was required to recover the material than in the past. The better grade of rough agate sold for $2 to $50 per pound and some rare stones up to $150. About 90 percent of the

[1] Commodity specialist.
[2] Literature-research clerk.

TABLE 1.—Value of production and imports of precious and semiprecious stones in the United States,[1] 1867–1955, in thousand dollars

Year	Production	Imports	Year	Production	Imports
1867	[2]	$1,319	1912	$320	$41,363
1868	[2]	1,063	1913	319	45,432
1869	[2]	1,998	1914	125	19,211
1870	[2]	1,779	1915	170	26,194
1871	[2]	2,351	1916	218	50,267
1872	[2]	3,034	1917	131	37,794
1873	[2]	3,134	1918	107	23,443
1874	[2]	2,372	1919	112	102,968
1875	[2]	3,479	1920	265	73,980
1876	[2]	2,617	1921	518	36,525
1877	[2]	2,235	1922	[2]	66,617
1878	[2]	3,071	1923	[2]	74,148
1879	[2]	3,965	1924	[2]	71,264
1880	[2]	6,870	1925	[2]	73,915
1881	[2]	8,607	1926	[2]	78,291
1882	[2]	8,923	1927	[2]	64,950
1883	$206	8,127	1928	[2]	67,964
1884	222	9,139	1929	[2]	75,317
1885	210	6,043	1930	[2]	38,642
1886	119	8,260	1931	[2]	21,126
1887	164	10,832	1932	[2]	12,771
1888	140	10,558	1933	20	13,752
1889	189	11,978	1934	3	17,908
1890	119	13,106	1935	5	27,612
1891	235	12,757	1936	12	38,146
1892	312	14,522	1937	32	50,494
1893	264	10,198	1938	127	28,305
1894	132	7,427	1939	235	40,488
1895	114	6,574	1940	340	37,769
1896	98	4,619	1941	240	33,777
1897	131	6,277	1942	150	28,449
1898	161	10,163	1943	67	72,110
1899	186	17,209	1944	41	77,530
1900	233	13,559	1945	40	114,435
1901	289	22,815	1946	325	189,018
1902	328	24,754	1947	570	110,538
1903	308	26,525	1948	500	115,990
1904	324	27,229	1949	500	84,186
1905	326	36,846	1950	500	118,500
1906	208	43,602	1951	500	128,954
1907	471	31,867	1952	500	124,699
1908	415	13,700	1953	487	130,194
1909	534	40,238	1954	607	[3] 143,589
1910	296	40,704	1955	814	175,262
1911	344	40,820			

[1] Includes Alaska.
[2] Not available.
[3] Revised figure.

TABLE 2.—Localities in the United States where gem materials were reported to have been found in 1955

State	County or district	Locality	Gem material
Alaska	Seward district	Seward	Pyrite, jasper, plasma, and epidote.
Do	Shungnak district	Kobuk	Jade.
Do	Chichagof district	Baranof	Agate.
Arizona	Apache	Globe	Peridot.
Do	do	St. Johns	Petrified wood.
Do	Coconino	Flagstaff	Do.
Do	Gila	Claypool	Turquois.
Do	do	Globe	Serpentine, turquois, hypersthene, and peridot.
Do	do	Miami	Turquois.
Do	Greenlee	Clifton	Agate.
Do	do	Duncan	Jasper, chalcedony, and agate.
Do	Maricopa	Black Gap	Copper silicate.
Do	do	Cavecreek	Jasper.
Do	do	Globe	Amethyst.
Do	do	Hassayampa	Chalcedony.
Do	do	New River	Agate.
Do	do	Phoenix	Jasper and agate.
Do	do	Rock Springs	Marble.

TABLE 2.—Localities in the United States where gem materials were reported to have been found in 1955—Continued

State	County or district	Locality	Gem material
Arizona	Maricopa	Tonopah	Chalcedony.
Do	Pima	Ajo	Chalcedony (desert rose).
Do	Pinal	Superior	Apache tears.
Do	Yavapai	Prescott	White jade, lavender agate, and chrysoprase.
Do	Yuma	Quartzsite	Quartz crystals and orbicular rhyolite.
Do	do	Salome	Jasper.
Do	do	Yuma	Rhyolite.
California	Amador	Fiddletown	Rhodonite.
Do	El Dorado	Georgetown	Idocrase, vesuvianite, and garnet
Do	Imperial	Winterhaven	Jasp-agate.
Do	do	Ogilby	Chalcedony.
Do	Inyo	Bigpine	Quartz crystals.
Do	do	Trona	Onyx.
Do	Kern	Boron	Morrisonite.
Do	do	Randsburg	Agate.
Do	do	Rosamond	Rhodonite.
Do	do	Tejon Ranch	Do.
Do	Lake	Lower Lake	Quartz crystals.
Do	Marin	Inverness	Petrified whalebone.
Do	Mendocino	Covelo	Jade and jasper.
Do	Monterey	Lucia	Nephrite.
Do	Mono		Geode.
Do	Napa	Etna Springs	Quartz crystals.
Do	Nevada	North Bloomfield	Opal.
Do	do	Nevada City	Do.
Do	Placer	Colfax	Jade (nephrite).
Do	Riverside	Anza	Rose quartz.
Do	do	Blythe	Fire agates.
Do	San Benito	New Idria	Benitoite, jadeite, and silicified serpentine.
Do	San Bernardino	Kramer Junction	Jasp-agate.
Do	do	Needles	Blue agate.
Do	do	Shoshone	Amethyst.
Do	do	Wrightwood	Rhodonite.
Do	San Diego	Mesa Grande	Tourmaline.
Do	do	Pala	Beryl, kunzite, and tourmaline (blue).
Do	do	Ramona	Essonite garnet.
Do	San Francisco	San Francisco	Jasper.
Do	San Luis Obispo	Nipomo	Agate.
Do	Siskiyou	Happy Camp	Jade.
Do	Tulare	Dunlap	Topaz.
Colorado	Chaffee	Nathrop	Aquamarine and phenacite.
Do	do	Salida	Agate and beryl.
Do	Douglas	Sedalia	Topaz.
Do	do	Westcreek	Amazonstone.
Do	El Paso	Colorado Springs	Phenacite and amazonite.
Do	Fremont	Howard	Agate.
Do	do	Texas Creek	Rose quartz.
Do	Jefferson	Deckers	Amazonstone crystals and amazonstone.
Do	do	Hartsel	Tourmaline
Do	Kiowa	Kiowa	Agate.
Do	Mesa	Grand Junction	Dinosaur bone.
Do	Mineral	Creede	Amethyst and marcasite agate.
Do	Montrose	Paradox	Covellite.
Do	Rio Grande	Del Norte	Marcasite agate.
Do	Saguache	do	Agate.
Do	do	Villa Grove	Turquois.
Do	San Juan	Silverton	Rhodonite.
Do	San Miguel	Nucla	Dinosaur bone, jasper, and sloth bone.
Do	Teller	Colorado Springs	Amazonstone.
Do	do	Florissant	Amazonite.
Do	do	Lake George	Do.
Georgia	Rabun		Amythest.
Do	Towns		Ruby and sapphire.
Do	Troup	La Grange	Rose quartz.
Maine	Oxford	Stow	Aquamarine and beryl.
Michigan	Emmet	Petoskey	Petoskey stone.
Do	Houghton	Calumet	Agate.
Do	Keweenaw	Copper Harbor	Datolite and thomsonite.
Do	do	Phoenix	Cholorastrolite.
Do	Marquette	Ishpeming	Jasper.
Minnesota	Cook	Grand Marais	Thomsonite.
Do	Lake	Beaver Bay	Agate (Lake Superior).
Do	St. Louis	Duluth	Do.

TABLE 2.—Localities in the United States where gem materials were reported to have been found in 1955—Continued

State	County or district	Locality	Gem material
Montana	Custer	Miles City	Agate and moss agate.
Do	Dawson	do	Agate.
Do	Fergus		Sapphire.
Do	Prairie	Terry	Agate.
Do	Rosebud	Rosebud	Do.
Nebraska	Sioux	Orella	Chalcedony and agate.
Nevada	Elko	Elko	Chalcedony.
Do	Esmeralda	Tonopah	Turquois.
Do	Humboldt	Denio	Common and fire opal.
Do	do	Golconda	Rhodonite.
Do	Lander	Battle Mountain	Turquois.
Do	Mineral	Mina	Do.
Do	do	Luning	Petrified wood.
Do	Nye	Tonopah	Turquois.
Do	Washoe		Sulfur and piedmontite crystals and schroeckingerite.
New Mexico	Eddy	Carlsbad	Galven and agate.
Do	Hildalgo	Duncan, Arizona	Chalcedony and agate eyes.
Do	Luna	Deming	Agate.
Do	San Juan	Redrock	Ricolite.
Do	Sierra	Bingham	Blue fluorite.
Do	do	Torc	Desert scenic stone.
New York	Warren	North Creek	Garnet.
North Carolina	Alexander	Hiddenite	Quartz and rutile.
Do	Clay		Ruby and sapphire crystals.
Do	Macon	Franklin	Ruby.
Do	Yancey	Spruce Pine	Emerald.
Oregon	Jackson	Medford	Jasper, agate, petrified wood, rhodonite, and quartz.
Do	Jefferson	Madras	Moss agate.
Do	Lake	Burns	Obsidian.
Do	Linn	Crawfordsville	Purple agate.
Do	Wasco		Jasper, quartz, opal, and agate.
Puerto Rico	Cabo Rojo Municipality.	Rio Guanajibo	Chalcedony.
Do	Comerio Municipality.	Rio Pinas	Nephrite.
Do	Humacao Municipality.	Playa de Humacao	Jasper.
Do	San Juan Municipality.	Condado Beach	Jade.
Do	San Sebastian Municipality.	Rio Guatemala	Fossil coral.
South Dakota	Custer	Custer	Agate and rose quartz.
Do	do	Fairburn	Fairburn agate, jasp-agate, and rose quartz.
Do	do	Hermosa	Jasp-agate.
Do	Pennington	Creston	Agatized wood.
Do	do	Keystone	Garnet.
Texas	Brewster	Alpine	Agate.
Do	Gillespie	Eckert	Amethyst.
Do	Mason	Katemcy	Topaz, amazonstone, smoky quartz, and green fluorite.
Do	Travis	Mason	Topaz.
Utah	Beaver	Beaver	Blue valley agate and obsidian.
Do	do	Milford	Obsidian.
Do	Emery	Ferron	Petrified wood.
Do	do	Black Rock	Obsidian.
Do	Garfield	Hatch	Onyx.
Do	Grand	Cisco	Agate.
Do	do	Green River	Lace agate and jasper.
Do	do	Moab	Agate.
Do	do	Thompson	Jasp-agate and dinosaur bone.
Do	Iron	Cedar City	Agate.
Do	Juab	Dragway Mountain	Geodes.
Do	Kane	Orderville	Septarium nodules.
Do	Millard	Cave Fort	Jasper.
Do	do	Milford	Obsidian.
Do	San Juan	Joy	Agate and topaz.
Do	Sevier	Salina	Agate.
Do	Washington	Central	Do.
Do	Wayne	Torrey	Petrified wood.
Virginia	Amelia	Amelia	Amazonite.
Do	Madison	Syria	Unakite (Pikes Peak epidote).
Washington	Benton	Mabton	Opalized wood.
Do	Kittitas	Ellensburg	Agate and petrified wood.
Do	Klickitat	Roosevelt	Moss agate.
Wisconsin	Clark	Greenwood	Agate.

TABLE 2.—Localities in the United States where gem materials were reported to have been found in 1955—Continued

State	County or district	Locality	Gem material
Wyoming	Carbon	Baggs	Turitella agate.
Do	do	Saratoga	Agatized wood.
Do	Fremont	Lander	Jade, sweetwater agate, and petrified wood.
Do	do	Riverton	Agate and jade.
Do	do	Shoshoni	Jade.
Do	do	South Pass City	Algae.
Do	do	Three Forks	Jade.
Do	Natrona	Casper	Agate.
Do	Sweetwater	Eden	Petrified wood.
Do	do	Farson	Agatized wood, eden-valley wood, and petrified wood.
Do	do	Green River	Agate.
Do	do	Rock Springs	Petrified wood.
Do	do	Wamsutter	Agate and turitella.

agate found had no value. The value of moss-agate production from this area was estimated at $5,000 to $10,000.

Jade.—Alaska jade continued to be the most important gem material of the Territory. A large quantity of the raw material was shipped to Germany and Japan for cutting and polishing. The business of selling jade handicraft to tourists continued to flourish.

Wyoming production had some importance, but the float material was more difficult to find. The 1955 jade production in Wyoming was valued at $10,000 and came mainly from an area near Lander, Fremont County.

California production was reported to be approximately $5,000. Nephrite was probably the most important jade material in the State and ranged in color from pale to dark bluish green. A new jade locality was discovered near Cloverdale, Sonoma County, Calif.

Arizona produced a small quantity of white jade near Prescott.

Opal.—The Rainbow Ridge mine near Denio, Humboldt County, Nev., was reported to be developing a vein of precious opal within streaks of opalized wood. This mine has produced opals since 1909 and recovered one of the largest pieces of precious opal ever recorded, weighing 7 pounds.[3] Production from this area was about $4,000 in 1955.

Some opal was produced in Nevada County, Calif.

Petrified Wood.—It was reported that in Wyoming the largest production of petrified wood was from an area around Farson, Sweetwater County, where 2 tons was collected. The total value of Wyoming production was approximately $10,000.

About 10 tons of petrified wood was produced near Medford, Jackson County, Oreg.

Rhodonite.—Some interest was shown in rhodonite during 1955, and a large deposit of this material was reported in Amador County, Calif. Most of it was poor grade.

About 2 tons of rhodonite was produced in Humboldt County, Nev., and smaller quantities were recovered in other States. The total production in the United States was less than $10,000.

Topaz.—A new discovery of topaz crystals was reported in New

[3] Mining World, vol. 17, No. 9, August 1955, p. 100.

Hampshire in the vicinity of Conway, Carroll County. Only a few clear 5- to 10-carat pieces suitable for cutting were obtained from each crystal.

The production of topaz from Mason County, Tex., continued during 1955, and it was estimated that 5,500 grams with a value of over $6,000 was recovered. These stones were fine light-blue and made excellent gem stones. In the San Creek area, Tulore County, Tex., a production of over $1,000 was reported.

Turquois.—Large quantities of low-grade turquois from Arizona were reported sold as gem material at prices ranging from $1.50 to $3 per pound.

The Lone Mountain Turquoise mine, Nye County, Nev., produced about $20,000 of turquois in 1955. Another producer was the Blue Gem lease near Battle Mountain, Lander County. Some turquois was mined on claims north and west of Columbus Flat near Candelaria, Mineral County, Nev.

Miscellaneous Gems and Specimens.—A report was published on garnet deposits near Wrangell, Alaska.[4] These garnets were of the almandite variety and averaged ½ to ⅝ inch in diameter.

One hundred and fifty pounds of dinosaur bone was found near Thompson, Grand County, Utah, and 300 pounds was found near Grand Junction, Mesa County, Colo. Smaller quantities were reported elsewhere. Petrified whalebone valued at over $200 was recovered in Inverness, Marin County, Calif.

Additional varieties of specimens reported found in 1955 from various localities were: Amber, sulfur, piedmontite, schroeckingerite, copper silicate, quartz, pyrite, and others.

Gem stones reported as more precious types than the common varieties were highly esteemed when cut and polished and had a greater value in the gem-stone trade. They are listed in table 3, according to variety, State, and value of 1955 production.

TABLE 3.—Value of selected gem stones produced in 1955

Variety	State	Value	Variety	State	Value
Amethyst	Arizona	$18,500	Fire chalcedony	Arizona	$2,500
Do	Texas	(1)	Fire opal	Nevada	4,000
Amethyst agate	New Mexico	2,000	Peridot	Arizona	2,500
Aquamarine	Colorado	1,800	Pink chalcedony	do	200
Blue tourmaline	California	2,000	Purple agate	do	4,800
Desert rose	Arizona	500	Rose quartz	Georgia	400
Fairburn agate	South Dakota	500	Sapphire	Montana	800
Fire agate	Arizona	500			
Do	California	2,500			

[1] Value not reported.

CONSUMPTION

A survey was taken by N. W. Ayer & Son, Inc., to establish trend information on sales, inventories, prices, and customer preferences on diamond jewelry. It is estimated that the United States consumes three-fourths of the world cut-diamond production, and in 1955 its value was approximately $151.5 million. The Central Selling Organ-

[4] Houston, J. R., The Garnet Deposits Near Wrangell, Alaska: Rocks and Minerals, vol. 30, No. 11-12, November-December 1955, pp. 563-569.

ization reported sales of gem and industrial diamonds to be 10 and 45 percent, respectively, greater in 1955 than in 1954.[5]

The consumption of gem stones (excluding diamonds) in the United States during 1955 was greater, in line with increased imports of sapphires, rubies, emeralds, pearls, and semiprecious stones and the larger quantity of gem stones domestically produced. Amateur lapidaries consumed most of the domestic gem-stone production.

PRICES

The average retail prices for gem diamonds in 1955 follow: ¼-carat, $130; ½-carat, $310; 1-carat, $860; 2-carat, $2,140; 3-carat, $3,530.[6] The greater demand for precious and semiprecious gem stones increased the prices of imported material.

FOREIGN TRADE [7]

The value of gem-stone imports into the United States in 1955 increased 22 percent over 1954. Gem diamonds composed 86 percent of the total value of imports. Pearls (precious and semiprecious) and synthetic gem-stone imports increased 11 percent in 1955 over 1954.

The value of imports of gems and precious stones into the United States from 1867 to 1955, inclusive, is shown in table 1. Table 4 lists the 1954 and 1955 imports of precious and semiprecious stones, and table 5 shows the imports of gem diamonds for the same period.

In 1955 the United States exported 46 percent more gem stones (precious, semiprecious, synthetic, and imitation) than in 1954.

TABLE 4.—Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1954–55

[U. S. Department of Commerce]

Item	1954		1955	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty free	[1] 887,702	[1] $59,423,768	1,064,932	[2] $76,735,186
Cut but unset, suitable for jewelry, dutiable	594,772	62,758,349	707,859	[2] 74,833,550
Emeralds: Cut but not set, dutiable	24,460	385,063	45,235	1,564,676
Pearls and parts, not strung or set, dutiable:				
Natural		503,753		669,351
Cultured or cultivated		[2] 4,333,890		[2] 6,197,897
Other precious and semiprecious stones:				
Rough and uncut, duty-free		[2] 265,837		228,939
Cut but not set, dutiable		[2] 1,848,989		[2] 2,837,932
Imitation, except opaque, dutiable:				
Not cut or faceted		[2] 37,902		[2] 25,885
Cut or faceted:				
Synthetic		[2] 283,302		[2] 298,985
Other		[2] 13,651,937		[2] 11,806,001
Imitation, opaque, including imitation pearls, dutiable		[2] 35,014		[2] 19,185
Marcasites, dutiable: Real and imitation		61,073		44,439
Total		[1] [2] 143,588,877		[2] 175,262,026

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable to years before 1954.

[5] Switzer, George, 31st Annual Report on the Diamond Industry, 1955: Jewelers' Circ.-Keystone, 1956, p. 2.
[6] Switzer, George, 31st Annual Report on the Diamond Industry, 1955: Jewelers' Circ.-Keystone, 1956, p. 3.
[7] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 5.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1954–55, by countries

[U. S. Department of Commerce]

Country	Rough or uncut			Cut but unset		
	Carats	Value: Total	Value: Average	Carats	Value: Total	Value: Average
1954						
North America:						
Bermuda	6,231	$118,899	$19.08			
Canada	4,984	514,120	103.15	275	$59,487	$216.32
Mexico	100	750	7.50			
Total	11,315	633,769	56.01	275	59,487	216.32
South America:						
Brazil	6,890	161,606	23.46	350	28,985	82.81
British Guiana	2,064	63,591	30.81			
Venezuela	81,442	2,421,299	29.73			
Total	90,396	2,646,496	29.28	350	28,985	82.81
Europe:						
Belgium-Luxembourg	67,969	7,232,086	106.40	335,173	35,110,962	104.75
France	14,563	346,162	23.77	4,405	594,543	134.97
Germany, West				38,724	2,645,535	68.32
Netherlands	11,673	802,417	68.74	25,866	2,973,356	114.95
Switzerland	1,455	82,314	56.57	208	124,199	597.11
United Kingdom	632,394	44,923,762	71.04	4,732	1,267,999	267.96
Total	728,054	53,386,741	73.33	409,108	42,716,594	104.41
Asia:						
Ceylon				12	1,717	143.08
India				1,156	216,743	187.49
Israel	4,066	42,836	10.54	137,073	11,620,417	84.78
Japan	186	2,779	14.94	398	34,751	87.31
Lebanon	1,325	146,867	110.84	53	22,271	420.21
Malaya	453	55,351	122.19			
Total	6,030	247,833	41.10	138,692	11,895,899	85.77
Africa:						
Belgian Congo	204	24,717	121.16			
French Equatorial Africa	16,812	731,630	43.52			
Liberia	2,843	35,729	12.57			
Union of South Africa	[1] 32,048	[1] 1,716,853	[1] 53.57	46,347	8,057,384	173.85
Total	[1] 51,907	[1] 2,508,929	[1] 48.35	46,347	8,057,384	173.85
Grand total	[1] 887,702	[1] 59,423,768	[1] 66.94	594,772	62,758,349	105.52
1955						
North America:						
Bermuda	2,205	228,467	103.61			
Canada	5,900	569,306	96.49	127	14,125	111.22
Netherlands Antilles				29	39,955	1,377.76
Total	8,105	797,773	98.43	156	54,080	346.67
South America:						
Brazil	4,127	199,085	48.24	113	13,427	118.82
British Guiana	2,566	73,104	28.49			
Venezuela	90,236	2,642,087	29.28	48	7,662	159.63
Total	96,929	2,914,276	30.07	161	21,089	130.99
Europe:						
Austria				7	3,674	524.86
Belgium-Luxembourg	102,676	10,692,952	104.14	427,422	45,354,711	106.11
France	9,203	730,133	79.34	4,470	869,862	194.60
Germany, West	1,141	11,215	9.83	48,948	3,452,716	70.54
Italy				136	127,461	937.21
Netherlands	2,573	261,443	101.61	22,243	2,633,320	118.39
Switzerland	29,965	1,911,100	63.78	250	58,799	235.20
United Kingdom	728,285	56,960,288	78.21	5,464	947,127	173.34
Total	873,843	70,567,131	80.75	508,940	53,447,670	105.02

See footnotes at end of table.

TABLE 5.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1954–55, by countries—Continued

[U. S. Department of Commerce]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
Asia:						
Hong Kong	294	$1,177	$4.00			
India				249	$29,042	$116.63
Indonesia	130	19,497	149.98			
Iraq				103	9,284	90.14
Israel	4,136	44,821	10.84	157,326	13,735,028	87.30
Japan				837	80,848	96.59
Lebanon	549	44,750	81.51			
Malaya	71	12,201	171.85			
Saudi Arabia				2	700	350.00
Total	5,180	122,446	23.64	158,517	13,854,902	87.40
Africa:						
French Equatorial Africa	8,110	383,815	47.33			
Liberia	14,536	422,726	29.08			
Nigeria	415	6,158	14.84			
Rhodesia and Nyasaland, Federation of				21	8,365	398.33
Union of South Africa	57,814	1,520,861	26.31	40,064	7,447,444	185.89
Total	80,875	2,333,560	28.85	40,085	7,455,809	186.00
Grand total	1,064,932	[2]76,735,186	72.06	707,859	[2]74,833,560	105.72

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable to earlier years.

TECHNOLOGY

Several books were published during 1955 on identification of rocks and minerals.[8] The structure and optical behavior of jadeite [9] and methods of identifying petrified wood [10] were discussed. Articles were published on the origin of jadeite and rose quartz.[11]

Block caving was initiated at the Kimberly, Union of South Africa, diamond mine.[12]

Methods of cutting amethyst [13] and asterated quartz [14] were described. The process of "tumbling" gem stones, giving instructions on types of equipment and abrasives for grinding and polishing, was published.[15] Polishing and cutting of cleavable gem stones such as kunzite, zircon, spodumene, and barite were discussed in an article.[16]

[8] Pearl, R. M., How to Know Minerals and Rocks: McGraw-Hill Book Co., Inc., New York, N. Y., 1955, 192 pp.
Wahlstrom, E. E., Petrographic Mineralogy: John Wiley & Sons, Inc., New York, N. Y., 1955, 408 pp.
Jensen, D. E., My Hobby Is Collecting Rocks and Minerals: Hart Publishing Co., New York, N. Y., 1955, 122 pp.
[9] Raman, C. V., and Jayaraman, A., The Structure and Optical Behavior of Jadeite: Proc. Indian Acad. Sci., vol. 41a, 1955, pp. 117–120; Chem. Abs., vol. 50, No. 19, Oct. 10, 1955, column 13031–f.
[10] Mineralogist, Identifying Wood: Vol. 23, No. 2, February 1955, pp. 72–74.
[11] de Roever, W. P., Genesis of Jadeite by Low-Grade Metamorphism: Am. Jour. Sci., vol. 253, No. 5, May 1955, p. 9283.
Petrun, V. F., [The Origin of Rose Quartz in Hydrothermal Veins]: Zapiski Vsesoyus. Mineralog. Odshchestva, vol. 84, 1955, pp. 191–197. Chem. Abs., vol. 50, No. 22, Nov. 25, 1955, column 15650–i.
[12] Gallagher, W. S., New Approach to Diamond Mining at Kimberly: Optima (Johannesburg, South-West Africa), vol. 5, No. 2, June 1955, pp. 52–61.
[13] Dake, H. C., How to Cut Amethyst: Mineralogist, vol. 23, No. 2, February 1955, pp. 92–94.
[14] Bly, Merwyn, The Cutting of Asterated Quartz Cabochons: Mineralogist, vol. 9, No. 9, September 1955, pp. 327–330.
[15] Dake, H. C., The Tumbled Gems: Mineralogist, vol. 23, No. 3, March 1955, pp. 133–138.
[16] Zinkanikas, John, Treatment of Cleavable Gemstones: Rocks and Minerals, vol. 30, No. 5–6, May–June 1955, pp. 266–269.

The investigation on discoloring of ordinary violet amethysts that change to a colorless, yellow or brown variety at 400°–500° C. and a discolored green amethyst was reviewed.[17]

The Consolidated Diamond Mines of South-West Africa, Ltd., have developed a method to recover diamonds from gravel by treating them with a water-repellent coating.[18] A summary of the latest metallurgical methods for the recovery of diamonds in the Belgian Congo was given by the Academie royale des sciences coloniales, Paris, France.[19]

An article described the formation of various varieties of quartz and chalcedony and their modes of occurrence.[20]

A new lapis-lazuli-colored synthetic gem stone with a hardness of 8 and specific gravity of 3.58 was developed in Germany.[21] A process for purifying alumina used to produce synthetic gem material was developed in Japan.[22] Included was the removal of iron, titanium, and rarer elements by only two recrystallizations.

A patent was obtained for an apparatus by which synthetic jewels are manufactured.[23] Another patent was issued for a process whereby cobalt or nickel oxide is added to TiO_2 to produce a single crystal varying in color from yellow to deep red when fired in an oxidizing atmosphere.[24]

WORLD REVIEW

The 1955 world diamond production reached an alltime high of 21.5 million carats, exceeding by 5 percent the previous record high reported in 1954. Of this total over 4 million carats were gem quality. Countries reporting major increases in production in 1955 were Belgian Congo, French West Africa, Gold Coast, Sierra Leone, South-West Africa, and Venezuela. Table 6 shows the world production of diamonds, 1951–55, by countries.

Angola.—The production of diamonds in Angola during 1955 was 743,378 carats. The proportion of gem diamonds was unknown.[25]

Belgian Congo.—All the diamond companies in Belgian Congo pooled their resources to conduct geological surveys of the areas in their respective concessions during a period of 3 years beginning July 1955.[26]

The production of diamonds in Belgian Congo from 1913–55 is shown in table 7.

Brazil.—Discovery of an aquamarine weighing 134.5 pounds was reported in the State of Minas Gerais. Its value was placed at $400,000.[27]

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17 Rose, H., and Lietz, J., [A Green Discolored Amethyst]: Naturwissenschaften, vol. 41, 1954, p. 448; Chem. Abs., vol. 50, No. 17, Sept. 10, 1955, column 11511–d.

18 Mine and Quarry Engineering, vol. 21, No. 11, November 1955, pp. 463–471.

19 Bureau of Mines, Mineral Trade Notes, Special Supplement 47: Vol. 41, No. 4, October 1955, pp. 5–7.

20 Walton, James, The Formation of Quartz and Chalcedony: Gemologist (London), vol. 24, No. 288, July 1955, pp. 119–123; vol. 24, No. 289, August 1955, pp. 139–142; vol. 24, No. 290, September 1955, pp. 164–169; vol. 24, No. 291, October 1955, pp. 191–194.

21 Bambauer, H. V., and Schmitt, C. H., [A New Lapis-Lazuli-Colored Synthetic]: Fortschr. Mineral., vol. 33, 1955, p. 130; Chem. Abs., vol. 49, No. 21, Nov. 10, 1955, column 14587–d.

22 Shiro, I., Alumina for Synthetic Gem Material: Jour. Chem. Soc. (Japan), Ind. Chem. Sec., vol. 58, 1955, pp. 181–183; Chem. Abs., vol. 49, No. 20, Oct. 25, 1955, column 14282–i.

23 Dauncey, L. A. (assigned to General Electric Co., Ltd., London), Apparatus for Manufacturing Synthetic Jewels: U. S. Patent 2,692,456, Oct. 26, 1954.

24 Merker, Leon (assigned to National Lead Co., New York, N. Y.), Colored Rutile Boules and Method for Making the Same: U. S. Patent 2,715,071, Aug. 9, 1955.

25 Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 4, April 1956, p. 25.

26 Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 4, October 1955, p. 35.

27 Washington Post and Times Herald, Dec. 21, 1955.

TABLE 6.—World production of diamonds, 1951–55, by countries, in carats [1]

(Including industrial diamonds)

	1951	1952	1953	1954	1955
Africa:					
Angola	734, 324	743, 302	729, 337	721, 607	743, 378
Belgian Congo	10, 564, 667	11, 608, 763	12, 580, 256	12, 619, 378	13, 041, 487
French Equatorial Africa	136, 000	163, 400	140, 144	152, 529	136, 900
French West Africa	101, 000	136, 080	180, 000	216, 000	318, 450
Gold Coast	1, 752, 878	2, 189, 557	2, 180, 728	2, 135, 141	2, 276, 631
Sierra Leone	475, 759	451, 426	472, 934	[3] 898, 608	[2 3] 930, 038
South-West Africa	478, 075	541, 027	617, 411	683, 536	797, 207
Tanganyika	108, 625	143, 023	172, 304	326, 009	325, 525
Union of South Africa:					
Lode	1, 967, 272	2, 093, 138	2, 397, 755	[4] 2, 544, 305	[4] 2, 276, 894
Alluvial	[5] 239, 063	[5] 282, 681	[5] 300, 000	[5] 314, 000	[2 5] 310, 000
South America:					
Brazil	[2] 200, 000	[2] 200, 000	[2] 200, 000	[2] 200, 000	[2] 200, 000
British Guiana	43, 260	38, 305	35, 308	30, 073	33, 298
Venezuela	63, 226	98, 291	84, 790	96, 983	141, 147
Other countries	[2] 3, 000	[2] 5, 000	[2] 5, 000	[2] 5, 000	[2] 5, 000
Grand total	16, 917, 000	18, 694, 000	[6] 20, 096, 000	20, 440, 000	21, 540, 000

[1] Source: Jewelers' Circular-Keystone, 31st Annual Report on the Diamond Industry: 1955, p. 7.
[2] Estimate.
[3] Includes an estimated production by African natives of about 500,000 carats.
[4] Pipe mines under De Beers control for 1954 included 75,225 carats and 58,787 carats in 1955 from De Beers alluvial diggings at Kleinzee.
[5] Includes an estimated 100,000 carats from the State mines of Namaqualand.
[6] Revised figure.

Burma.—Gem-stone production in Burma declined sharply in 1955 from 1954. Ruby production dropped from 21,628 carats to 17,053, sapphire production from 46,872 to 6,150, and spinel production from 31,163 to 5,400. All production for 1955 may not have been reported.[28]

Canada.—The most famous jade locality in Canada is in the Fraser River Valley of British Columbia. Some of the jade is light green and has excellent translucency.[29]

Ceylon.—The production of gem stones during 1955 was estimated by the Ceylon Department of Mineralogy to be from $315,000 to $420,000.[30] Ceylon's exports to the United States in 1955 were 17 percent more than in 1954. The principal stones were sapphire, ruby, cat's-eye, aquamarine, topaz, garnet, zircon, amethyst, and moonstone.

China.—It was reported that diamond-bearing deposits were discovered in northern Hunan Province in central China.[31]

TABLE 7.—Belgian Congo diamond production, 1913–55, in thousand carats

Year	Production	Year	Production	Year	Production	Year	Production
1913	16	1924	548	1935	3, 812	1946	6, 033
1914	24	1925	884	1936	4, 634	1947	5, 474
1915	49	1926	1, 141	1937	4, 925	1948	5, 825
1916	54	1927	1, 042	1938	7, 206	1949	9, 650
1917	100	1928	1, 649	1939	8, 380	1950	10, 147
1918	164	1929	1, 908	1940	9, 603	1951	10, 565
1919	215	1930	2, 519	1941	5, 866	1952	11, 609
1920	225	1931	3, 528	1942	6, 018	1953	12, 580
1921	174	1932	3, 990	1943	4, 882	1954	12, 619
1922	250	1933	2, 257	1944	7, 533	1955	13, 041
1923	415	1934	3, 331	1945	10, 386		
						Total	195, 250

[28] United States Embassy, Rangoon, Burma, State Department Dispatch 68: July 31, 1956, 24 pp.
[29] Bennett, John, A Gem Hunter in Canada: Mineralogist, vol. 23, No. 2, February 1955, pp. 60–62.
[30] United States Embassy, Colombo, Ceylon, State Department Dispatch 685: Mar. 1, 1956, 53 pp.
[31] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 3, September 1955, p. 42.

Colombia.—In 1955 the Ministry of Mines and Petroleum continued to review the laws and regulations governing the mining of emeralds. Certain temporary regulations were put into effect early in the year, so that mining would not be interrupted.[32]

Japan.—In 1954, 130,000 first-grade pearls were produced off the southern tip of Awagi Island. Plans in 1955 called for increased plantings until production of 1 million pearls per year is reached.[33]

Liberia.—New diamond deposits continued to be reported. Contrary to popular belief Liberian gem diamonds are of good quality. The business of cutting and polishing diamonds was started in Liberia in 1955, and equipment was installed for processing small stones for the export market.

The law governing the sale, purchase, and mining of diamonds, enacted by the 1954–55 session of the National Legislature was reported to be excellent. It did not impose too many restrictions and encouraged the large growth that the industry had during 1955.[34]

Rhodesia and Nyasaland, Federation of.—On August 19, 1955, an agreement was reached between De Beers Corp. and the Northern Rhodesian Legislative Council under which diamond-mining rights in the Territory will be relinquished to the Government in 1986.[35]

Sierra Leone.—It was reported that illicit diamond mining and trading increased during 1954 and 1955.[36]

Thailand.—The most important precious stones produced in Thailand in 1955 were black sapphires and Siamese rubies.[37]

Union of South Africa and South-West Africa.—Quotas on gem diamonds, released by the Central Selling Organization in 1955, for 1955–60, inclusive, were as follows: Government of Union of South Africa, 10 percent; Administration of South-West Africa, 26 percent; De Beers Consolidated Mines, Ltd., 25 percent; Diamond Corp., Ltd., 35 percent; and Premier (Transvaal) Diamond Mining Co., Ltd., 4 percent.[38]

Gem-stone production in South-West Africa in 1955 is shown in table 8.

TABLE 8.—Gem-stone production in South-West Africa, 1955 [1]

Gems	Production	Sales
Diamonds ... carats	797,198	789,475
Tourmaline ... grams	31,651	7,780
Amethyst ... pounds	22,680	
Chalcedony ... do	2,286	
Tiger's eye ... tons	(2)	2

[1] United States Consulate, Johannesburg, South-West Africa, State Department Dispatch 244: May 1, 1956, 3 pp.
[2] Not available.

Venezuela.—It was estimated that the 1955 production of pearls from Venezuela was nearly US$1.5 million.[39]

[32] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, p. 54.
[33] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 3, March 1955, p. 37.
[34] United States Embassy, Monrovia, Liberia, State Department Dispatch 330: May 3, 1956, 6 pp.
[35] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 5, November 1955, p. 43.
[36] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 3, March 1956, pp. 24–25.
[37] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 2, February 1956, p. 34.
[38] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 2, February 1956, p. 24.
[39] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 48.

Gem Stones

By John W. Hartwell [1] and Eleanor B. Waters [2]

GEM-STONE production in the United States in 1956 was $925,000, a 13-percent increase over 1955, due largely to the reported increased production of agate, diamond, jade, and turquois. The reported United States production did not include considerable quantities of gem materials and mineral specimens gathered by individuals for their private collections.

During the year nationally distributed magazines and newspapers continued to publish articles on gem stones and reports of valuable discoveries by individuals, stimulating the hobby or "industry" of gem-stone collecting and effecting increased production in many States.

In 1956 the Rocky Mountain Empire Investors acquired the famous Yogo sapphire mines in Judith Basin County, Mont., from the New Mine Sapphire Syndicate owned by a British concern. These deposits produced an estimated $20 million worth of gems during 37 years of operation.

On March 10, 1956, the Federal Trade Commission put into effect rules on the trade practices of the diamond industry, providing controls on sales and on advertised offers for sale to prospective purchasers of any diamonds that have been artificially colored or tinted by irradiation, heating, or any other means without disclosure.

The United States Atomic Energy Commission announced on March 17, 1956, that requests for irradiation of gems would be treated in the same manner as requests for irradiation of other materials.[3]

DOMESTIC PRODUCTION

In 1956 quartz gems and mineral specimens comprised approximately 50 percent of the value of all gem materials collected. Jade and turquois followed in importance, with 11 and 8 percent, respectively. Gem diamonds, being reported for the first time in several years, were credited with over 1.5 percent of the total. Oregon was again the leading producing State, with a 67-percent increase over 1955. Other States that reported substantial increases were Arkansas, Arizona, Montana, New Mexico, New York, North Carolina, South Dakota, Utah, Washington, and Wyoming.

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[1] Commodity specialist.
[2] Research assistant.
[3] Atomic Energy Commission, Commission Announces Gem Irradiation Policy: Release 798, Mar. 17, 1956, 2 pp.

TABLE 1.—Estimated production of gem stones in the United States for 1955 and 1956, in thousand dollars

State	1955	1956	State	1955	1956
Arizona	97	104	New Jersey	(2)	(2)
Arkansas	4	25	New Mexico	25	30
California	(1)	90	New York	(2)	2
Colorado	48	30	North Carolina	(2)	1
Florida		(2)	Oregon	150	250
Georgia	(2)	(2)	Pennsylvania	(2)	(2)
Idaho	5	(1)	South Dakota	7.4	10
Maine	5	(2)	Texas	115	115
Maryland		(2)	Utah	6	10
Michigan	(2)	(2)	Virginia	(2)	
Minnesota	(2)	(2)	Washington	65	75
Montana	(1)	35	Wyoming	57	75
Nebraska	2.4	3	Other States and Territories	226	20
Nevada	(1)	50			
New Hampshire	5	(2)	Grand total	818	925

[1] Included in other States and Territories.
[2] Figures of less than $1,000 included in "Other States and Territories."

TABLE 2.—Localities in the United States where gem materials were reported to have been found in 1956

State, county, and locality	Gem material
ALASKA	
Shungnak district: Kobuk.	Jade.
Chichagof district: Petersburg.	Agates and petrified wood.
ARIZONA	
Apache: St. Johns	Agate.
Cochise: Bisbee	Shattuckite.
Gila:	
Claypool	Apache tears.
Coolidge Dam	Agate.
Four Peaks area	Amethyst.
Globe	Agate, chrysocolla, and serpentine.
Miami	Turquois.
Salt River Canyon	Serpentine.
San Carlos Reservation.	Peridot.
Graham: Black Hills	Chalcedony.
Greenlee:	
Ash Springs Canyon	Agate.
Black Jack	Do.
Clifton	Do.
U. S. Highway 666	Do.
Duncan	Agate and jasper.
Limestone Canyon	Jasper-agate, agate, and jasper.
Mule Creek	Agate.
Sunset Peak	Do.
Maricopa:	
Saddle Mountain	Fire agate and pink chalcedony.
Superstition Mountains.	Agate.
Mohave: Chloride	Chalk turquois.
Navajo:	
Holbrook	Petrified wood.
Petrified Forest	Do.
Pima: Tuscon Mountains.	Chalcedony.
Pinal: Mammoth-Sombrero.	Agate.
Yavapai	Agate, jasper, chromium spar, and white jade.
ARIZONA—continued	
Yuma:	
Quartzsite	Plume agate, purple agate, desert roses, and quartz crystal.
Salome	Striped obsidian and jasper.
Yuma	Petrified iron wood.
Do	Rhyolite and agate.
ARKANSAS	
Garland:	
Crystal Springs	Quartz crystal.
Mountain Valley	Do.
Hot Spring: Hot Spring	Do.
Montgomery: Mount Ida.	Do.
Pike: Murfreesboro	Diamond.
CALIFORNIA	
Calaveras: Copperopolis	Copper.
Colusa: Sulphur Creek	Onyx (chalcedony).
Fresno: Coalinga	Chert and petrified wood.
Humbolt	Jasper (Chalcedony).
Imperial:	
Calexico	Sand spikes.
Ogilby	Garnet and kyanite ore.
Plaster City	Fossil oystershell.
Do	Palm wood and paisley agate.
Inyo:	
Inyo Mountains	Quartz crystal.
Panamint Mountains	Bloodstone.
Tecopa	Quartz (amethyst).
Kern:	
Boron	Jasper.
Rosamond	Rhodonite.
Tejon Ranch	Do.
Lake	Cinnabar, obsidian, jasper, and myrickite.
Marin: Bolinas	Whale bone.
Mendocino: Covelo	Jade and jasper.
Modoc: Davis Creek	Obsidian.

TABLE 2.—Localities in the United States where gem materials were reported to have been found in 1956—Continued

State, county, and locality	Gem material	State, county, and locality	Gem material
CALIFORNIA—continued		COLORADO—continued	
Mono: Hot Creek	Geode.	Montrose:	
Monterey:		Long Park	Dinsoaur bone.
King City	Limestone.	Naturita Canyon	Jasper.
Jade Cove, near Big Sur.	Jade.	Park: Hartsell	Moss opal.
Napa:		Saguache:	
Manhattan mine	Onyx.	Carnero Creek	Agate.
Do	Jasper (chalcedony).	Del Norte	Moss-plume agate.
Placer	Agate.	La Garita	Agate and amethyst.
Riverside:		Twin Mountains	Agate.
Blythe	Fire agate.	Villa Grove	Turquois.
Chuckawalla Mountains.	Agate geode.	San Juan: Eureka	Rhodonite.
Wiley Well	Chalcedony, jasper, and geode.	Sedgwick	Fossil wood and agate.
San Benito:		Teller:	
Hollister	Benitoite specimens.	Cripple Creek	Agate.
Do	Jadeite.	Crystal Peak area	Amazonstone.
San Bernardino:		Florrisant	Amazonite.
Blue Danube mine	Agate.	Lake George	Amazonite and smoky quartz.
Cadiz	Opalite.	FLORIDA	
Kingston Mountains	Amethyst.	Hillsborough: Tampa	Agatized coral.
Havasu Lake	Blue agate.	GEORGIA	
Ludlow	Moss agate.	Towns: Bell Creek	Corundum.
Needles	Petrified palm, blue agate, black palm, chalcedony, and jasper.	Troup: La Grange	Rose quartz.
Newberry area	Agate and petrified wood.	IDAHO	
Siam area	Crawfordite.	Canyon:	
Yermo	Petrified wood.	Nampa	White plume.
San Diego:		Do	Agate.
Mesa Grande	Spessartite garnet.	MAINE	
Ramona	Tourmaline, topaz, and smoky quartz.	Oxford:	
San Francisco: Indian Creek.	Nephrite.	Albany	Rose quartz.
San Luis Obispo: Nipomo.	Agate.	Stow	Amethyst.
San Mateo	Jasper.	MARYLAND	
Santa Clara: Morgan Hill.	Do.	Cecil: Conowingo	Williamsite.
Siskiyou:		MICHIGAN	
Clear Creek	Jadeite.	Keweenaw:	
Happy Camp	Californite.	Keweenaw Peninsula	Agate and thomsonite.
Do	Jade.	MINNESOTA	
Tulare: Sequoia National Forest.	Crystal (rock).	Lake: Shore of Lake Superior	Do.
COLORADO		MONTANA	
Chaffee:		Custer: Miles City	Agate.
Salida	Aquamarine.	Gallatin:	
Wellsville district	Agatized wood.	Gallatin Gateway	Corundum and rose quartz.
Do	Agate, onyx, and garnet.	Willow Creek	Petrified wood and blue agate.
Clear Creek: Buffalo Creek.	Amazonite.	Meagher: Fort Logan	Agate.
Custer: Westcliffe	Agatized wood.	Prairie: Terry	Do.
Douglas: Devil's Head	Topaz and smoky quartz.	Rosebud: Forsyth	Montana agate.
Elbert: Kiowa	Petrified wood.	Yellowstone: Billings	Agate.
Fremont:		NEVADA	
Garden Park	Alabaster, coprolite, and satin spar.	Esmeralda:	
Howard	Agatized wood.	Lone Mountain	Turquois.
Jefferson:		Do	Howardite.
Crystal Peak	Amazonite.	Humboldt	Fire opal.
Pine	Amazonstone and topaz.	Lander:	
Las Animas: Kim	Rose agate.	Battle Mountain	Turquois and rhodonite.
Mesa: Glade Park	Dinosaur bone.	Cortez Mining district	Turquois.
Mineral:		Ivanhoe	Opalite.
Amethyst Mine	Amethyst.	Lincoln:	
Bulldog Mountain	Banded agate.	Empy Mountain	Agate and blue quartz.
Creede	Agate and amethyst.		

TABLE 2.—Localities in the United States where gem materials were reported to have been found in 1956—Continued

State, county, and locality	Gem material	State, county, and locality	Gem material
NEVADA—continued		SOUTH DAKOTA—con.	
Mineral:		Custer—continued	
Fish Lake Valley	Obsidian.	French Creek	Jasper.
Montgomery Pass	Do.	Hells Canyon	Teepee agate.
Do	Turquois.	Pennington:	
NEW HAMPSHIRE		Bad Lands	Blue chalcedony, agate, agatized wood, and jasper.
Coos:		Quinn	Petrified wood.
Bald Face Mountain	Topaz.	TEXAS	
NEW JERSEY		Brewster:	
Passaic:		Alpine	Agate and fire opal.
Grove Brook	Carnelian.	Rio Grande River	Agate.
Paterson	Amethyst and prehnite.	El Paso: El Paso	Do.
NEW MEXICO		Pecos: Hovey	Do.
		Taylor: Abilene	Topaz and smoky quartz.
Bernalillo: Mud Springs	Desert scenic stone.	UTAH	
Catron:			
John Kerr Canyon	Agate.	Emery: Castle Dale	Agate.
Hidalgo: Red Rock	Agate and serpentine.	Garfield:	
Luna: Deming	Agate.	Escalante	Petrified wood.
Sierra: Engle	Do.	Hatch	Onyx.
Socorro: Socorro	Do.	Grand: Moab	Agate.
Valencia:		Juab: Thomas Range	Do.
Laguna Reservation	Selenite, jasper, and agate.	Kane:	
NEW YORK		Kanab	Petrified wood and septarian nodule.
		Orderville	Do.
Herkimer: Middleville	Quartz.	Do	Agate.
Orange: Tuxedo	Tourmaline.	Millard: Black Rock	Snowflake obsidian.
Rockland: Hillburn	Pink garnet.	Tooele: Dugway	Geode.
Warren: North Creek	Garnet.	Utah: Lehi	Onyx.
Westchester	Garnet and quartz.	Washington: Central	Agate and jasper.
NORTH CAROLINA		Wayne	Petrified wood, petrified bone, agate, and obsidian.
Avery: Cranberry	Epidote and unakite.		
Buncombe: Balsam Gap	Kyanite.	WASHINGTON	
Iredell: Statesville	Rose quartz.		
Macon:		Kittitas:	
Burningtown Gap	Corundum.	Columbia River	Petrified wood.
Franklin	Do.	Klickitat:	
Mitchell:		Lyle	Agate.
Crabtree	Emerald.	Roosevelt	Petrified wood.
Roan Mountain	Unakite.		
Spruce Pine	Golden beryl, biotite, and feldspar.	WYOMING	
OREGON		Albany: Bean Ranch	Dendritic agate.
Baker:		Carbon	Petrified wood and black jade.
Baker	Petrified wood.		
Green Horn	Do.	Fremont:	
Benton: Corvallis	Purple agate.	Absaroka Range	Agate and petrified wood.
Crook:		Crooks Mountain	Jade.
Prineville	Agate and thunderegg.	Dubois	Nephrite.
Do	Polka-dot agate.	Lander	Jasper.
Douglas	Carnelian agate.	Shoshoni	Jade.
Jefferson:		Sweetwater River	Agate.
Madras	Agate.	Johnson	Petrified wood.
Do	Thunderegg.	Natrona	Agate and petrified wood
Lake: Glass Butte	Obsidian.	Park	Do.
Lane:		Sweetwater:	
London Mountain	Blue agate.	Bitter Creek	Oolitic and agatized agate.
Malheur:			
Sucker Creek	Agate.	Eden	Petrified wood.
Do	Petrified wood.	Eden Valley	Petrified algae, eden wood, turritella, and petrified wood.
Morrow	Thunderegg.		
SOUTH DAKOTA		Farson	Fossil wood and petrified wood.
Custer:			
Custer	Agate, rose quartz, jasper, agatized wood, and breccia.	Hays Ranch	Petrified wood.
		Oregon Butte	Do.
Fairburn	Fairburn agate, jasper, breccia, and agatized wood.	Rock Springs	Jade and turritella agate.
		Wamsutter	Turritella and algae agate.
		Uinta: Carter	Petrified wood.

Agate.—Many sections of the United States reported sales of agate below the average of the last 5 years; but increased production from Arizona, Montana, Oregon, South Dakota, Texas, and Wyoming overshadowed any losses and resulted in agate becoming the principal gem material produced in 1956. It was estimated that agate valued at over $100,000 was produced during the year. Considerable quantities of this material were "tumbled" and sold as baroque gems.

Oregon was the leading producer in 1956, with an estimated value of $50,000, doubling the 1955 figure. Agate was found in most sections of the State, but the more important areas were in Jefferson, Crook, and Deschutes Counties.

Increased output in Arizona during 1956 resulted in the State producing the second largest quanity of agate, with a reported value of $25,000. Areas in Greenlee, Yuma, and Yavapai Counties were the chief sources, with a reported production value at nearly $10,000.

New Mexico continued production from a locality near Deming, Luna County, with an increase of 10 percent over 1955.

Fairburn agates of South Dakota were reported scarce, and prices were rising. In 1956, Sweetwater and Fremont Counties, Wyo., reported production over $8,000. The Montana agate deposits have been exploited for nearly 75 years, and known areas are now reaching depletion.

Diamond.—A 15.33-carat diamond valued at $8,000 was found at the Crater of Diamonds, Murfreesboro, Ark., on March 4, 1956. During the year, over 15,000 individuals hunted for diamonds in the Murfreesboro, Ark., area, and 93 more diamonds were found averaging 0.56 carat, with a total value of $8,700.

A flawless, blue-white, rough diamond, 425 carats, the world's 9th largest, was purchased by a New York jeweler. The largest gem that could be obtained from this stone would be a 200-carat, emerald-cut stone.[4]

Jade.—The jade industry during 1956 experienced one of the best years since discovery of jade in Wyoming in 1930. It was estimated that United States and Alaska mined over 32,000 pounds valued at nearly $100,000. The average price ranged from $2 to $8, depending upon quality and color. Large quantities of jade were exported to Germany and Japan for cutting and polishing.

In Wyoming, Fremont County was the leading producer, with a value estimated at $50,000. Carbon and Sweetwater Counties produced smaller quantities, valued at approximately $8,000.

The Empire Jade Co. and the Government-sponsored Shungnak Jade project continued procuring jade from the Shungnak district, Alaska. It was reported that a 2,000-pound jade boulder was successfully removed from this district and was expected to be sold in the Orient.[5]

A small quantity of white jade was produced in Yavapai County, Ariz.

In California a small production was reported from Monterey, Mendocino, and San Benito Counties.

Petrified Wood.—In 1956 over 150 tons of petrified wood was produced from an area west of the Petrified Forest National Monument

[4] Life, The Big Diamond: Vol. 40, No. 8, Feb. 20, 1956, pp. 57–58, 60.
[5] Engineering and Mining Journal, vol. 157, No. 10, October 1956, p. 136.

in Navajo County, Ariz. Most of this material was sold to tourists and lapidaries for cutting and polishing, but some was used as building material for rock gardens and fireplaces. Production from Arizona was estimated at $35,000.

Sweetwater County, Wyo., continued production in 1956, with a value estimated at $5,000. Utah production was valued at nearly $3,000, principally from Garfield County. In Nevada approximately $3,000 worth was produced in 1956.

Production was also reported from California, Colorado, Montana, Oregon, and Washington. Ginko, tempskya, and other rare fossil woods were produced in small quantities.

Turquois.—Nevada was the leading turquois producer in 1956, with a value estimated at $25,000. R. J. Frank and James Klopper, lessees of the Lone Mountain mine, and T. E. Sabin, of the Battle Mountain deposits, mined 85 percent of the total State production.

Arizona production of turquois in 1956 was nearly $20,000, with most material originating from the Sleeping Beauty mine, Gila County.

The Villa Grove turquois mine, Sagauche County, Colo., production was valued at over $15,000.

A report contained information on the origin, occurrence, and properties of turquois in three California and Nevada mines.[6]

CONSUMPTION

The United States, which depends completely upon foreign sources for gem diamonds, has increased consumption each year and in 1956 imported 39 percent of the world supply. In 1956 the value of all gem material consumed in the United States was estimated at $189 million, of which less than 1 percent was produced domestically. Most gem stones produced in the United States were used by amateur lapidaries, but some jade and other less valuable stones were exported to Germany and Japan for cutting, carving, and polishing and returned for sale in the United States.

PRICES

In 1956 the average diamond prices per carat, imported into the United States, were: Cut, but unset, $109.35; and rough or uncut, $72.58. The average price of cut diamonds per carat decreased from 1946 to 1956, whereas the price of rough stones increased because of a shortage and greater demand for better grade diamonds.

[6] Hewett, D. F., Geology and Mineral Resources of the Ivanpah Quadrangle, California and Nevada: Geol. Survey Prof. Paper 275, 1956, pp. 165–166.

As a result of negotiations between the United States and 21 other countries, tariff rates were reduced in 1956 on several categories of jewelry and related goods, including imitation semiprecious and precious stones, cut, uncut, or faceted.[7]

FOREIGN TRADE [8]

The value of gem-stone imports into the United States in 1956 increased 7 percent over 1955. Gem diamonds accounted for 86 percent of the total, the same as in 1955. Imports of pearls and precious, semiprecious, and synthetic gem stones increased 8 percent in 1956 over 1955.

In 1956 the United States exported 27 percent less and reexported 48 percent more gem stones (precious, semiprecious, synthetic, and imitation) than in 1955.

TABLE 3.—Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1955–56

[Bureau of the Census]

Item	1955		1956	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty-free	[1] 1,066,637	[1, 2] $76,798,651	1,188,332	$86,243,214
Cut but unset, suitable for jewelry, dutiable	707,859	[2] 74,883,550	693,142	[2] 75,795,826
Emeralds: Cut but not set, dutiable	45,235	1,564,676	50,931	1,688,429
Pearls and parts, not strung or set, dutiable:				
Natural		669,351		[2] 626,237
Cultured or cultivated		[2] 6,197,897		[2] 8,024,660
Other precious and semiprecious stones:				
Rough or uncut, duty-free		228,939		[2] 280,692
Cut but not set, dutiable		[2] 2,837,932		[2] 3,116,372
Imitation, except opaque, dutiable:				
Not cut or faceted		[2] 25,885		[2] 40,496
Cut or faceted:				
Synethetic		[1, 2] 298,133		[2] 402,272
Other		[1, 2] 11,806,853		[2] 11,448,744
Imitation, opaque, including imitation pearls, dutiable		[2] 19,185		[2] 30,410
Marcasites, dutiable: Real and imitation		44,439		38,911
Total		[1, 2] 175,325,491		[2] 187,736,263

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with years before 1954.

[7] Jewelers' Circular-Keystone, vol. 76, No. 11, August 1956, p. 210.
[8] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activties, Bureau of Mines, from records of the Bureau of the Census.

TABLE 4.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1955–56, by countries

[Bureau of the Census]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1955						
North America:						
Bermuda	2,205	$228,467	$103.61			
Canada	5,900	569,306	96.49	127	$14,125	$111.22
Netherland Antilles				29	39,955	1,377.76
Total	8,105	797,773	98.43	156	54,080	346.67
South America:						
Brazil	4,127	199,085	48.24	113	13,427	118.82
British Guiana	2,566	73,104	28.49			
Venezuela	[1] 91,348	2,642,087	[1] 28.92	48	7,662	159.63
Total	[1] 98,041	2,914,276	[1] 29.73	161	21,089	130.99
Europe:						
Austria				7	3,674	524.86
Belgium-Luxembourg	102,676	10,692,952	104.14	427,422	45,354,711	106.11
France	9,203	730,133	79.34	4,470	869,862	194.60
Germany, West	1,141	11,215	9.83	48,948	3,452,716	70.54
Italy				136	127,461	937.21
Netherlands	2,573	261,443	101.61	22,243	2,633,320	118.39
Switzerland	29,965	1,911,100	63.78	250	58,799	235.20
United Kingdom	[1] 728,878	[1] 57,023,753	[1] 78.23	5,464	947,127	173.34
Total	[1] 874,436	[1] 70,630,596	[1] 80.77	508,940	53,447,670	105.02
Asia:						
Hong Kong	294	1,177	4.00			
India				249	29,042	116.63
Indonesia	130	19,497	149.98			
Iraq				103	9,284	90.14
Israel	4,136	44,821	10.84	157,326	13,735,028	87.30
Japan				837	80,848	96.59
Lebanon	549	44,750	81.51			
Malaya	71	12,201	171.85			
Saudi Arabia				2	700	350.00
Total	5,180	122,446	23.64	158,517	13,854,902	87.40
Africa:						
French Equatorial Africa	8,110	383,815	47.33			
Liberia	14,536	422,726	29.08			
Nigeria	415	6,158	14.84			
Rhodesia and Nyasaland, Federation of				21	8,365	398.33
Union of South Africa	57,814	1,520,861	26.31	40,064	7,447,444	185.89
Total	80,875	2,333,560	28.85	40,085	7,455,809	186.00
Grand total	[1] 1,066,637	[2] 76,798,651	72.00	707,859	[2] 74,833,550	105.72
1956						
North America:						
Bermuda	498	48,664	97.72			
Canada	4,929	576,212	116.90	279	22,304	79.94
Mexico				57	23,467	411.70
Total	5,427	624,876	115.14	336	45,771	136.22
South America:						
Brazil	2,456	112,342	45.74	253	20,196	79.83
British Guiana	6,595	200,740	30.44			
Colombia	86	12,055	140.17			
Surinam				85	834	9.81
Uruguay				75	23,000	306.67
Venezuela	56,996	1,644,575	28.85	156	25,363	162.58
Total	66,133	1,969,712	29.78	569	69,393	121.96

See footnotes at end of table.

TABLE 4.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1955–56, by countries—Continued

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1956—Continued						
Europe:						
Austria				480	$52, 800	$110. 00
Belgium-Luxembourg	139, 965	$16, 579, 867	$118. 46	422, 002	46, 810, 415	110. 92
Czechoslovakia				25	5, 660	226. 40
France	4, 634	436, 790	94. 26	9, 293	1, 173, 809	126. 31
Germany, West	2, 442	108, 457	44. 41	38, 333	2, 750, 098	71. 74
Italy				64	8, 806	137. 59
Netherlands	3, 776	212, 270	56. 21	21, 987	2, 696, 243	122. 63
Switzerland	11, 085	429, 418	38. 74	385	340, 049	883. 24
United Kingdom	810, 591	60, 991, 614	75. 24	3, 526	536, 427	152. 13
Total	972, 493	78, 758, 416	80. 99	496, 095	54, 374, 307	109. 60
Asia:						
Ceylon				14	1, 058	75. 57
Hong Kong	76	1, 662	21. 87	4	419	104. 75
India				1, 424	121, 254	85. 15
Israel	2, 556	51, 011	19. 96	145, 950	13, 169, 447	90. 23
Japan				1, 050	88, 242	84. 04
Lebanon	89	7, 666	86. 13			
Malaya				111	15, 670	141. 17
Total	2, 721	60, 339	22. 18	148, 553	13, 396, 090	90. 18
Africa:						
Belgian Congo	11, 500	27, 042	2. 35			
British East Africa	74	740	10. 00			
Egypt				77	6, 674	86. 68
French Equatorial Africa	48, 012	1, 242, 420	25. 88			
Liberia	35, 536	1, 420, 676	39. 98	15	4, 130	275. 33
Southern British Africa				1	487	487. 00
Union of South Africa	46, 436	2, 138, 993	46. 06	47, 496	7, 898, 974	166. 31
Total	141, 558	4, 829, 871	34. 12	47, 589	7, 910, 265	166. 22
Grand total	1, 188, 332	86, 243, 214	72. 58	693, 142	[2] 75, 795, 826	109. 35

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the Bureau of the Census data known to be not comparable with years before 1954.

TECHNOLOGY

Articles were published on cutting and polishing spinel;[9] sapphire polishing, using rubber-bonded wheels;[10] and gem-stone drilling.[11] Processes and techniques used in photographing minerals in color were published.[12] A history on manufacture of synthetic diamonds, rubies, sapphires, emeralds, and their industrial uses was written.[13] An automatic Verneuil furnace was described, and details and illustrations regarding its operation were given.[14]

Faustite, a newly identified mineral similar to turquois, was discovered in the Copper King mine, Eureka County, Nev. It occurred as an apple-green vein filling in altered shale. The mineral contains

[9] Mineralogist, How to Cut Spinel: Vol. 24, No. 12, December 1956, pp. 478, 480.
[10] Mineralogist, Rubber-Bonded-Wheel Sapphire Polishing: Vol. 24, No. 11, November 1956, pp. 425–426.
[11] Bowser, L. E., Notes on Gem Drilling: Mineralogist, vol. 24, No. 11, November 1956, pp. 426, 428, 430.
[12] Getsinger, F. R., Photographing Minerals in Color: Arizona Highways, vol. 32, No. 11, November 1956, pp. 15–17.
[13] Wisconsin Engineer, vol. 60, No. 6, 1956, pp. 18–20; Chem. Abs., vol. 50, No. 22, Nov. 25, 1956, column 16208–i.
[14] Verma, R. K., Sirkar, G. N., and Chatterjee, S., An Automatic Verneuil Furnace: Gemmologist (London), vol. 25, No. 296, March 1956, pp. 52–56.

zinc, in addition to the regular mineral composition of turquois.[15] Lazulite with a sky-blue color and hardness of 6 was found in coarse-grained crystal aggregates.[16] An unusual garnet with rare cubic and octahedral faces, found between Canton and Ball Ground, Cherokee County, Ga., was described.[17] Pale-blue cordierite was unearthed in a mica mine in Monroe County, Ga. This gem material was found in irregular masses up to ¾ inch across.[18]

Twelve mineral specimens were described, giving the synonyms, nomenclature, varieties, compositions, crystallography, physical and optical properties, tests and diagnoses, occurrence, and uses. Each mineral was illustrated in color. These mineral specimens were: Rhodochrosite, cuprite, smaltite, smithsonite, chalcopyrite, magnetite, cerussite, sodalite, molybdenite, apatite, wulfenite, and gypsum.[19]

A historical article was published on the mining and production of emeralds in Columbia.[20]

The origin of gem-quality corundum found in placer deposits in Ceylon was considered to be a contact zone where syenite was intruded into and desilicated by crystalline limestone.[21]

The gem material, benitoite ($BaTiSi_3O_9$), was synthesized hydrothermally.[22]

Conversion of one mineral to another was achieved in the laboratory by duplicating the conditions developed in the earth at extreme depth.[23]

A comprehensive report was written on the synthetic-gem-stone industry of India.[24]

Experiments on diamond synthesis were continued in 1956 by the General Electric Co. The chamber in which the diamonds were formed was approximately 5/16 inch in diameter and 1 inch in depth. Operating pressures were increased from the original 1.5 million p. s. i. to 2.5 million p. s. i., with temperatures up to 5,000° F. About 80 percent of the raw material used was converted into diamond. The largest diamond produced was one-hundredth carat.[25]

A standard color code for diamond pastes, showing colors used by 15 manufacturers, was issued in chart form.[26] Methods of determining diamond color characteristics, with illustrations in color, were described.[27]

A mixture of powdered TiO_2 and MgO, fused in a Verneuil furnace at 1,830°–1,870° C., produced a blue-black crystal. Subsequent

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[15] Erd, R. C., Foster, M. D., and Proctor, P. D., Faustite, A New Mineral and Zinc Analogue of Turquois: Am. Mineralogist, vol. 38, No. 11–12, November–December 1953, pp. 964–972; Ceram. Abs., vol. 39, No. 11, November 1956, p. 248j.

[16] De, Aniruddha, Lazulite From Sini, Saraikela (Bihar): Sci. and Culture (India), vol. 21, 1956, p. 746; Chem. Abs., vol. 50, No. 22, Nov. 25, 1956, column 16573-e.

[17] Georgia Mineral Newsletter, vol. 9, No. 1, Spring 1956, p. 19.

[18] Georgia Mineral Newsletter, vol. 9, No. 2, Summer 1956, p. 73.

[19] Mine and Quarry Engineering (London), Minerals Specimens No. 28–39: Vol. 22, No. 1, January 1956, pp. 12–13; No. 2, February 1956, pp. 58–59; No. 3, March 1956, pp. 102–103; No. 4, April 1956, pp. 136–137, No. 5, May 1956, pp. 174–175; No. 6, June 1956, pp. 220–221; No. 7, July 1956, pp. 270–271; No. 8, August 1956, pp. 318–319; No. 9, September 1956, pp. 362–363; No. 10, October 1956, pp. 412–413; No. 11, November 1956, pp. 458–459; No. 12, December 1956, pp. 508–509.

[20] Morello, Ted, The Gem of Colombia: Americas, vol. 8, No. 10, October 1956, pp. 21–24.

[21] Wells, A. J., Corundum From Ceylon: Geol. (Hertford, England), vol. 93, No. 1, January–February 1956, pp. 25–31.

[22] Rase, D. E., and Roy, Rustum, Phase Equilibria in the System $BaTiO_3$–SiO_2: Jour. Am. Ceram. Soc., vol. 38, November 1955, pp. 389–395.

[23] Mining Journal (London), The Creation of Minerals: Vol. 246, No. 6284, Jan. 27, 1956, p. 125.

[24] Sarma, M. V., Manufacture of Synthetic Gems in India: [1956 (?) Revision of an earlier publication], 8 pp. The Huxley Press, 114 Armenian Street, Madras, India.

[25] Journal of Gemmology (London): Vol. 5, No. 7, July 1956, p. 387.

[26] Industrial Diamond Review, Color Codes for Diamond Pastes: Vol. 16, No. 188, 1956, pp. 136–137; Ceram. Abs., vol. 39, No. 11, November 1956, p. 231e.

[27] Custers, J. F. H., Colors in Diamonds: Optima (Johannesburg), vol. 6, No. 2, June 1956, pp. 48–51.

oxidation at decreasing temperatures from 1,100°–500° C. produced a substantially white material exhibiting asterism.[28] Patents were obtained on a lapidary wheel [29] and a lapidary template and dopstick.[30]

Many agates can readily be colored by heat treating at 200°–300° C., cooling, and then applying inorganic salts by various methods.[31]

Polarized light regularly transmitted by fibrous chalcedony and the character of the spectra exhibited by iridescent agate were described.[32]

In Japan the standard pearl necklace is 17 inches long, and the average center pearl is 7–7½ millimeters. The largest pearl produced is 11 millimeters but requires 5 to 6 years to grow. Normally, a 2-year cycle produces the average-size pearl.[33] Seeds for pearls and pearl oysters treated for several minutes in thyroxine solution, and cultured in the usual manner, gave nearly 100 percent pink or rainbow-colored pearls.[34]

WORLD REVIEW

In 1956 world diamond production increased 1.6 million carats, or 7 percent, over 1955. Of the world total, 21 percent was of gem quality. Countries reporting increases in production were: Sierra Leone, 35 percent; South-West Africa, 22 percent; French West Africa, 22 percent; Tanganyika, 10 percent; Belgian Congo, 7 percent; and French Equatorial Africa, 6 percent.

Australia.—A joint Australian, Japanese, and United States pearl-culture farm was established in Brecknock Harbor between Augustus Island and the Australian mainland on June 20, 1956. It was reported that 35,000 immature oysters would be planted the first year. Most of the pearls produced were to be sold in the United States.[35]

Belgian Congo.—Belgian Congo, the world's largest producer of diamonds, increased production nearly 1 million carats in 1956 over 1955; 5 percent was gem quality.[36] It was reported that inquiries were made by United States dealers regarding the feasibility of obtaining increased quantities of mineral specimens and semi-precious stones.[37] A low-grade diamond deposit in Belgian Congo being developed by the Société Minière de Beceka, in 1956, undertook to lower costs and increase production by using a heavy-medium separation process in its washing and concentration plant.[38]

Colombia.—The quality and quantity of emeralds produced in Colombia during 1956 were below expectations. Three mines were in operation, one of which was owned by a United States company.[39]

French Equatorial Africa.—A 149-carat diamond was found in the mine, Société Minière de l'Est Oubangui. It was estimated that 40

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[28] Merker, Leon (assigned to National Lead Co.), Monocrystalline Rutile: U. S. Patent 2,760,874, Aug. 28, 1956.

[29] Vorado, P. A., Lapidary Wheel: U. S. Patent 2,745,225, May 15, 1956.

[30] Ponting, F. W., Lapidary Template and Dopstick: U. S. Patent 2,735,246, Feb. 21, 1956.

[31] Gemmologist (London), Agate Coloring by Heat Treatment: Vol. 25, No. 304, November 1956, pp. 208–209.

[32] Raman, C. V., and Jayarman, A., Optical Behavior of Cryptocrystalline Quartz: Proc. Indian Acad. Sci., vol. 41A, January 1955, pp. 1–6; Ceram. Abs., vol. 39, No. 4, April 1956, p. 84f.

[33] U. S. Consulate, Kobe-Osaka, Japan, State Department Dispatch 45: Sept. 13, 1956, p. 10.

[34] Takaoka, Susumu, Pink or Rainbow-Colored Cultured Pearls: Japanese Patent 1330, Feb. 26, 1955; Chem. Abs., vol. 50, No. 22, Nov. 25, 1956, column 17260b.

[35] U. S. Consulate, Perth, Australia, State Department Dispatch 1: July 27, 1956, p. 6.

[36] Gemmologist (London), vol. 25, No. 294, January 1956, p. 8.

[37] U. S. Consulate, Elisabethville, Belgian Congo, State Department Dispatch 45: Feb. 20, 1956, p. 1.

[38] U. S. Consulate, Elisabethville, Belgian Congo, State Department Dispatch 40: Mar. 19, 1957, pp. 1, 5.

[39] U. S. Embassy, Bogota, Colombia, State Department Dispatch 304: Nov. 9, 1956, p. 1.

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TABLE 5.—World production of diamonds, 1947–51 (average) and 1952–56, by countries, in thousand carats [1] (including industrial diamonds)

	1947–51 (average)	1952	1953	1954	1955	1956
Africa:						
Angola	728	743	729	722	743	740
Belgian Congo	8,332	11,609	12,580	12,619	13,041	14,013
French Equatorial Africa	119	163	140	153	137	146
French West Africa	91	136	180	216	318	390
Ghana (Gold Coast) [2]	1,076	2,190	2,181	2,135	2,277	2,127
Sierra Leone	539	451	473	399	930	[2] [3] 1,427
South-West Africa	325	541	617	684	797	970
Tanganyika	141	143	172	326	328	359
Union of South Africa:						
Lode	1,259	2,093	2,398	2,544	2,277	[4] 2,235
Alluvial [5]	273	283	300	314	310	300
South America:						
Brazil [2]	235	200	200	200	200	300
British Guiana	35	38	35	30	33	30
Venezuela	63	98	85	97	141	94
Other countries [2]	3	5	5	5	5	5
Grand total (rounded)	13,225	18,695	20,095	20,445	21,540	23,135

[1] Rounded from Jewelers' Circular-Keystone, 32d Annual Report on the Diamond Industry: 1956, p. 7.
[2] Estimated.
[3] Including unofficial production and Liberia.
[4] Includes alluvial diggings at Kleinzee.
[5] Including State owned mines of Namaqualand.

to 50 percent of the diamonds mined in French Equatorial Africa was of gem quality.[40]

India.—In 1956 it was reported that the Switzerland synthetic gem industry was establishing a similiar enterprise in India, to be called the Indo-Swiss Synthetic Gem Manufacturing Co., Ltd. Production would start early in 1957, with an annual production of 12 tons. In 1956 India consumed about 50 tons of synthetic gem materials in the cutting of gem stones.[41]

Israel.—In 1956 diamond exports increased 14 percent by weight and 19 percent by value over 1955. About 20 percent of the imported material was purchased from sources other than the London Diamond Syndicate. The United States was the largest purchaser, with 54 percent of the diamond exports.[42]

Japan.—It was estimated that in 1956 $1 million worth of hand-cut or carved semiprecious stones was produced in Japan. Wide varieties of semiprecious stones were imported by Japan for the hand-carving industry.[43]

Large losses in the pearl industry, caused by typhoons, were announced. Investigations were made to determine the possibility of moving the pearl industry to the Inland Sea and of establishing a crop of 30 million oysters the first year.[44]

Liberia.—A diamond rush was reported in western Liberia, around the Bomi Hills, and other areas.[45]

[40] U. S. Consulate, Elisabethville, French Equatorial Africa, State Department Dispatch 18: Oct. 31, 1956, p. 3.
[41] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 3, March 1957, pp. 20–21.
[42] U. S. Embassy, Tel Aviv, Israel, State Department Dispatch 486: Mar. 22, 1956, pp. 1, 2.
[43] U. S. Consulate General, Yokohama, Japan, State Department Dispatch 22: Sept. 17, 1956, pp. 1, 2.
[44] U. S. Consulate, Nogoya, Japan, State Department Dispatch 16: Oct. 8, 1956, p. 5.
[45] U. S. Embassy, Monrovia, Liberia, State Department Dispatch 368: June 13, 1956, pp. 5, 6.

Thailand.—Few precious and semiprecious gem stones originate in Thailand—most were imported, cut and polished, and exported. In 1956 the value of imports was $305,000 and exports $660,000.[46]

Tanganyika.—In 1956 Tanganyika produced 10 percent more diamonds than in 1955. The Williamson diamond mine produced 96 percent, and Alamasi, Ltd., mined the balance.[47] A new diamond-recovery plant with a crude-material capacity of 7,000 to 7,500 tons per day was installed at the Williamson diamond mine.[48]

Union of South Africa.—A concession was obtained by the Planned Investment Trust, Ltd., Johannesburg, with Canadian financial support, to prospect for base metals and diamonds and other precious stones.[49] In 1956 Mallin diamond mines, Zwartruggens, Transvaal, Union of South Africa, expanded its diamond production by mining 6,500 tons a month, averaging 10,500 carats; 20 percent was gem quality.[50]

[46] U. S. Embassy, Bangkok, Thailand, State Department Dispatch 695: Apr. 4, 1956, p. 6.
[47] U. S. Consulate, Dar es Salaam, Tanganyika, State Department Dispatch 139: May 23, 1956, pp. 24, 25.
[48] U. S. Consulate, Dar es Salaam, Tanganyika, State Department Dispatch 139: May 23, 1956, p. 25.
[49] U. S. Consulate, Johannesburg, Union of South Africa, State Department Dispatch 108: Nov. 7, 1956, p. 1.
[50] Gemmologist (London), vol. 25, No. 294, January 1956, p. 8.

Gem Stones

By John W. Hartwell[1] and Betty Ann Brett[2]

GEM MATERIAL collected during 1957 in the United States was valued at about $900,000, slightly less than in 1956.

New regulations on the advertising of jewelry and gem stones in publications, circulars, or orally, were issued by the Federal Trade Commission on June 28, 1957. These regulations apply to all manufacturers, importers, and sellers and are designed to protect the trade and public from unfair practices.

DOMESTIC PRODUCTION

No new localities for gem materials were reported in 1957. Sources of gem materials were listed in previous Gem Stones chapters.

About 800 gem and mineral clubs were active in the United States in 1957, mostly in the Rocky Mountain and Pacific Coast areas. The number of members was not known but was reported to be close to 40,000; about one-quarter owned and operated their own lapidary equipment.

Collecting gem material in the Pacific Northwest by amateurs was reported becoming more difficult, as more privately owned properties were closed to collectors. Collecting gained popularity in the East.

Some owners of gem-stone claims opened their land to collectors for certain fees and used power-operated dirt-moving equipment to uncover the gem material.

In the Pacific Northwest commercial producers of baroque or "tumbled"-type gems reported production valued at nearly $100,000. Because of the popularity of baroque jewelry, suitable "tumbling" material was difficult to obtain. Commercial lapidaries sold less of this type of jewelry because more amateurs "tumbled" their own material.

Six States—Oregon, California, Nevada, Texas, Arizona, and Washington—produced 72 percent of the total reported value of gem materials in 1957. Oregon led in production, with an estimated $200,000—20 percent less than was reported in 1956.

Agate.—Agate produced in the United States during 1957 was valued at more than $125,000, a 25-percent increase over 1956. Commercial and amateur lapidaries sold about 200 short tons of "tumbled" agate material as baroque gems. Principal States, in decreasing order of production, were: Oregon, New Mexico, Arizona, Texas, and Wyoming. Output in Oregon was valued at approximately $60,000, a 20-percent increase over 1956. Principal areas of production were Jefferson, Crook, and Deschutes Counties. Reports from New Mexico indicated an agate production of nearly $25,000, largely from near Deming, Luna County.

[1] Commodity specialist.
[2] Statistical clerk.

Arizona produced agate worth an estimated $15,000, principally from Greenlee, Maricopa, Pima, and Yuma Counties; this was a 40-percent decrease from the value reported in 1956.

Emerald.—The emerald mine near Little Switzerland, N. C., formerly leased by the American Gem and Pearl Co., was reopened by Little Switzerland Emerald Mines, Inc.

Yearly production of synthesized emeralds by C. F. Chatham, San Francisco, Calif., was estimated at 60,000 carats. About 10 percent of the stones were high quality, retailing at $90 to $120 per carat.[3]

Jade.—Jade production in the United States during 1957 was valued at $50,000, a 50-percent reduction from 1956. About half of the total value was reported from Wyoming.

During 1957 the Empire Jade Co., Shungnak district, Alaska, produced jade estimated equal to the 1956 output. Some jade boulders were cut to sizes suitable for 24-inch saws and sold to retailers in the United States. The balance of the material was exported to Germany for finishing into jewelry. The Government-sponsored Shungnak Jade Project in Alaska did not sell raw jade but continued to finish ornamental objects and jewelry. Only a small part of the jade, purchased from Eskimo claim owners, was gem quality.

Petrified Wood.—Production of petrified wood decreased in quantity and value from the record reported during 1956. Estimated value of production from four States was as follows: Arizona, $25,000; Utah, $5,000; Wyoming, $4,000; and Colorado, $3,000.

Gingko, tempska, and other rare fossil woods were produced in small quantities in California, Montana, Oregon, and Washington.

Turquois.—Arizona became the principal turquois-producing State in 1957, surpassing Nevada, the leading State in 1956. Arizona production of turquois was $30,000. Localities near Miami and Kingman produced about 7,500 pounds of low-grade material valued at $17,000. Nevada reported production of 1,300 pounds of high-grade material, which was valued at $13,000. The Lone Mountain and Battle Mountain mines were the principal producers. Turquois also was produced in Colorado.

Miscellaneous Gem Materials.—Fire-opal production from the Virgin Valley area, Nevada, was reported for the first time since 1955. Production was valued at $52,000.

A dispatch from the Pike County diamond field, Arkansas, states that a diamond weighing 3.11 carats was found during 1957. One diamond weighing 15.33 carats was found in 1956 near the same location.[4]

Development of the Yogo sapphire mine in Judith Basin County, Mont., uncovered 2 large stones, weighing 4½ and 5½ carats. Plans were made to build a mill in 1958.

Over 5 tons of obsidian and quantities of other durable gem materials were used by lapidaries for "tumbling" during 1957 to fill the demand for baroque gems.

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[3] Morello, Ted, Green Treasure of the Andes: Nature Mag., vol. 50, No. 10, December 1957, p. 515.
[4] Washington Evening Star, Woman Finds 3.11-Carat Diamond in Arkansas Mine: 105th Year, No. 140, May 20, 1957, p. A5.

TABLE 1.—Estimated production of gem stones in the United States, 1955–57, in thousand dollars

	1955	1956	1957
Alaska	(2)	(2)	(2)
Arizona	97	104	75
Arkansas	4	25	(1)
California	(1)	90	100
Colorado	48	30	35
Connecticut			(2)
Florida		(2)	(2)
Georgia	(2)	(2)	(2)
Idaho	5	(1)	5
Illinois			2
Iowa			(2)
Maine	5	(2)	(2)
Maryland		(2)	(2)
Michigan	(2)	(2)	(2)
Minnesota	(2)	(2)	(2)
Missouri			(2)
Montana	(1)	35	35
Nebraska	2.4	3	2
Nevada	(1)	50	100
New Hampshire	5	(2)	(1)
New Jersey	(2)	(2)	(2)
New Mexico	25	30	30
New York	(2)	2	5
North Carolina	(2)	1	(2)
North Dakota			(2)
Oregon	150	250	200
Pennsylvania	(2)	(2)	(2)
South Dakota	7.4	10	15
Texas	115	115	100
Utah	6	10	12
Washington	65	75	75
Wyoming	57	75	65
Other States and Territories	226	20	36
Total	818	925	882

[1] Included with "Other States and Territories."
[2] Figures of less than $1,000 included with "Other States and Territories."

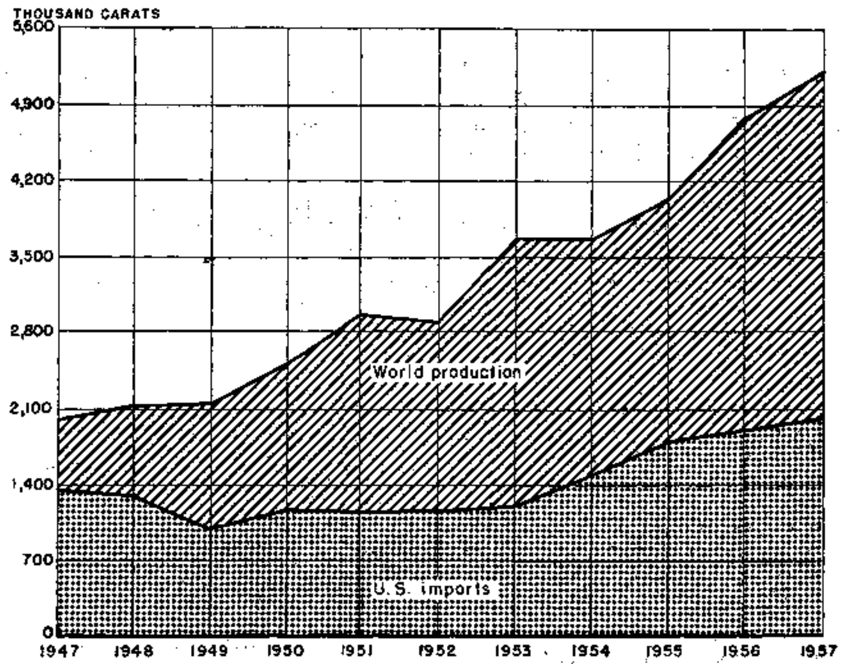

FIGURE 1.—World production and United States imports of gem diamonds, 1947–57.

CONSUMPTION

Sales of lapidary equipment and supplies, gem materials (excluding diamond), and mineral specimens were estimated at nearly $5 million. Synthetic gem-stone purchases from producers in the United States were estimated to be about $1 million; other countries supplied over

$10 million. Purchases of natural gem material, exclusive of diamond, from other sources was reported to be nearly $15 million.

The apparent consumption (domestic production plus imports minus exports) of gem stones in the United States in 1957 was over $142 million.

PRICES

In January 1957 the Diamond Trading Co. of London, England, announced price increases of 5 to 7½ percent on all qualities of rough diamonds used in manufacturing regular goods, tapered baguettes, and melee.[5]

The average diamond prices per carat imported into the United States were for cut, but unset, $107.28 and for rough or uncut, $76.93. The upward trend of prices paid for rough or uncut stones continued in 1957, with an average increase of $4.35 per carat; prices for cut but not set stones decreased $2.07 per carat.

Average prices paid for sapphire imported into the United States for consumption were $9.67 higher per carat in 1957 than in 1956.

FOREIGN TRADE[6]

Imports of gem stones into the United States in 1957 decreased 10 percent in value from 1956. This was the first decrease reported since 1952. Gem diamonds supplied 85 percent of the total imports, compared with 86 percent in 1956.

TABLE 2.—Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1956–57

[Bureau of the Census]

Item	1956		1957	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty-free	[1] 1,176,832	[1] $86,216,172	1,002,696	$77,142,072
Cut but unset, suitable for jewelry, dutiable	693,142	[2] 75,795,826	609,775	65,418,387
Emeralds: Cut but not set, dutiable	50,931	[2] 1,688,429	37,245	1,594,789
Pearls and parts, not strung or set, dutiable:				
Natural		[2] 626,237		480,172
Cultured or cultivated		[2] 8,024,660		9,508,701
Other precious and semiprecious stones:				
Rough or uncut, duty-free		[2] 280,692		629,814
Cut but not set, dutiable		[2] 3,116,372		3,163,573
Imitation, except opaque, dutiable:				
Not cut or faceted		[2] 40,496		59,598
Cut or faceted:				
Synthetic		[2] 402,272		463,687
Other		[2] 11,448,744		10,061,841
Imitation, opaque, including imitation pearls, dutiable		[2] 30,410		23,054
Marcasites, dutiable: Real and imitation		38,911		26,413
Total		[1] [2] 187,709,221		168,572,101

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the Bureau of the Census data known to be not comparable with years before 1954.

[5] Jewelers' Circular-Keystone, The Diamond Industry, 1956: P. 2.
[6] Figures on imports and exports compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce, Bureau of the Census.

The principal imported gem stones that showed decreases in value were imitation gems (25 percent), natural pearls (23 percent), and diamond (11 percent). Increases were noted in rough or uncut precious and semiprecious gems, excluding diamond and cultured pearls, 124 and 18 percent, respectively.

TABLE 3.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1956–57, by countries

[Bureau of the Census]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1956						
North America:						
Bermuda	498	$48,664	$97.72			
Canada	4,929	576,212	116.90	279	$22,304	$79.94
Mexico				57	23,467	411.70
Total	5,427	624,876	115.14	336	45,771	136.22
South America:						
Brazil	2,456	112,342	45.74	253	20,196	79.83
British Guiana	6,595	200,740	30.44			
Colombia	86	12,055	140.17			
Surinam				85	834	9.81
Uruguay				75	23,000	306.67
Venezuela	56,996	1,644,575	28.85	156	25,363	162.58
Total	66,133	1,969,712	29.78	569	69,393	121.96
Europe:						
Austria				480	52,800	110.00
Belgium-Luxembourg	139,965	16,579,867	118.46	422,002	46,810,415	110.92
Czechoslovakia				25	5,660	226.40
France	4,634	436,790	94.26	9,293	1,173,809	126.31
Germany, West	2,442	108,457	44.41	38,333	2,750,098	71.74
Italy				64	8,806	137.59
Netherlands	3,776	212,270	56.21	21,987	2,696,243	122.63
Switzerland	11,085	429,418	38.74	385	340,049	883.24
United Kingdom	810,591	60,991,614	75.24	3,526	536,427	152.13
Total	972,493	78,758,416	80.99	496,095	54,374,307	109.60
Asia:						
Ceylon				14	1,058	75.57
Hong Kong	76	1,662	21.87	4	419	104.75
India				1,424	121,254	85.15
Israel	2,556	51,011	19.96	145,950	13,169,447	90.23
Japan				1,050	88,242	84.04
Lebanon	89	7,666	86.13			
Malaya				111	15,670	141.17
Total	2,721	60,339	22.18	148,553	13,396,090	90.18
Africa:						
British East Africa	74	740	10.00			
Egypt				77	6,674	86.68
French Equatorial Africa	48,012	1,242,420	25.88			
Liberia	35,536	1,420,676	39.98	15	4,130	275.33
Southern British Africa				1	487	487.00
Union of South Africa	46,436	2,138,993	46.06	47,496	7,898,974	166.31
Total	[1] 130,058	[1] 4,802,829	[1] 36.93	47,589	7,910,265	166.22
Grand total	[1] 1,176,832	[1] 86,216,172	[1] 73.26	693,142	75,795,826	109.35

[1] Revised figure; Belgian Congo revised to none.

TABLE 3.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1956–57, by countries—Continued

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1957						
North America: Canada	5,850	$567,531	$97.01	419	$52,190	$124.56
South America:						
Argentina	147	2,600	17.69	9	615	68.33
Brazil	3,426	135,503	39.55	778	75,620	97.20
British Guiana	4,782	135,938	28.43	236	24,011	101.74
Surinam	2,726	88,438	32.44			
Venezuela	61,890	2,057,533	33.24	4	493	123.25
Total	72,971	2,420,012	33.16	1,027	100,739	98.09
Europe:						
Belgium-Luxembourg	130,646	13,308,054	101.86	345,899	37,482,783	108.36
France	21,052	846,483	40.21	6,228	987,074	158.49
Germany, West	588	18,498	31.46	29,873	2,019,582	67.61
Hungary				105	3,500	33.33
Italy				147	21,839	148.56
Netherlands	4,248	319,044	75.10	22,686	2,914,262	128.46
Switzerland	917	27,160	29.62	134	107,905	805.26
United Kingdom	646,424	55,447,905	85.78	3,275	551,728	168.47
Total	803,875	69,967,144	87.04	408,347	44,088,673	107.97
Asia:						
Hong Kong				3	274	91.33
India	23	2,250	97.83	385	259,119	673.04
Iran				147	12,519	85.16
Israel	3,462	128,664	37.16	151,488	13,685,980	90.34
Japan	249	4,148	16.66	1,297	115,718	89.22
Malaya	300	43,655	145.52			
Thailand				152	1,283	8.44
Total	4,034	178,717	44.63	153,472	14,074,888	91.71
Africa:						
Belgian Congo	4,150	13,584	3.27			
British East Africa				1	515	515.00
French Equatorial Africa	23,690	633,920	26.76			
French West Africa	2,469	52,572	21.29			
Liberia	45,496	1,607,795	35.34			
Southern British Africa				42	3,250	77.38
Union of South Africa	40,161	1,700,797	42.35	46,284	7,063,491	152.61
Total	115,966	4,008,668	34.57	46,327	7,067,256	152.55
Oceania: Australia				183	34,641	189.30
Grand total	1,002,696	77,142,072	76.93	609,775	65,418,387	107.28

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with years before 1954.

WORLD REVIEW

In a historical world review of diamond discoveries, production, and sales it was estimated that, in 1955, nearly 22 thousand workers were engaged in cutting and polishing diamonds. Belgium led in number of workers, with 10,700, followed by Germany, 4,000; Israel, 2,500; and the United States, 2,000. The remaining workers were in 11 countries. Rough diamonds sold by the Diamond Syndicate during 1920–29, and the Central Selling Organization, 1930–56, were included. Sales in 1956 were nearly $210 million.[7]

[7] Leeper, Sir Reginald, The Development of the Diamond Industry: Optima (Johannesburg), vol. 7, No. 3, September 1957, pp. 125–129.

NORTH AMERICA

Canada.—An increased quantity of jade was produced from the Frazer River deposits of British Columbia, Canada, during 1957. These deposits were becoming more important as a source of good gem material as deposits in the United States and Alaska were being depleted.

Cuba.—The diamond cutting and polishing industry established during World War II was reported almost nonexistent in 1957. Over 12,000 carats were exported to the United States from 1947 to 1950, inclusive; none was exported from 1951 to 1956.[8]

Guatemala.—A study on jade and jade artifacts found in Guatemala gave the history of use; nomenclature; geologic occurrence; chemical, physical, and optical properties; and types of jade and other green minerals used in meso-American cultures.[9] After the study was published a jade deposit was found in place near Monzanal, Guatemala.

Mexico.—The quality, quantity, and location of agate, amethyst, apatite, beryl, danburite, garnet, obsidian, opal, orthoclase, scapolite, topaz, and tourmaline were reported. Many agate varieties, including iris, moss, flame, plume, and banded, were considered more valuable than other gem materials found. Agate was produced in large quantities.[10]

It was reported that a "lost" Mexican jade deposit was traced to an area near Taxco, Guerrero.[11]

SOUTH AMERICA

Surinam.—A diamond area near Rosebel and Sabanpassie, known since 1880, was investigated by the Geological and Mining Service. Diamond was found in eluvial conglomerate deposits. Mining would depend on the adaptability of large-scale equipment.[12]

Venezuela.—Over 19,000 carats of gem-quality diamonds was produced in 1956, equivalent to 20 percent of total diamond production. Only a small part was domestically cut and polished. Pearls sold in domestic jewelry came from local sources but were only a small part of the total production. Most of the pearls produced were exported.[13]

ASIA

India.—A total of 360 tons of ore from 20 sampling shafts, sunk at intersections of gridlines 250 feet apart, in the Panna diamond-mining area yielded 63 diamonds, equivalent to 12.5 carats per 100 tons.

Iran.—An estimated 15,000 pounds of turquois was mined in Nishapur during 1956. Production in 1957 was reported to be 30 percent less in quantity but 15 percent more in value. Sales to the United States were about $2,400.[14]

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[8] U. S. Embassy, Havana, Cuba, State Department Dispatch 412: Nov. 18, 1957, p. 1.
[9] Foshag, W. F., Mineralogical Studies on Guatemalian Jade: Smithsonian Miscellaneous Collections, vol. 135, No. 5, Dec. 3, 1957, 60 pp.
[10] Barron, E. M., Report on Mexican Gem Minerals: Unpublished.
[11] Science Newsletter, vol. 71, No. 13, Mar. 30, 1957, p. 198.
[12] U. S. Consulate, Paramaribo, Surinam, State Department Dispatch 115: Nov. 20, 1957, p. 3.
[13] U. S. Embassy, Carácas, Venezuela, State Department Dispatch 409: Jan. 7, 1958, pp. 39–40.
[14] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 6, December 1957, pp. 28–29.

Israel.—Progress was reported by the Israel diamond-polishing industry, which anticipated exports valued at $31 million during 1957, compared with $24.5 million in 1956. According to spokesmen of the industry, employment rose to about 3,000. The average "added value" of the diamond increased from 17 to 20 percent.[15]

Japan.—The pearl industry overproduced in the spring during declining prices, cut production, increased exports, and stabilized prices in the last half of 1957. Production for the year was 45,469 pounds—4,134 pounds less than in 1956. Exports were 55,140 pounds valued at $14.3 million.[16]

U. S. S. R.—Diamond was discovered in an area of over 115 square miles near Yakutia. In an article describing the deposits, data were given on diamond properties and methods of prospecting, petrography, and mineralogy of the kimberlite. The largest diamond found weighed 32.5 carats; but in typical deposits, 70 to 90 percent of the diamonds were smaller than 1/10 carat. Because the stones were small, the field might be regarded principally as a source of industrial diamond.[17]

The Yakutia discoveries also were summarized and references to Russian publications describing the six separate diamond-bearing areas were given. It was indicated that about 19 percent of the diamonds were good industrial stones and gem stones.[18]

AFRICA

Angola.—The Portuguese Government was formulating plans to develop a diamond-cutting and polishing industry in Lisbon, utilizing diamond produced in Angola. Most of the Angola output was gem quality (60 percent), and was exported to the United Kingdom.[19]

Belgian Congo.—A decree effective August 1, 1957, was issued increasing the base value of Kasai diamonds, but reducing the export tax from 5 to 3 percent ad valorem.

French West Africa.—On February 20, 1957, at Kerouane, French Guinea, an African cooperation, Bakima, was created for diamond exploitation in the Famarodou area. This organization was established to protect the authorized miners and to help stop the illegal production and sale of diamond. The history of the area and methods of mining were related.[20]

Liberia.—Diamond exports in 1956 were over 1 million carats, more than 5 times the 1955 exports.[21]

A second diamond rush was reported in the Suehn-Bopolo district, northeast of Bomi Hills, about 75 miles from Monrovia.[22]

Rhodesia and Nyasaland, Federation of.—An emerald discovery near the Belingwe Native Reserve, Southern Rhodesia, was placed under Government control. Specimens were sent to the United States

[15] U. S. Embassy, Tel Aviv, Israel, State Department Dispatch 222: Oct. 15, 1957, p. 3.
[16] U. S. Consulate, Nagoya, Japan, State Department Dispatch 43: Jan. 10, 1958, p. 1.
[17] Davidson, C. F., The Diamond Fields of Yakutia: Min. Mag. (London), vol. 47, No. 6, December 1957, pp. 329–338.
[18] Moyar, A., The Diamond Industry in 1956–57, Vlaams Economisch Verbond (Antwerp, Belgium), undated; Pp. 72–76.
[19] U. S. Consulate, Luanda, Angola, State Department Dispatch 62: Nov. 26, 1957, pp. 1–2.
[20] U. S. Consulate, Dakar, French West Africa, State Department Dispatch 241: Apr. 10, 1957, pp. 1–7.
[21] U. S. Embassy, Monrovia, Liberia, State Department Dispatch 256: Apr. 10, 1957, pp. 2–3.
[22] U. S. Embassy, Monrovia, Liberia, State Department Dispatch 206: Feb. 6, 1957, pp. 5–6.

for appraisal. The value and extent of deposits were not known.[23]

Tanganyika.—In 1957 production from the Williamson and Alamasi, Ltd., diamond mines exceeded that for 1956. Exports from the territory increased about 4 percent in weight and over 1 percent in value. Improvements made by Alamasi, Ltd., increased the output above the average of former years.[24] John T. Williamson, principal owner of the Williamson Diamond, Ltd., mine died January 8, 1958.[25]

Union of South Africa.—The Diamond Export Duty Act of 1957 was approved and adopted by the Government. This act, consolidating the export duty acts of 1917, 1919, 1947, 1950, and 1956, which were wholly or partly repealed, regulated the export duty of rough and uncut diamonds from the Union of South Africa.[26]

The DeBeers Consolidated Mines, on behalf of the Central Sales Organization, reported sales of gem diamond in 1957 totaling nearly \$148 million, the highest on record and about \$6 million over 1956.[27]

H. F. Oppenheimer became chairman of the board of DeBeers Consolidated Mines, Ltd., on the death of his father, Sir Ernest Oppenheimer, on November 25, 1957.[28]

OCEANIA

Australia.—Recovery of an additional 100 tons of oystershell by Japanese "pearlers" outside the 10-mile zone was approved by the Australian Government. The number of pearls recovered was not known.

A quantity of cultured pearls was produced by the Australian-Japanese-United States company described in the 1956 Gem Stones chapter.[29]

TECHNOLOGY

Scheelite crystals 7/16 inch in maximum dimensions were discovered in the Tyler Creek tungsten mine near Deer Creek, Calif. Crystals are rare, because most deposits contain only disseminated scheelite grains.[30]

A series of articles was published on gem materials, listing the properties that make them highly esteemed. Information on localities and facts about cutting and polishing were given.[31]

The properties of natural and artificial gem stones and methods of distinguishing between them were described.[32]

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[23] Rhodesia and Nyasaland Newsletter (Salisbury), Value of Rhodesian Emerald Find Still Unknown: Feb. 7, 1958, p. 3.

[24] U. S. Consulate, Dar es Salaam, Tanganyika, State Department Dispatch 157: Feb. 19, 1958, p. 4.

[25] Canadian Mining Journal, The Late John T. Williamson: Vol. 51, No. 550, February 1958, p. 120.

[26] U. S. Embassy, Pretoria, Union of South Africa, State Department Dispatch 76: Sept. 3, 1957, p. 1.

[27] DeBeers Consolidated Mines, Ltd., Annual Report, 1957: p. 18.

[28] DeBeers Consolidated Mines, Ltd., Annual Report, 1957: pp. 7–9, 11.

[29] U. S. Consulate, Perth, Australia, State Department Dispatch 3: Aug. 28, 1957, p. 4.

[30] California State Division of Mines, Mineral Information Service, Scheelite-Crystal Discovery: Vol. 10, No. 5, May 1, 1957, pp. 6–7.

[31] Owens, G. S., Gems: Rocks and Minerals, vol. 32, Nos. 1–2, January–February 1957, pp. 43–46; Report on Spinel: Nos. 7–8, July–August 1957, pp. 375–377; Beryl: Nos. 9–10, September–October 1957, pp. 469–472; Report on Chrysoberyl: Nos. 11-12, November-December 1957, pp. 582–585.

Cole, Bill, Tourmaline: Rocks and Minerals, vol. 32, Nos. 1–2, January-February 1957, pp. 47–48; Turquoise: Nos. 3-4, March–April 1957, pp. 146-147; Feldspar Gems: Nos. 5–6 May-June 1957, pp. 268-269; Quartz Gems (part I, The Crystalline Forms): Nos. 7–8, July–August 1957, pp. 400–401; Quartz Gems (part II, The Crysptocrystalline Forms): Nos. 9–10, September–October 1957, pp. 473-474.

[32] Blas, L. [Characteristics of Natural and Synthetic Gems]: Ion, vol. 16, No. 176, March 1956, pp. 147–152; Eng. Index Service No. 57–1879; Ind. Diamond Rev. Abs., vol. 17, No. 198, May 1957, p. B78.

A review of the gem-stone industry in California included mineralogy and geology, occurrences, locations of deposits, mining, utilization and treatment, markets, and a bibliography.[33]

A method of forming emerald crystals under high temperature and pressure was given.[34]

Sapphires grown in aqueous solutions—a process similar to that used to grow quartz crystals—appeared free from strain. The crystals might be useful in manufacturing optical items. The process might be used to make synthetic rubies and star sapphires under controlled conditions.[35]

A synthetic gem—strontium titanate—was made by the Verneuil process. It had an index of refraction higher than diamond and a hardness of 6 on the Mohs scale.[36]

Quality corundum crystals without strains and with minimum brittleness were grown by the Verneuil process.[37]

A report on gem stones and industrial crystals other than natural discussed the inadequacies of the terminology used in the trade to describe the finished products.[38]

Twelve mineral specimens were described, giving the synonyms, nomenclature, varieties, compositions, crystallography, physical and optical properties, tests, diagnoses, occurrence, and uses. Each mineral was illustrated in color. These mineral specimens were listed in chronological order: Beryl, sphalerite, chrysocolla, garnierite, pitchblende, chromite, quartz, corundum, fuller's earth, kyanite, pyrrhotite, and feldspar.[39]

A formula for calculating the weight of regular cuts of gem stones and pearls, particularly brilliant-cut diamonds, was given. Tables and graphs were included.[40]

A new instrument, the refractoscope, to determine the density and/or the index of refraction of gem stones, was introduced to jewelers and gemmologists.[41]

Laboratory methods to remove surface coatings from rough diamonds by chemical means were investigated. Present methods require a window cut into the stone to determine its quality.[42]

The color terminology and quality grades in diamond evaluation were discussed.[43]

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[33] Wright, L. A., Gem Stones: Chap. in Min. Commodities of California, California Div. Mines, Bull. 176, December 1957, pp. 205–214.

[34] Hurst, V. J., Mineralogical Notes: Georgia Mineral Newsletter, vol. 10, No. 3, Autumn 1957, p. 96.

[35] Chemical Engineering News, vol. 35, No. 38, Sept. 23, 1957, p. 62.

[36] Pough, R. H., Fabulite: Jewelers' Circ.-Keystone, vol. 127, No. 8, May 1957, pp. 78–83.

[37] Ikornikova, N. Yu., and Popova, A. A. [Preparation of Uniaxial Crystals of Synthetic Corundum]; Doklady Akad. Nauk (S. S. S. R.), vol. 106, No. 3, 1956, pp. 460–461; Ceram. Abs., vol. 40, No. 7, July 1957, column 172i.

[38] Pough, F. H., Reconstruction, Synthesis, Culture-or-What?: Jewelers' Circ.-Keystone, vol. 127, No. 10, July 1957, pp. 69–70, 87; No. 11, August 1957, pp. 160, 162, 188, 190; No. 12, September 1957, pp. 94, 96, 98, 114, 153; vol. 128, No. 1, October 1957, pp. 126, 128, 193–195.

[39] Mine and Quarry Engineering (London), Mineral Specimens No. 40–51: Vol. 23, No. 1, January 1957, pp. 14–15; No. 2, February 1957, pp. 58–59; No. 3, March 1957, pp. 102–103; No. 4, April 1957, pp. 144–145; No. 5, May 1957, pp. 190–191; No. 6, June 1957, pp. 238–239; No. 7, July 1957, pp. 288–289; No. 8, August 1957, pp. 334–335; No. 9, September 1957, pp. 380–381; No. 10, October 1957, pp. 428–429; No. 11, November 1957, pp. 472–473; No. 12, December 1957, pp. 516–517.

[40] Schiebel, W. [Formula for Calculating the Weight of Regular Cuts of Gemstones and Pearls, Particularly of the Brilliant Cut Diamond]: Deutsch. Gesell. Edelsteinkunde Ztschr., No. 18, Winter 1956–57, pp. 16–22; Ind. Diamond Rev. Abs., vol. 17, No. 196, March 1957, p. B53.

[41] Pough, F. H., Refractoscope: Jewelers' Circ.-Keystone, vol. 127, No. 9, June 1957, pp. 62, 64, 66, 111.

[42] International Cooperation Administration, Monthly Report, Bureau of Mines Metallurgist, Rio de Janeiro, Brazil, July 1957: July 31, 1957, 2-page airgram.

[43] Klippel, Robert, Modern Diamond Assorting: Jewelers' Circ.-Keystone, vol. 127, No. 11, August 1957, pp. 152, 154, 156, 158; No. 12, September 1957, pp. 90, 92, 123.

The properties of certain natural and synthetic colorless gem stones were described.[44]

Methods of determining the difference between true jade and artificially colored jade were given.[45]

Patents, suitable for use in lapidary processes, were obtained on a diamond bandsaw,[46] a diamond-filled-paste applicator,[47] an automatic feeder for cooling lapidary grinding tools,[48] a machine for grinding gem diamonds to selected shapes,[49] and an apparatus for cutting and polishing gem facets.[50]

Patents were also issued on a process of bonding diamond powder on a tool grinding face,[51] and a method of producing blue-white boules, which have gemlike properties.[52]

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[44] Pough, F. H., Colorless Stones: Jewelers' Circ.-Keystone, vol. 128, No. 2, November 1957, pp. 100, 102, 112–114.

[45] Wong, Edward, Be Sure It's Really Fine Jade: Jewelers' Circ.-Keystone, vol. 128, No. 3, December 1957, pp. 70, 84.

[46] Barron, J. H., Diamond Bandsaw: U. S. Patent 2,784,536, Mar. 12, 1957.

[47] Booth, S. M., Applicator for Applying a Diamond-Filled Paste to a Working Surface: U. S. Patent 2,775,851, Jan. 1, 1957.

[48] Loecy, J., Jr., Control Means for Cooling of Dressing Diamond or the Like: U. S. Patent 2,781,035, Feb. 12, 1957.

[49] Salzer, A., Automatic Diamond Cutting and Polishing Device: U. S. Patent 2,829,472, Apr. 8, 1958.

[50] Collar, L. H., Machine for Grinding and Polishing Gem Facets: U. S. Patent 2,779,138, Jan. 29, 1957.

[51] Keeleric, G. F., Process for Making Abrasive Article: U. S. Patent 2,785,060, Mar. 12, 1957.

[52] Merker, Leon (assigned to National Lead Co.), Synthetic Rutile Composition: U. S. Patent 2,801,182, July 30, 1957.

Gem Stones

By John W. Hartwell[1] and Betty Ann Brett[2]

THE ESTIMATED VALUE of gem material produced in the United States in 1958 exceeded $1 million for the first time. Material collected was nearly 1 million pounds.

The Federal Trade Commission suggested that the descriptive terms—cultured, man-made, and created-by-man—should not be used as designations for laboratory-produced emeralds, sapphires, or other gem stones. It was suggested that they be called synthetic, imitation, simulated, or some word of like meaning to distinguish them from natural stones.

DOMESTIC PRODUCTION

Forty-one States reported production compared with 32 in 1957. Oregon was the leading producing State with an estimated $200,000, the same as in 1957. Ten States—Oregon, California, Texas, Nevada, Arizona, Washington, Wyoming, Utah, Colorado, and Montana—produced 87 percent of the total value. Increased production was reported for 19 States; decreased production, for 3 States.

Gem materials were found in about 200 new localities mostly in Eastern States. The principal varieties of gem material produced in decreasing order, by weight, were petrified wood, agate, rose quartz, quartz crystal, obsidian, and jade. In decreasing order, by value, the principal varieties were turquois, agate, petrified wood, jade, and quartz crystal.

Agate.—Agate produced was valued at $50,000, a 60-percent drop from 1957. Only 39 tons of this material was collected, compared with 200 tons in 1957. The principal States, in decreasing order of production, were Oregon, New Mexico, California, Wyoming, and Texas. The value of production in Oregon was about the same as in 1957; that in New Mexico was about half the 1957 value.

Diamond.—Production of diamond in Arkansas was reported at 475 carats, valued at over $5,000. Hundreds of individuals paid fees for the privilege of searching for the gems on privately owned diamond deposits in Pike County.

Three diamonds, smoky in color, were recovered from a mud pipe in Pershing County, Nev., and a claim was filed on the deposit. Diamond also was discovered 155 feet underground by the Jersey Quarry Co. in an unidentified locality in Illinois. The diamonds from Illinois were reported to be too small for gems.

[1] Commodity specialist.
[2] Statistical clerk.

Jade.—Jade production was valued at $60,000, a 20-percent increase compared with 1957. Alaska was the principal producing State, followed by Wyoming, California, and Colorado.

Jade was found in its place of formation in Fremont County, Nev. All jade previously recovered in this area was from alluvial deposits.

In California, good-quality jade was recovered from a deposit under 36 feet of water off the coast at San Simeon by skin divers. Jade also was produced in Arizona and Nevada.

A new lapidary shop was built at the Shungnak Jade Project School, Shungnak, Alaska, and a portable diamond drill was obtained to core jade boulders as an aid in the search for gem-grade material. A shortage of gem-quality jade prompted intensified prospecting.

Petrified Wood.—Over 110 tons of petrified wood was produced, about equal to the 1957 quantity. Estimated value of production was about $50,000, principally from Arizona, Utah, Wyoming, Oregon, and California. Navajo County, Ariz., was the main producing area, with a value estimated at $12,000.

Turquois.—Arizona was the leading producing State, with 80,000 pounds, but because the turquois was low grade its value was only $16,000. Nevada produced only 1,500 pounds but led in value of production with $30,000. Colorado production was 350 pounds, valued at $16,000. New Mexico production was about 5,000 pounds, valued at $5,000.

Miscellaneous Gem Material.—Rose quartz production in South Dakota was 35 tons, valued at $5,000. A small output also was reported from Maine.

A vein of noncrystalline smoky quartz, ranging from light brown to deep black, was discovered in Jasper County, Ga. Excellent gems were cut from unflawed pieces.[3]

Precious opal produced in Nevada was valued at less than $2,000, compared with $52,000 in 1957.

Obsidian (26,000 pounds) valued at $7,000 was about 2½ times the quantity estimated for 1957. Obsidian was used principally in tumbling machines for making baroque gems.

Quartz crystal (52,000 pounds), valued at $23,000, came principally from Garland and Montgomery Counties, Ark. Other producing States were California, Utah, and Pennsylvania.

Feldspar gem-stone production totaled 9,000 pounds, valued at $5,000. The principal producing States were South Dakota, Virginia, Pennsylvania, and Colorado.

About 1,800 pounds of beryl specimens, valued at $1,500 was produced in Mohave County, Ariz.

Copper mineral specimens totaling 6,800 pounds valued at $11,000 were produced in Arizona. Of this total, 1,300 pounds was chrysocolla, valued at about $3,800.

The quantity and value of some other gem stones produced were: Fluorite, 5,000 pounds, $1,400; onyx, 15,000 pounds, $5,000; rhodonite, 10,000 pounds, $3,000; and tourmaline, 2,000 pounds, $8,000.

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[3] Gleason, F. E., Smoky Quartz in Georgia: Georgia Mineral Newsletter, vol. 11, No. 4, Winter 1958, pp. 132–133.

TABLE 1.—Estimated production of gem stones in the United States, in thousand dollars

	1957	1958		1957	1958
Alaska	(1)	(1)	New York	5	8
Arizona	$75	$86	North Carolina	(2)	1.3
Arkansas	(1)	23	Oregon	200	200
California	100	150	Pennsylvania	(2)	2
Colorado	35	38	South Dakota	15	16
Connecticut	(2)	3	Texas	100	100
Idaho	5	5	Utah	12	40
Illinois	2	1.3	Vermont		1
Maine	(2)	5	Virginia		3
Maryland	(2)	1.5	Washington	75	75
Montana	35	35	Wyoming	55	52
Nebraska	2	2	Other States [3]	36	21
Nevada	100	100			
New Hampshire	(2)	5	Total	882	1,006
New Jersey	(2)	4			
New Mexico	30	28			

[1] Included with "Other States."
[2] Less than $1,000 value with "Other States" include: Florida (1957), Georgia (1957–58), Iowa (1957–58), Kansas (1958), Kentucky (1958), Massachusetts (1958), Michigan (1957–58), Minnesota (1957–58), Missouri (1957–58), North Dakota (1957–58), Ohio (1958), Oklahoma (1958), South Carolina (1958), Tennessee (1958), and West Virginia (1958).

CONSUMPTION

Sales of lapidary equipment and supplies, gem materials (excluding diamond), and mineral specimens slightly exceeded 1957 sales, with an estimated $5.5 million. Synthetic and imitation gem-stone sales from domestic and foreign suppliers were estimated at $11 million. Purchases of natural gem materials, exclusive of diamond, were reported to be about $15 million.

The apparent consumption (domestic production plus imports minus exports) of gem stones was over $151 million compared with $142 million in 1957.

PRICES

Retail prices for some natural gem stones, cut and polished in foreign countries, in 1957–58 were as follows:

Variety, size or color:	*Range of prices per carat, dollars*
Alexandrite (1–2 carats)	5–15
Alexandrite (5–20 carats)	Up to 200
Alexandrite (cats-eye, 5–6 carats)	Up to 100
Chrysoberyl (1 carat)	20–25
Garnet (demantoid, 1–2 carats)	Up to 100
Peridot (up to 6 carats)	1–2
Peridot (100 and over)	8–18
Ruby (2 carats and over)	2,500 up
Ruby (½ carat and under)	2–5
Ruby (star, all sizes)	Up to 1,500
Sapphire (golden)	10–25
Spinel (ruby)	Up to 100
Spinel (purple, pink, blue)	Up to 10
Tourmaline (purple, pink, ruby)	Up to 15
Tourmaline (green)	5–10
Zircon (pale blue)	1–2
Zircon (deep blue)	8–10
Zircon (white)	4–7

SOURCE: Jewelers' Circular-Keystone, vol. 128, No. 7, April 1958, pp. 104, 110, 112, 114–117; No. 8, May 1958, pp. 68, 70, 76; No. 9, June 1958, pp. 58, 60, 62.

Wholesale prices paid per carat for rough and uncut alexandrite ranged from $300 to $500 for Ceylon stones and up to $500 for the Siberian variety. Sapphires of the alexandrite variety, from Ceylon, cost about $50 per carat wholesale.

FOREIGN TRADE[4]

Imports of gem stones decreased nearly 2 percent in value from 1957. Gem diamonds supplied 85 percent of total imports, the same as in 1957. Precious stone imports from the Federation of Rhodesia and Nyasaland were reported for the first time and were valued at $141,000.

Decreases in the value of cut but not set imported gem stones were reported for synthetic gems (51 percent), emeralds (31 percent), and rubies and sapphires (10 percent). Increases were noted in natural pearls (24 percent), rough or uncut precious stones (excluding diamond) (22 percent), and cultured pearls (9 percent).

WORLD REVIEW

World diamond production increased 2.7 million carats over 1957. Of the world total, 18 percent was of gem quality. Sales of gem diamond in 1958 were 5.2 million carats valued at about $140 million compared with 5.5 million carats valued at $148 million in 1957.

TABLE 2.—Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States

[Bureau of the Census]

Item	1957		1958	
	Carats	Value (thousand)	Carats	Value (thousand)
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty-free	[1] 997,162	[1 2] $77,170	1,129,297	$72,430
Cut but unset, suitable for jewelry, dutiable	609,775	65,418	718,422	68,065
Emeralds: Cut but not set, dutiable	37,245	[2] 1,595	38,848	1,100
Pearls and parts, not strung or set, dutiable:				
Natural		480		597
Cultured or cultivated		[2] 9,509		10,347
Other precious and semiprecious stones:				
Rough or uncut, duty-free		[2] 630		717
Cut but not set, dutiable		[1] 3,164		2,904
Imitation, except opaque, dutiable:				
Not cut or faceted		[2] 60		65
Cut or faceted:				
Synthetic		[2] 464		228
Other		[1 2] 10,125		9,311
Imitation, opaque, including imitation pearls, dutiable		[2] 23		17
Marcasites, dutiable: Real and imitation		[2] 26		26
Total		[1 2] 168,664		165,807

[1] Revised figure.
[2] Data known to be not comparable with 1958.

[4] Figures on imports and exports compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U.S. Department of Commerce, Bureau of the Census.

Countries reporting increases in production were: Tanganyika, 28 percent; Belgian Congo, 7 percent; and Ghana, 7 percent. All other countries reported lower production than in 1957.

TABLE 3.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, by countries

[Bureau of the Census]

Country	1957				1958			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Carats	Value (thousand)	Carats	Value (thousand)	Carats	Value (thousand)	Carats	Value (thousand)
North America: Canada	5,850	$568	419	$52	6,085	$885	1,318	$103
South America:								
Argentina	147	3	9	(1)	290	7	10	12
Brazil	3,426	135	778	76	5,631	295	287	17
British Guiana	4,782	136	236	24	6,739	210	40	6
Surinam	2,726	88			27	1		
Venezuela	61,890	2,058	4	(1)	39,405	1,114	40	4
Total	72,971	2,420	1,027	100	52,092	1,627	377	39
Europe:								
Austria							62	9
Belgium-Luxembourg	130,646	13,308	345,899	37,483	192,980	12,831	455,267	40,740
France	21,052	846	6,228	987	11,267	424	7,386	898
Germany, West	588	18	29,873	2,020	784	19	35,323	2,442
Hungary			105	4				
Italy			147	22			119	60
Netherlands	4,248	319	22,686	2,914	8,252	983	24,046	2,927
Switzerland	917	27	134	108			279	100
United Kingdom	[2] 646,890	[2] 55,507	3,275	552	646,077	50,448	6,543	1,447
Total	[2] 804,341	[2] 70,025	408,347	44,090	859,360	64,705	529,025	48,623
Asia:								
Ceylon							142	21
Hong Kong			3	(1)			207	15
India	23	2	385	259			57	4
Iran			147	13				
Israel	3,462	129	151,488	13,686	7,088	146	150,438	12,769
Japan	249	4	1,297	116			308	22
Lebanon					1,250	60		
Malaya, Federation of }	300	44						
Singapore, Colony of }					290	42		
Thailand			152	1				
Total	4,034	179	153,472	14,075	8,628	248	151,152	12,831
Africa:								
Belgian Congo	4,150	14			5,025	30		
British East Africa			1	(1)	479	15		
French Equatorial Africa	23,690	634			6,521	224		
French West Africa	2,469	52			3,686	92		
Ghana					72,951	553		
Liberia	45,496	1,608			22,989	805	4	(1)
Southern British Africa			42	3				
Union of South Africa	[2] 34,161	[2] 1,670	46,284	7,063	88,815	3,191	36,546	6,469
Western Portuguese Africa					666	55		
Total	[2] 109,966	[2] 3,978	46,327	7,066	201,132	4,965	36,550	6,469
Oceania: Australia			183	35				
Grand total	[2] 997,162	[2] [3] 77,170	609,775	65,418	1,129,297	72,430	718,422	68,065

[1] Less than $1,000.
[2] Revised figure.
[3] Data known to be not comparable with 1958.

NORTH AMERICA

Canada.—Upstream gravels near Princeton district, British Columbia, yielded seven or eight minute diamonds. The area was staked, and further prospecting and sampling were anticipated.[5]

An article on industrial minerals in Canada contained a section on the occurrence of gem stones and mineral crystals. Some information was given on the size of the Canadian gem-stone industry.[6]

SOUTH AMERICA

Brazil.—In 1957 the National Department of Mineral Production authorized rough-diamond exports of over 7,800 carats valued at nearly $250,000 and over 55,600 carats of cut semiprecious gems valued at about $5,500.[7]

British Guiana.—Exports of diamond in 1958 were 31,000 carats valued at $1,394,000 or over $42 per carat, compared with 29,000 carats in 1957. The 1958 production of diamond reversed a decreasing trend apparent since 1955.[8]

A new diamond-cutting plant was established, costing $20,000.[9]

Paraguay.—No gem stones were produced, but probable locations were discussed in a report.[10]

Venezuela.—Nearly 14,500 carats of gem-quality diamonds were produced compared with about 24,800 carats in 1957.[11]

EUROPE

Belgium.—The demand for gem diamond lessened throughout the world, especially in the United States, Belgium's principal buyer.

Imports of cuttable gem diamonds decreased 20 percent by weight compared with 1957, and imports of polished gems were 37 percent less. Exports were 7 percent less.

Purchasers in the United States bought 79 percent by weight of all uncut gem diamonds sold and 50 percent of the polished gems.[12]

Portugal.—The Government established a diamond-cutting corporation, Sociedade Portuguesa de Lapidocão de Diamantes in Lisbon. This company will process stones produced in Angola, formerly exported to the United Kingdom, and will purchase additional stones from London diamond interests.[13]

United Kingdom.—Gem-diamond sales of the Central Selling Organization in London were $138.4 million, 6.4 percent below 1957 sales.[14]

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[5] Canadian Mining Journal, Royal Canadian Venturers: Vol. 79, No. 9, September 1958, p. 154.

[6] Western Miner and Oil Review (Vancouver, B.C.), The Search for Industrial Minerals in Canada: Vol. 31, No. 6, June 1958, pp. 36–37.

[7] U.S. Embassy, Rio de Janeiro, Brazil, State Department Dispatch 332: Sept. 23, 1958, p. 2.

[8] U.S. Consulate, Georgetown, British Guiana, State Department Dispatch 150: Mar. 13, 1959, p. 30.

[9] Mining Journal (London): Vol. 251, No. 6426, Oct. 17, 1958, p. 421.

[10] Eckel, E. B., Geology and Mineral Resources of Paraguay, A Reconnaissance: Geol. Survey Prof. Paper 327, 1959, p. 83.

[11] U.S. Embassy, Caracas, Venezuela, State Department Dispatch 856: May 14, 1958, p. 1; Dispatch 962: Apr. 29, 1959, Encl. 1, p. 2.

[12] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 6, June 1959, pp. 30–32.

[13] U.S. Embassy, Lisbon, Portugal, State Department Dispatch 337: Jan. 2, 1958, p. 1.

[14] Jewelers' Circular-Keystone, vol. 129, No. 5, February 1959, p. 142.

ASIA

Afghanistan.—Lapis lazuli production totaled over 1.5 short tons. The value of the uncut material was $41 to $45 per pound, and the cut and polished gems were valued at $59 to $136 per pound.[15]

India.—The production of emeralds in 1957 totaled 338,000 carats, compared with 474,000 carats in 1956. Diamond production was 790 carats in 1957 and 1,535 in 1958.[16]

Israel.—Diamond exports from Israel were US$32.7 million in 1957, and US$32 million in 1958. It was estimated they would reach US$35 million during the 1959–60 period.[17]

Japan.—Pearl standards were raised to reduce the number of inferior grade pearls exported. Members of the Pan-Japan Pearl Cultivators Cooperation warned all pearl producers to avoid buying or selling cultured pearls produced by using a nucleus of synthetic material. The difficulty of drilling such pearls without breaking caused a damaging effect upon the cultured pearl export trade.[18]

The United States was the biggest market for cultured pearls, taking about 70 percent of exports. The remainder was exported to Europe. Exports of over 54,000 pounds of cultured pearls to the United States was expected in 1958.[19]

Thailand.—Only a small quanity of gem stones originate in Thailand. Imports in 1956 were over 13 million carats, of which 12 million was synthetic stones. Most of the imported gems were cut, polished, and sold locally. Gem-stone exports were over 1 million carats, principally synthetic gems, zircons, and sapphires.[20]

U.S.S.R.—A 7-year plan was drafted for the development of the Yakutia diamond industry in the U.S.S.R. It was expected that the home demand for gem diamonds would be met under this plan.[21] During exploitation of the Yakutia diamond deposits, gem-quality chrysolites were found.[22]

AFRICA

Basutoland.—Diamond was discovered in a kimberlite pipe in the Makhotlong area. Only small gem and industrial diamonds were recovered.[23]

French Guinea.—A short history was written on the occurrence and production of diamond in French Guinea. Most gem diamonds found were of poor quality. Production was 250,000 carats.[24]

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[15] U.S. Embassy, Kabul, Afghanistan, State Department Dispatch 466: May 23, 1959, Encl. 1, p. 1.

[16] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 2, August 1958, p. 24.
U.S. Embassy, New Delhi, India, State Department Dispatch 1237: Apr. 23, 1958, p. 1.

[17] U.S. Embassy, Tel Aviv, Israel, State Department Dispatch 533: Feb. 26, 1959, p. 10.

[18] Japan Trade Bulletin, Synthetic Nuclei Attacked by Pearl Cultivators: No. 219, Dec. 1, 1958, p. 4.

[19] Jewelers' Circular-Keystone, Japan Expects a Big Boost in Pearl Exports This Year: Vol. 129, No. 5, February 1959, p. 140.

[20] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 6, June 1958, pp. 37–38.

[21] Mining Journal (London), vol. 251, No. 6428, Oct. 31, 1958, p. 478.

[22] Ilin, I. V., Kuryleva, N. A., Popugayeva, L. A., and Cigal, Ya. B. [Chrysolites From the Kimberlite Tubular Columns of Yakutiya as Precious Stones for Jewelry Industry]: Razvedka; Okhrana Nedr., No. 2, 1958, pp. 8–9; Library of Congress Ref. Card 132, Jan. 17, 1958.

[23] Mine and Quarry Engineering (London), New Diamondfield: Vol. 24, No. 8, August 1958, p. 343.

[24] Moyal, Maurice, Guinea's Mineral Wealth: Min. Mag. (London), vol. 252, No. 6446, Mar. 6, 1959, p. 255.

Liberia.—Diamond mining was established on a small scale by the Liberian Government in 1936. Real interest in diamond mining began in 1953, and in early 1957, 30,000 people were prospecting and mining around the Lofa River. Because of the disorder of the diamond rush and the loss of manpower for other activities the Government closed the diamond fields in April 1957. In July 1958 they were reopened to prospectors on a controlled basis, except for an area near the Lofa River which was withheld for future large-scale mining by concessionaires. By late 1958 more than 1,300 prospecting licenses and 400 mining licenses had been issued. Foreigners were excluded from mining or prospecting, except in concessions. No thorough geologic survey of the diamond field was made. Diamond production was difficult to estimate because of the great number of diamonds smuggled into Liberia from nearby countries. Illicit imports into Liberia were thought to be valued at $10 million in 1956 and $5 million in 1957. The reduction in 1957 was attributed to stricter export controls in Sierra Leone.[25]

Exports of diamond in 1957 were 800,000 carats valued at $1.5 million, but only 20,000 carats valued at $200,000 was gem quality.[26]

Rhodesia and Nyasaland, Federation of.—Samples of the emeralds found near the Belingwe Native Reserve, known as the Sandawana emeralds, were sent to the United States for valuation. The initial shipment weighed 1.27 ounces and produced 40 cut stones weighing 6.54 carats valued at $375. The second parcel, weighing 5.6 ounces, produced 200 carats of cut gems valued at about $6,000. Many other gem materials, including diamond, chrysoberyl, amethyst, and rose quartz, have been found in Southern Rhodesia.[27]

A second emerald discovery was reported near the initial Belingwe find. The emeralds in this deposit were of lower quality.[28]

South-West Africa.—Production and exports of gem stones in 1958 was reported as follows: [29]

TABLE 4.—Production and exports of gem stones, South-West Africa

Production	Exports	
	Quantity	Value
Diamond [1]	640,752 carats	$32,100,000
Amethyst (20.84 tons)	14.67 tons	7,400
Rose quartz (2 tons)	1.28 tons	616
Tiger's eye [1]	1 ton	560
Tourmaline (10,700 grams)	1,000 grams	420

[1] Data not available.

[25] U.S. Embassy, Monrovia, Liberia, State Department Dispatch 180: Jan. 6, 1959, pp. 16–17.
[26] Mining Journal (London), Liberia's Diamond Laws: Vol. 251, No. 6429, Nov. 7, 1958, p. 506.
[27] Jason, Lewis, Valuing Gems Stones Found in Rhodesia: Rhodesian Min. Eng. (Salisbury), vol. 23, No. 8, August 1958, p. 38.
[28] Bureau of Mines, Mineral Trade Notes; Vol. 47, No. 6, December 1958, p. 35.
[29] U.S. Consulate, Johannesburg, South-West Africa, State Department Dispatch 245: Mar. 3, 1959, p. 2.

Tanganyika.—The De Beers Consolidated Mines, Ltd., and the Tanganyika Government became equal owners in the Williamson Diamond, Ltd., mine at Mwadui under terms of an agreement signed August 13, 1958.[30]

Diamond production from the Williamson mine was 515,762 carats valued at over $12 million, an alltime high and an increase of 143,160 carats over 1957 production. The recently constructed treatment plant of the Williamson Diamond, Ltd., operated at full capacity during the year.[31]

A mining claim acquired by Tanganyika Corundum, Corp., Ltd., in 1958 contained ruby of near precious quality and corundum associated with zoisite as an apple-green rock suitable for art objects. Early production was anticipated.[32]

The De Beers Consolidated Mines, Ltd., 71st Annual Report, 1958, included a statement by the chairman of the board that the most important development during 1958 was the purchase jointly with the Government of Tanganyika of the entire share capital of the Williamson Diamond, Ltd. For 50 percent interest about $7.1 million was paid and in addition a loan of nearly $3.7 million was made to the Tanganyika Government to assist them in financing their share of the business. This loan is repayable out of dividends received by the Government on its shareholding in Williamson Diamonds.

The financing of the sale of the Williamson mine was unusual in that it was based indirectly on an issue of Anglo American Corporation of South Africa, Ltd., bonds that were offered by the Deutsche Bank Aktiengesellschaft of Frankfurt, West Germany, for sale to the public in Germany. The capital thus raised was used to support a loan by the Anglo American Corporation to De Beers Consolidated Mines, Ltd. Details of the transaction were presented in a joint announcement by the Directors of De Beers and the Anglo American companies issued September 3, 1958.

Union of South Africa.—A new $4 million diamond treatment and recovery plant at the De Beers mine at Kimberley was opened by H. F. Oppenheimer, chairman of De Beers Consolidated Mines, Ltd., June 10, 1958. The plant was capable of handling 20,000 tons of ore a day. The plant will serve Du Toitspan, Bultfontein, and Wesselton mines, as well as the De Beers mine, should it come back into production.[33]

A diamond deposit discovered near Swartruggens, Transvaal, was described.[34]

OCEANIA

Australia.—Precious opal weighing 136 pounds was discovered in southern Australia. Three pieces of these opal in the rough, valued at $175,000 were shipped to the United States.[35] Another opal, weigh-

[30] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 5, November 1958, pp. 30, 31.
[31] U.S. Consulate, Dar es Salaam, British East Africa, State Department Dispatch 272: Mar. 20, 1959, p. 3.
[32] Mining Magazine (London), Corundum (Ruby): Vol. 100, No. 3, March 1959, p. 149.
[33] Engineering and Mining Journal: Vol. 159, No. 7, July 1958, p. 159.
[34] Mining Magazine (London), Investigation of a Transvaal Diamond Occurrence: Vol. 100, No. 3, March 1959, pp. 181–182.
[35] Wall Street Journal, Unfinished Pieces of Largest Opal Stone Ever Found Arrive in U.S. From Australia: Vol. 152, No. 80, Oct. 16, 1958, p. 4.

ing 5 pounds, 14 ounces, was found in the Andamooka opal field. It contained about 2 pounds of precious opal valued at $337 an ounce.

Diamond prospecting and mining in Australia were discussed.[36] The government of Western Australia granted a temporary reserve in the Kimberley area for diamond prospecting. In New South Wales placer diamond mining has been active for a number of years. The diamonds are of high quality but small, and only a few are suitable for jewelry.

TECHNOLOGY

Geochemical prospecting for diamonds by testing soils and plants for nickel was noted as a possibility.[37]

The history, geology, and use of diamond found in India were published.[38]

A British Guiana Geological Survey publication reported a complete survey of the diamond resources of the colony.[39]

The history and geology of the Bubani Emerald mine, India, were published. The emeralds, found in pockets or lenses in a talc-actinolite-biotite schist in the vicinity of pegmatites, often are associated with apatite and green mica.[40]

A review of the gem-stone industry in California included mineralogy and geology, occurrences, locations of deposits, and a bibliography.[41]

Each monthly issue of the Mine and Quarry Engineering (London) journal beginning with October 1953 described a mineral, giving the synonyms, nomenclature, varieties, composition, crystallography, physical and optical properties, tests, diagnoses, occurrences, and uses. Each mineral was illustrated in color. In the 1958 issues the minerals in chronological order were: Vanadinite, wollastonite, pyromorphite, vivianite, monazite, graphite, magnesite, bauxite, garnet, lepidolite, dioptase, and sphaerocobaltite.

The method used by the Consolidated Diamond Mines of South-West Africa, Ltd., in developing its 240-mile-long diamond property on the sea coast was described. The report of the recovery procedures including sampling, overburden removed, excavation and tramming, and preliminary treatment of the diamondiferous gravels.[42]

A series of articles published in German on synthetic emeralds contained information on varieties produced, manufacturing methods, characteristic differences between American and German synthetic emeralds, and causes of cracks formed in production. All articles were illustrated.[43]

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[36] Mining Magazine (London), Diamonds: Vol. 99, No. 3, September 1958, p. 164.

[37] Mine and Quarry Engineering (London), Geochemical Prospecting for Diamonds: Vol. 25, No. 4, April 1959, p. 192.

[38] Kulkarni, M. G., Prosperity Through Diamonds: Malaney & Co., Bombay, India, 1958, 98 pp.

[39] Pollard, E. R., Dixon, C. G., and Dujardin, R. A., Diamond Resources of British Guiana: British Guiana Geol. Survey (Georgetown); Min. Mag. (London), vol. 98, No. 4, April 1958, pp. 195–196.

[40] Bagchi, T. C., The Geology of the Bubani Emerald Mine: Indian Min. Jour. (Calcutta), vol. 6, No. 3, March 1958, pp. 1–4, 11.

[41] California Division of Mines, Gem Stones: Min. Inf. Service, vol. 11, No. 6, June 1, 1958, pp. 1–7.

[42] Devlin, S. W., Mining Procedure and Method at C.D.M.: Jour. South African Inst. Min. and Met. (Johannesburg), vol. 59, No. 4, November 1958, pp. 184–201.

[43] Eppler, W. F., [Synthetic Emeralds] Deut. Goldschmiede Ztg., (Stuttgart), vol. 56, No. 4, April 1958, pp. 193–197; No. 5, May 1958, pp. 249–251; No. 6, June 1958, pp. 327–329; No. 7, July 1958, pp. 381–385; Ind. Diamond Abs., vol. 5, June 1958, p. A81; July 1958, p. A102; November 1958, p. A171; September 1958, p. A135.

Details were given on the synthesis of gems, differentiation of synthetic from natural stones, and the manufacture of rutile, quartz, emerald, and diamond.[44]

Information on the production of strain-free synthetic sapphire by a hydrothermal technique was given. The process involves dissolving and recrystallizing aluminum oxide from an aqueous solution under high pressure and temperature. Synthetic rubies also could be made, using the same process, if a small quantity of a chromate was added to the nutrient.[45]

Other articles on synthetic gem stones were published concerning the production and properties of synthetic corundum, quartz, and garnet; [46] the historical development of synthetic gems with references to optical and physical properties,[47] and methods of producing and crystallizing synthetic corundum.[48]

Processes used in the manufacture of synthetic crystals for industrial use were described.[49]

Synthetic lapis lazuli was made with color and appearance equal to the natural material but with the hardness and wear resistance of spinel.[50]

Black pearls were made by exposing white pearls to neutron bombardment in a reactor. The black luster was said to be permanent.[51]

The judging diamond with relation to origin, weight, luster, and color, and methods of cutting was discussed.[52]

A new system of calculating the weight of a cut gem stone was given.[53]

Ultrasonic methods used in cutting, drilling, and carving hard gem material were reviewed.[54]

It was determined that a small percentage of iron oxide—not chromium or vanadium—caused the colorization of green amazonite.[55]

Optical, electrical, and other physical tests were made on more than 1,000 gem diamonds to show adsorption by infrared light and to identify the variety of impurities.[56]

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[44] Espig, H., [Manufacture of Synthetic Precious Stones]: Chem. Tech. (Berlin), vol. 9, 1957, pp. 90–93; Ceram. Abs., vol. 41, No. 5, May 1, 1958, p. 132.

[45] Laudise, R. A., and Ballman, A. A., Hydrothermal Synthesis of Sapphire: Jour. Am. Chem. Soc., vol. 80, No. 11, June 5, 1958, pp. 2655–2657.

[46] Webster, R., Synthetic Gemstones: Gemmologist (London), vol. 27, No. 324, July 1958, pp. 124–129; No. 325, August 1958, pp. 146–152; No. 326, September 1958, pp. 170–173.

[47] Thomas, L. A., Synthetic Gems: Research (London), vol. 11, No. 12, December 1958, pp. 466–471; Ind. Diamond Abs., vol. 16, January 1959, p. A3.

[48] Barta, C., The Production and Properties of Synthetic Corundum: Ind. Diamond Rev., vol. 17, No. 201, August 1957, pp. 147–150.

[49] Hahn, Steven, Properties and Uses of Industrial Crystals: Product Eng., Design Digest Issue, October 1957, pp. C18–C21.

[50] Rocks and Minerals, Synthetic Lapis Lazuli Spinel: Vol. 34, No. 268, January-February 1959, p. 18.

[51] Jewelers' Circular-Keystone, News Notes "Briefly": Vol. 129, No. 6, March 1959, p. 160.

[52] Bagot, M., How to Judge the Value of a Jewel: Realites (Paris), vol. 99, February 1959, pp. 35–39; Ind. Diamond Abs., vol. 16, March 1959, p. A39.

[53] Schlossmacher, K., [Estimation of Weight of Faceted Colored Stones by Measurement]: Gold v. Silber (Hamburg), vol. 11, No. 11, November 1958, pp. 13–14; Ind. Diamond Abs., vol. 16, January 1959, p. A3.

[54] Schiebel, W., [Ultrasonic Methods for Working Gemstones]: Zeits. Dtsch. Ges. für Edelsteinkunde, vol. 19, 1957, pp. 7–11; Ind. Diamond Abs., vol. 15, March 1958, p. A48.

[55] Basett, R., The Coloring Agent in Amazonstone (Amazonite): Geol. Survey Tanganyika, Dar-es-Salaam, Records Geol. Survey Tanganyika, No. 8, 1956, pp. 97–100; Chem. Abs., vol. 52, No. 7, Apr. 10, 1958, column 5217g.

[56] Bunting, E. N., and Van Valkenburg, A., Some Properties of Diamond: Am. Mineral., vol. 43, No. 1–2, January-February 1958, pp. 102–106.

Foreign patents were issued on gem construction,[57] color improvement of pale diamonds,[58] and an apparatus for manufacturing synthetic jewels.[59]

[57] Marks, R. V., Opalescent Gem Construction; Australian Patent 216,746, Official Jour., vol. 28, No. 29–34, August–September 1958; Ind. Diamond Abs., vol. 15, December 1958, p. A206.

[58] Custers, H. F. J., Dyer, H. B., and Ditchburn, R. W., Method for Improving the Colour of Pale Yellow or Brown Diamonds: Swiss Patent 332,126, Patentliste, No. 16–17, August–September 1958; Ind. Diamond Abs., vol. 15, December 1958, p. A206.

[59] General Electric Co., Ltd., Apparatus for Manufacturing Synthetic Jewels: British Patent 798,818, Official Journal (Patents), No. 3616, June 4, 1958; Ind. Diamond Abs., vol. 15, August 1958, p. A128.

Gem Stones

By John W. Hartwell[1] and Betty Ann Brett[2]

GEM stones and mineral specimens produced in the United States during 1959 had an estimated value of $1,185,000, nearly 18 percent more than in 1958. This increase was primarily due to a 235-percent gain from Utah and increases from 28 other States.

New gem stone deposits continue to be found in all sections of the United States. A few old deposits, thought depleted, were reestablished as producing localities with the introduction of new mining methods.

DOMESTIC PRODUCTION

Because of the many scattered, part-time, and amateur producers of gem stones it was not possible for the Bureau to canvass all operations. Therefore, the information is based on a partial survey, and the domestic production figures given in this chapter are estimates based on available data.

Production was reported for the first time from the 50th State, Hawaii. Oregon was the leading producing State, with an estimated $200,000, the same as in 1958. Eleven States—Oregon, California, Utah, Nevada, Texas, Arizona, Wyoming, Washington, Colorado, New Mexico, and Montana—produced 88 percent of the total value.

During the year petrified wood, turquoise, jade, agate, quartz crystal, and mineral specimens, in that order, comprised about 27 percent of the value of all gem materials and mineral specimens collected. Principal varieties produced, in decreasing order by weight, were petrified wood, agate, rose quartz, unclassified mineral specimens, quartz crystals, and jasper. These materials comprised about 10 percent of the total weight collected.

Agate.—Producers in 27 States reported recovering 35 tons of agate valued at $30,000, a 10-percent decrease in weight, and a 40-percent decrease in value from 1958. Principal producing States, in decreasing order of production, were Oregon, Utah, Wyoming, California, and Texas. Gem-stone industry representatives estimated that agate production from Oregon, Washington, Idaho, and Montana ranged from 50 to 200 tons.

Jade.—Over 11,000 pounds of jade valued at $35,000 was produced during 1959. Wyoming was the leading State in value ($17,000); Alaska led in quantity (5,625 pounds). Some processed jade, mined at Dahl Creek near Kobuk, Alaska, was sold at auction at the Anchorage Fur Rendezvous, Anchorage, at prices ranging from $3 to $22

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[1] Commodity specialist.
[2] Statistical clerk.

per pound. The average price paid for Alaskan jade, rough and uncut, was more than $2 per pound. Quantities of jade continued to be sent to West Germany for cutting and polishing.

Petrified Wood.—An estimated 350 tons of petrified wood valued at more than $100,000 was produced by 16 States during 1959—greater than three times the estimated 110 tons reported in 1958. Utah was the leading State, with nearly 200 tons valued at $60,000, followed by Arizona, Oregon, and Wyoming.

Quartz Crystal.—About 16 tons of quartz crystal valued at $10,000 was produced in 12 States. Arkansas led with over 13 tons valued at $5,000. About 11,000 carats of smoky quartz crystal valued at $1,000 was reported recovered in New Hampshire.

Turquoise.—Total U.S. production was estimated at 16,000 pounds with a value of $63,000. Arizona remained the leading producing State with 9,000 pounds valued at $18,200. The area around Globe and Miami yielded about 6,000 pounds valued at nearly $12,000. An additional 1,000 pounds valued at $2,000 was reported produced in the Cerbat Mountains in Mohave County.

In Nevada Lone Mountain Turquoise Mine, Esmeralda County, reported production of 550 pounds valued at $11,000. Total State production was nearly 1,500 pounds valued at $22,600.

The Villa Grove Lode Mine, Saguache County, Colo., reported production of 340 pounds valued at $16,000.

Miscellaneous Gem Material.—The quantity of mineral specimens produced in the United States was estimated at over 125,000 pounds valued at nearly $90,000. The principal producing States were Arizona and Colorado.

Tourmaline production at a Mesa Grande location in San Diego County, Calif., was 80 pounds valued at $7,200.

Production of 1.25 pounds of fire opal valued at $1,500 was reported from the Rainbow Ridge and Bonanza mines in Humboldt County, Nev. A new opal discovery near Yerington, Nev., was reported. One opal recovered in this deposit weighed 55 pounds.

Diamond production in Arkansas was reported at 110 carats valued at $825. During the year a 6.42 carat stone reportedly was found.

Sapphire production in North Carolina was estimated at $2,500. Montana production was reported by a mine owner to average about $6,000 per day; annual production was not given.

Rose quartz production at the Scott Mine, S. Dak., was 134,000 pounds valued at $5,000. Total U.S. production was estimated at 140,000 pounds with a value of $6,000.

The quantity and value of some other gem stones produced were: Amazonite, 2,000 pounds, $2,000; beryl specimens, 750 pounds, $1,300; fluorite, 7,000 pounds, $2,500; garnet, 500 pounds, $2,100; jasper, 23,000 pounds, $7,000; obsidian, 10,000 pounds, $6,500; peridot, 680 pounds, $1,600; and rhodonite, 9,000 pounds, $2,200.

CONSUMPTION

Consumption of diamond ($180 million) was about 28 percent higher; sales of cultured pearl ($13 million) were 25 percent higher; and sales of synthetic and imitation stones ($10 million) about 10 percent higher than 1958.

TABLE 1.—Estimated production of gem stones in the United States

(In thousand dollars)

	1958	1959		1958	1959
Alaska	(1)	$18	New Mexico	$28	$39
Arizona	$86	88	New York	8	8
Arkansas	23	18	North Carolina	1	9
California	150	150	North Dakota	1	1
Colorado	38	48	Ohio	(1)	2
Connecticut	3	5	Oklahoma	------	(1)
Florida	------	3	Oregon	200	200
Hawaii	------	(1)	Pennsylvania	2	3
Idaho	5	5	South Dakota	16	20
Illinois	1	1	Tennessee	1	------
Kansas	------	1	Texas	100	100
Maine	5	10	Utah	40	134
Maryland	2	2	Vermont	1	1
Massachusetts	------	(1)	Virginia	3	4
Michigan	------	1	Washington	75	75
Minnesota	1	------	West Virginia	1	1
Missouri	------	3	Wyoming	52	76
Montana	35	35	Other States	17	9
Nebraska	2	3			
Nevada	100	100	Total	1,006	1,184
New Hampshire	5	10			
New Jersey	4	6			

[1] Included with "Other States."

Apparent consumption (domestic production plus imports minus exports) of gem stones in the United States in 1959 was about $189 million.

PRICES

A booklet published early in 1960 listed retail replacement prices (for insurance purposes) for excellent and good quality, 1- to 40-carat, cut and polished gem stones.[3] The gem stones included agate, aquamarine, alexandrite, amazonite, amethyst, bloodstone, chrysoprase, cairngorm, citrine, diamond, emerald, garnet, hematite, jade, kunzite, labradorite, lapis lazuli, moonstone, morganite, onyx, opal, pearl, peridot, ruby, sardonyx, sapphire, synthetic gems, topaz, tourmaline, turquoise, and zircon. Prices ranged from $1 for a good quality 1-carat agate gem to $16,000 for an excellent quality 8-carat Siberian emerald, or ruby. Diamond prices were quoted for stones up to and including 3 carats.

FOREIGN TRADE [4]

Value of gem-stone imports into the United States in 1959 increased 28 percent over that of 1958. Gem diamond accounted for 85 percent of the total imports, about the same as had been reported since 1954.

Import value of natural pearls remained the same as in 1958, but cultivated pearls showed a 26-percent increase, primarily due to an increase of imports from Japan.

Emerald imports, cut but not set, showed an increase of $1.4 million, primarily because of imports from Switzerland of $1.1 million, compared with $170,300 in 1958. The average value per carat of emeralds imported from Switzerland in 1959 was $725.

[3] Guffey, Neal, Gem Appraisers' Guide: Lapidary Jewelers, Inc. (Georgetown), Washington, D.C., 1960, 56 pp.

[4] Figures on imports and exports compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U.S. Department of Commerce, Bureau of the Census.

Exports of gem stones, precious and semiprecious, from the United States was $5.6 million in 1959, compared with $3.6 million in 1958; and reexports were $19.6 million, compared with $11.5 million in 1958.

TABLE 2.—Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States

[Bureau of the Census]

Item	1958		1959	
	Carats	Value (thousands)	Carats	Value (thousands)
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty free	[1] 1,129,808	[1] $72,563	1,599,720	$94,299
Cut, but unset, suitable for jewelry, dutiable	718,422	[1] 68,068	928,699	86,366
Emeralds: Cut but not set, dutiable	38,848	1,100	88,875	2,450
Pearls and parts, not strung or set, dutiable:				
Natural		597		595
Cultured or cultivated		10,347		13,083
Other precious and semiprecious stones:				
Rough or uncut, duty free		717		678
Cut but not set, dutiable		2,904		3,990
Imitation, except opaque, dutiable:				
Not cut or faceted		65		64
Cut or faceted:				
Synthetic		228		243
Other		9,311		10,746
Imitation, opaque, including imitation pearls, dutiable		17		14
Marcasites: Real and imitation, dutiable		26		8
Total		[1] 165,943		212,536

[1] Revised figure.

WORLD REVIEW

World diamond production decreased 1.2 million carats below that of 1958—the first annual decrease in 13 years. Decreases from Sierra Leone (200,000 carats) and the Belgian Congo (1.8 million carats) were the principal causes of lower production. Increases in other countries reduced the difference, bringing total production to 26.8 million carats.

Sales of gem diamonds (reported by the Central Selling Organization, London, which sold about 90 percent of the world total) were $177 million, compared with sales of $138 million in 1958.

NORTH AMERICA

Dominican Republic.—Production and sales of amber in 1959 were about 161 pounds valued at $520.[5]

SOUTH AMERICA

Brazil.—Possibilities of exploiting the Brazilian diamond deposits by large companies were discussed. Brazil produced only 3 percent of the world's diamonds, but deposits were known in 12 States. These deposits were worked by large numbers of individuals who used

[5] U.S. Embassy, Ciudad Trujillo, Dominican Republic, State Department Dispatch 354: Apr. 22, 1960, p. 1.

TABLE 3.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, by countries

[Bureau of the Census]

Country	1958				1959			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Carats	Value (thousands)	Carats	Value (thousands)	Carats	Value (thousands)	Carats	Value (thousands)
North America:								
Canada	8,085	$885	1,318	$103	13,322	$1,259	817	$61
Mexico							15	1
Total	8,085	885	1,318	103	13,322	1,259	832	62
South America:								
Argentina	290	7	10	12	508	11		
Brazil	5,631	295	287	17	22,032	725	213	18
British Guiana	6,739	210	40	6	7,461	241	67	8
Colombia					216	5		
Surinam	27	1					25	3
Venezuela	39,405	1,114	40	4	47,518	1,411	19	2
Total	52,092	1,627	377	39	77,735	2,393	324	31
Europe:								
Austria			62	9			220	28
Belgium-Luxembourg	192,980	12,831	455,267	40,740	398,790	20,003	538,811	50,786
France	[1] 11,581	[1] 463	7,386	898	24,373	1,257	13,981	1,461
Germany, West	784	19	35,323	2,442	2,418	57	49,400	3,438
Italy			119	60	1,152	28	58	14
Netherlands	8,252	983	24,046	2,927	6,900	546	35,782	3,987
Switzerland			279	100	3,134	91	918	433
United Kingdom	[1] 646,274	[1] 50,542	6,543	1,447	877,236	63,669	7,398	1,016
Total	[1] 859,871	[1] 64,838	529,025	48,623	1,314,003	85,651	646,568	61,163
Asia:								
Ceylon			142	21				
Hong Kong			207	15				
India			57	4			1,970	331
Israel	7,088	146	150,438	12,769	6,625	158	240,552	17,497
Japan			308	22			1,828	159
Lebanon	1,250	60					3	1
Singapore, Colony of	290	42					32	13
Total	8,628	248	151,152	12,831	6,625	158	244,385	18,001
Africa:								
Belgian Congo	5,025	30						
British East Africa	479	15						
French Equatorial Africa	6,521	224			1,796	85		
French West Africa and Togo, Republic of	3,686	92			5,546	224		
Ghana	72,951	653			43,508	404		
Liberia	22,989	805	4	(2)	30,384	905		
Union of South Africa	88,815	3,191	36,546	[1] 6,472	106,801	3,220	36,590	7,109
Western Portuguese Africa	666	55						
Total	201,132	4,965	36,550	[1] 6,472	188,035	4,838	36,590	7,109
Grand total	[1] 1,129,808	[1] 72,563	718,422	[1] 68,068	1,599,720	94,299	928,699	86,366

[1] Revised figure.
[2] Less than $1,000.

TABLE 4.—World production of diamond, by countries

[In thousand carats]

Country	1958		1959	
	Gem	Industrial	Gem	Industrial
Africa:				
Angola	601	400	516	500
Belgian Congo:				
Bakwanga	304	15,700	396	13,800
Kasai	469	200	259	400
French Equitorial Africa [1]	45	60	40	60
French West Africa [1]	195	260	200	400
Ghana	1,232	2,200	876	2,200
Liberia [2]	323	500	470	500
Sierra Leone	590	900	644	650
South-West Africa	844	60	841	90
Tanganyika	231	290	274	350
Union of South Africa:				
Premier	316	960	323	950
De Beers Group	488	480	562	500
Other "pipe" mines [1]	40	70	30	70
Alluvial [1] [3]	100	100	250	150
Other regions:				
Brazil [1]	150	150	180	170
British Guiana	13	20	22	40
Venezuela	15	75	15	80
India, Borneo, Australia, U.S.S.R., and Others [1]	5	5	5	10
World total	5,961	22,430	5,903	20,920

[1] Estimate.
[2] Exports only.
[3] Including State-owned mines.

primitive recovery methods. Over 90 percent of the diamond recovered was gem stone, because little effort was made to save the small and industrial stones. Recovery of diamond by large companies may be difficult because of the low ratio of payable diamond material to worthless rock.[6]

The variety and approximate quantity of uncut gem stones exported from Brazil in 1959 are given in table 5.[7]

British Guiana.—Production of diamond in 1959 was more than 430,000 stones weighing about 62,330 carats, compared with more than 280,000 stones weighing about 33,000 carats in 1958.[8]

Colombia.—During 1958 the Banco de la Republica decided to reorganize the Muzo and Cosquez emerald mines. In mid-1959 a proposal was made by the Minister of Mines to establish the emerald mining industry as a "public utility," with exploitation rights

TABLE 5.—Gem stone exports from Brazil, uncut, 1959

Variety	Quantity (pounds)	Variety	Quantity (pounds)
Agate	357,300	Topaz	400
Amethyst	33,100	Tourmaline	600
Aquamarine	1,000	Other, n.e.s.	352,800
Cat's eye	10	Diamond (carats)	25,000
Citrine	1,800		

[6] Mieritz, R. E., Brazil, An Untapped Diamond Source: Min. World, vol. 21, No. 1, January 1959, pp. 41–43.
[7] U.S. Embassy, Rio de Janeiro, Brazil, State Department Dispatch 1044: Apr. 28, 1960, pp. 2–3.
[8] Industrial Diamond Review (London), News in Brief: Vol. 20, No. 231, February 1960, p. 38.

reserved for the Government. Renewable 5-year contracts could be granted to private companies under government supervision.[9]

Early in 1960 it was announced that these emerald mines would be worked by a new company, The Colombia Emerald Co. This company was organized with government and private capital. (Private capital came from foreign and domestic sources.)[10]

Production of emeralds in 1958 was over 93,000 carats of third-, fourth-, fifth-, and sixth-class material; 68,000 carats was classed as Morrallas (semicrystallized product having the appearance of turquoise matrix, but green in color). Emerald production in 1957 was estimated at 12,500 carats.[11]

Venezuela.—Production of gem diamond in 1959 was 15,103 carats.[12]

EUROPE

Belgium.—A decline in recent years in the number of apprentices for some parts of the Belgium diamond industry was due to lower wages, increased production demand, and inadequate training facilities. The industry, in recognition of the importance for a number of skilled workers, was considering establishing technical schools.[13]

Imports of cuttable gem diamonds in 1959 were about 4.4 million carats valued at $102 million, compared with 4.4 million carats worth more than $90 million in 1958. Exports of cuttable and polished diamond in 1959 were about 1.1 million carats valued at $115 million. Nearly 50 percent of the polished diamond, valued at $50 million, was exported to the United States.[14]

Finland.—Gem materials found in Finland include chrome diopside, which usually occurs as nontransparent material suitable for cabochons. (Transparent crystals of this diopside are rare.) Other gem materials reportedly found were almandine, blue cordierite, staurolite, quartz crystals, and garnet.[15]

Germany, East.—Russian authorities reported opening an amber mine at Palmniken, East Germany. Production was reported at 25 to 30 tons annually.[16]

Netherlands.—The Netherland Institute of Scientific Research of Precious Stones and Pearls installed X-ray equipment to distinguish natural and cultivated pearls. Examinations were available to private individuals for a fee.[17]

U.S.S.R.—A new diamond discovery in the northern Ural Mountains was reported. These diamonds were of gem quality.[18]

The quality of diamond produced from the Yakutian area was unknown, but 80 percent of the stones were small, ranging from 0.5 to 32.5 carats. The largest found was a 54.14-carat stone. Stones

[9] Bureau of Mines, Mineral Trade Notes: Vol. 50, No. 1, January 1960, p. 18.
[10] Mining World, vol. 22, No. 3, March 1960, pp. 81–82.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 49, No. 2, August 1959, p. 45.
[12] U.S. Embassy, Caracas, Venezuela, State Department Dispatch 942: Apr. 26, 1960, p. 1.
[13] U.S. Consulate, Antwerp, Belgium, State Department Dispatch 125: Dec. 23, 1959, 4 pp.
[14] Bureau of Mines, Mineral Trade Notes: Vol. 50, No. 6, June 1960, pp. 8–9.
[15] Laitakari, Aarne, Some Unusual Stones in Finland: Rocks and Minerals, vol. 34, No. 7–8, July-August 1959, p. 297.
[16] Mining Journal (London), vol. 253, No. 6477, Oct. 9, 1959, p. 340.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 49, No. 4, October 1959, p. 40.
[18] Mining Journal (London), Russian Diamonds: Vol. 254, No. 6490, Jan. 8, 1960, p. 46.

of gem quality were rare, although enough were found to start a small-scale jewelry-making industry.[19]

United Kingdom.—The Central Selling Organization in London reported that sales of gem diamond in 1959 rose to $176,492,923 from $138,377,948 in 1958. Sales of diamond in the United States (about three-fourths of world sales) benefited from increased business activity and restocking of inventories depleted during 1958.[20]

Cairngorms, amethysts, topaz, royal blue beryl, sapphires, garnets, sard, and agates from Scotland were described.[21]

ASIA

Afghanistan.—Lapis lazuli production in 1959 was about 2 tons, compared with 1.5 tons in 1958. Unit value of cut and uncut material ranged from $41 to $136, the same as in 1958.[22]

Bahrein, State of.—Reports indicated that the value of pearl production would reach $210,000 in 1959. The pearling industry had been declining for several years owing to consumer preference for Japanese cultured pearls.[23]

Burma.—The quantity and value of gem stones produced in 1959 were: Jadeite, 47,700 pounds valued at $72,800; ruby, 15,200 carats valued at $415,800; sapphire, 438,500 carats valued at $214,600; and spinel, 73,900 carats valued at $119,100.[24]

China.—Geologists reportedly discovered a diamond deposit in the Yuan River, Province of Hunan.[25]

India.—Production of emeralds totaled 249,000 carats, compared with 80,000 in 1958, and 338,000 in 1957. Diamond production was 682 carats in 1959, 1,535 in 1958, and 790 in 1957. Other precious and semiprecious stones also were produced during these years.[26]

A directory of mines, firms, and mineral commodities of India, giving the name and address of each company owning or operating mines, was published.[27]

Israel.—Israel was able to compete in world gem-diamond trade because of a low-wage level, high rate of raw material usage, and technical improvements in its production processes. Therefore, during 1959, new workers were trained, and additional diamond-cutting and -polishing enterprises were established. The raw materials and financial assistance were supplied by the Government.[28]

Exports of polished diamond were about 470,000 carats. This was a 37-percent increase over the 1958 production of 341,000 carats.[29]

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[19] Katkoff, V. Russia's Diamond Strike, How Potent?: Jewelers' Circ.-Keystone, vol. 129, No. 7, April 1959, pp. 85-91.
[20] Wall Street Journal, vol. 155, No. 5, Jan. 8, 1960, p. 15.
[21] Rhodesian Mining Journal, Gem Stones of Scotland: Vol. 30, No. 378, November 1958, p. 312.
[22] U.S. Embassy, Kabul, Afghanistan, State Department Dispatch 199: Apr. 9, 1960, p. 1.
[23] Bureau of Mines, Mineral Trade Notes: Vol. 50, No. 1, January 1960, p. 18.
[24] U.S. Embassy, Rangoon, Burma, State Department Dispatch 520: Apr. 27, 1960, Encl. 1, p. 1.
[25] Jewelers' Circular-Keystone, Briefly: Vol. 129, No. 12, September 1959, p. 144.
[26] U.S. Embassy, New Delhi, India, State Department Dispatch 1431; June 4, 1959, p. 35; Dispatch 1006: Apr. 25, 1960, Encl. 1, p. 1.
[27] Mine and Quarry Engineering (London), List of Indian Mines: Vol. 25, No. 6, June 1959, p. 281.
[28] Gemmologist, Report From Israel; Vol. 28, No. 338, September 1959, pp. 177–178.
[29] South African Mining and Engineering Journal (Johannesburg), Israeli Diamond Exports: Vol. 71, No. 3500, Mar. 4, 1960, p. 551.

Japan.—Pearl exports in 1959 were valued at nearly $29 million, an increase of $6 million over 1958.[30] Higher prices were expected because a typhoon in September 1959 caused about $15 million damage to the pearl industry. A shortage of quality cultured pearls might result for 2 to 5 years.[31]

A short history of the cultured-pearl industry of Japan, and recent techniques introduced by the industry, was reported.[32]

Thailand.—About 1 million carats of gem stones was imported in 1959, compared with 6.9 million in 1958. Of the 1959 imports, 99 percent were "precious and semiprecious stones, including synthetics, cut but not set, n.e.c." Exports, 1.1 million carats in 1958, rose to 3.4 million carats in 1959. Exports in 1959 included uncut sapphires (163,000 carats), cut sapphires (314,000 carats), and cut zircons (217,000 carats).[33]

AFRICA

French West Africa.—Upper Guinea has many alluvial diamond deposits, about which production data are not available. However, two mining companies, Soginex, a De Beers subsidiary, and Compagnie Miniere de Beyla, a French company, exported about 52,000 carats of gem diamond in 1959.[34]

Rhodesia and Nyasaland, Federation of.—Vulcan Minerals (Pvt.), Ltd., sold its emerald deposit in the Belingwe district of Southern Rhodesia to Rio Tinto Ltd. The new owner planned to make a geological and mining survey of the area.[35]

Amethyst production in 1958 was about 3,800 pounds valued at $462, reported by the Northern Rodesian Department of Mines.[36]

South-West Africa.—Gem-diamond exports in 1959 were 819,351 carats valued at $42,530,000. Other gem materials produced were rose quartz (4.25 tons), tourmaline (41.3 pounds), chalcedony (670 pounds), topaz (20,300 pounds), and amethyst. Almost 3 tons of amethyst valued at $1,176 was exported.[37]

Tanganyika.—The Tanganyika Corundum Corp. produced a few small specimens from its ruby-corundum claim acquired in 1958.[38]

A three-part historical and operational account of the Williamson Diamond mine was given. Part one described the property and the services rendered to the community. Part two discussed geology and mining operations. Part three gave information on the process of concentrating diamond.[39]

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[30] Foreign Commerce Weekly, Japanese Pearl Exports Set Record in 1959: Vol. 63, No. 5, Feb. 1, 1960, p. 29.

[31] Wall Street Journal, Cultured Pearl Sales Expected to Rise in '60 Despite Higher Prices: Vol. 155, No. 9, Jan. 14, 1960, p. 19.

Jewelers' Circular Keystone, Japan Typhoon Will Cause Pearl Shortage: Vol. 130, No. 4, January 1960, p. 116.

[32] Bureau of Mines, Mineral Trade Notes: Vol. 50, No. 1, January 1960, pp. 18–24.

[33] U.S. Embassy, Bangkok, Thailand, State Department Dispatch 552: Mar. 30, 1960, Encl. 10, p. 1; Dispatch 673: May 27, 1959, Encl. 10, p. 1.

[34] U.S. Embassy, Canakry, Republic of Guinea, State Department Dispatch 242: Mar. 30, 1960, p. 10.

[35] South African Mining and Engineering Journal (Johannesburg), Rio Tinto and Emeralds: Vol. 70, No. 3482, Nov. 6, 1959, p. 1153.

[36] U.S. Consulate, Johannesburg, Union of South Africa, State Department Dispatch 78: Sept. 29, 1959, Encl. 1, p. 1.

[37] U.S. Consulate, Johannesburg, Union of South Africa, State Department Dispatch 252: Mar. 31, 1960, p. 1.

[38] Mining Magazine (London), Tanganyika Mining Industry, 1959: Vol. 102, No. 3, March 1960, p. 161.

[39] Du Toit, G. J., The Williamson Diamond Mine: Mine and Quarry Eng. (London), vol. 25, No. 3, March 1959, pp. 98–103; No. 4, April 1959, pp. 146–153; No. 5, May 1959, pp. 194–200.

Union of South Africa.—Production of emerald crystals totaled 145 pounds in 1958, compared with 13 pounds in 1957. The leading producer in 1958 was the African Emerald Mining Co. (Pty.), Ltd., Pretoria. Tigers-eye production in 1958 and 1957 was 20 and 40 short tons, respectively.[40]

OCEANIA

Australia.—All important gem stones except ruby and jade have been found in Australia. However, only opal and to a lesser extent sapphire, diamond, and emerald have been recovered commercially.

The principal opal- producing areas were Coober Pedy and Andamooka in South Australia, Lightning Ridge and White Cliffs in New South Wales, and the Hayrick mine near Quilpie, Queensland.

TABLE 6.—Exports of opal from Australia [1] by destination

Country	1954	1955	1956	1957	1958
Ceylon	$20,906	$48,010	$22,340	$19,889	$17,703
Germany, West	55,662	64,180	76,715	143,777	156,507
Hong Kong	511	17,284	24,201	23,598	6,982
Japan	645	12,947	115,752	244,966	369,531
New Zealand	1,485	4,382	710	3,689	2,437
United Kingdom	5,103	7,397	2,860	27,554	12,611
Other British countries	3,519	7,775	981	18,543	5,519
United States	114,406	109,912	127,725	130,442	166,640
Other	1,861	3,559	18,106	34,769	49,076
Total	204,098	275,446	389,390	647,227	787,006

[1] Converted from Australian Mineral Industry, Quarterly Review: Vol. 12, No. 2, pt. 1, November 1959, p. 24.

Sapphire has been produced from the Anakie field, Queensland, and the Inverell district of northeastern New South Wales. In 1920 gems valued at $125,000 were produced in the Anakie field; however, by 1958 the annual production value had fallen to about $1,800. The sapphire was found in the form of water-worn fragments, presumably liberated from basalt deposits. Other gem stones found in these alluvial deposits were green, yellow, and orange-yellow transparent to translucent corundum.

In 1959 Tungsten Consolidated Ltd., bought 40 percent interest in an Inverell sapphire deposit. While developing the property, more than 100 ounces of gem-quality corundum was produced per week; about 30 ounces was cuttable.

Diamond was small, off color, and not of gem quality. The principal producing areas were Copeton, Bingara, and Cudgegong fields of New South Wales.

Emerald production also was small. The principal producing area was near Poona, Western Australia.

Complete statistical information on Australian and Japanese pearl-fishing operations in areas off the Australian coast were compiled by the Australian Fisheries Division, Department of Primary Industry. These statistics, published in two volumes, covered the

[40] Bureau of Mines, Mineral Trade Notes: Vol. 49, No. 6, December 1959, pp. 41–42.

industry from mid-19th century through 1957. Annual supplements were planned for succeeding years.[41]

Pearl production values from 1954 to 1957 were \$8,192, \$7,493, \$16,173, and \$28,067, respectively. Ornamental shell (mother-of-pearl, trochus, and green snail) production for fiscal year 1957–58 was 2,809 short tons, about \$2.9 million in value.[42]

French Oceania.—Mother-of-pearl shell exports totaled 535 short tons at \$795,000 in 1957, and 693 tons at \$1,132,000 in 1956. About 85 percent of the exports were to France and West Germany.[43]

TECHNOLOGY

A guide to the minerals and rocks of Minnesota was published.[44]

The quartz family minerals, including the phanero and cryptocrystalline varieties found in California, were described. General references also were included.[45]

The geographical, geological, morphological, and economic conditions of the important mineral deposits of the Burmese Union were discussed. These minerals included precious gem stones and jade.[46]

An occurrence of jadeite in Kotaki, Niigata Prefecture, Japan, and its association with albite and a calciferous rock was studied. It was stated that albite placed under high pressure was transformed into jadeite with liberation of SiO_2.[47]

Studies were made on rocks from the west slope of the Urals containing genetic accessory minerals which accompany diamond in Ordovician gravels.[48]

A pale green, fine-grained, ornamental rock from the Transvaal, Union of South Africa, known as South African jade, and another type of garnet, uvarovite, were described.[49]

The Jewelers' Circular-Keystone magazine, beginning with the January 1959 issue, gave facts and legends about birthstones for each month of the year. These gem stones in chronological order were garnet, amethyst, aquamarine, diamond, emerald, pearl, ruby, sardonyx, sapphire, opal, topaz, and turquoise.

Each monthly issue of the Mine and Quarry Engineering (London) journal beginning with October 1953 described a mineral, giving the synonyms, nomenclature, varieties, composition, crystallography, physical and optical properties, tests, diagnoses, occurrences, and uses. Each mineral was illustrated in color. In the 1959 issues the minerals in chronological order were: Ilmenite, aragonite, tourmaline, adamite,

[41] U.S. Embassy, Canberra, Australia, State Department Dispatch 509: June 22, 1959, 2 pp.
[42] Bureau of Mines, Mineral Trade Notes: Vol. 50, No. 1, January 1960, pp. 16–17.
[43] Bureau of Mines, Mineral Trade Notes: Vol. 49, No. 4, October 1959, p. 40.
[44] Schwartz, G. M., and Thiel, G. A., Guide to the Minerals and Rocks of Minnesota: Univ. of Minnesota, 1958, pp. 1–26.
[45] California Division of Mines, Quartz Family Minerals: Min. Inf. Service, vol. 12, No. 4, April 1959, pp. 1–5.
[46] Jungwirth, Josef, Mining in Burmese Union—Present Status and Development Possibilities: Berg-u hüttenmänn. Monatsh. montan. Hochschule Leoben, vol. 104, 1959, pp. 143–151; Chem. Abs., vol. 53, No. 21, Nov. 10, 1959, col. 19721b.
[47] Shido, Fumiko, Calciferous Amphibole Rich in Sodium From Jadeite Bearing Albite of Kotaki, Niigata Prefecture: Chishitsugaku Zasshi (Tokyo), No. 64, 1958, pp. 595–600; Chem. Abs., vol. 53, No. 11, June 10, 1959, col. 9914c.
[48] Verbitskaya, N. P., and Gapeeva, G. M., Possible Sources of Diamonds in Alluvial Deposits of the West Slope of the Urals: Razvedka i Okhrana Nebr., vol. 25, No. 3, 1959, pp. 8–12; Chem. Abs., vol. 53, No. 18, Sept. 25, 1959, col. 16840e.
[49] Frankel, J. J., Uvarovite Garnet and South African Jade (Hydrogrossular) From the Bushveld Complex, Transvaal: Am. Mineral., vol. 44, No. 5–6, May–June 1959, pp. 565–591.

campylite, asbestos, autunite, analcime, epidote, anglesite, prehnite, and niccolite.

An inexpensive cardboard-mounted dichroscope was offered for sale in the latter part of 1959. This simple instrument helps in identifying colored stones and in distinguishing many synthetic from natural gems.[50]

An article on the atomic structure of diamond crystal presented new knowledge and led to a better understanding of the properties of diamonds. Also, current theories concerning the hardness of diamond were given.[51]

Sizable diamonds have been sold that were coated in such a way that some of the objectionable color was absorbed or neutralized. The coating made the stones appear whiter and therefore more valuable. Methods of restoring the original color and the efforts of the Jewelers Vigilance Committee to discover some simple optical test to detect the coatings was reported.[52]

Four types of facets may be made when recutting diamonds with old-fashioned designs. This recutting is said to give better refraction but causes a weight loss of 10 to 50 percent.[53]

The refractive indices, absorption coefficients, and biabsorption were determined for two synthetic ruby samples, one colored pink by 0.11 percent Cr_2O_3 (chromic oxide) and the other colored deep red by 1.40 percent Cr_2O_3.[54]

A method for making rubies, similar to the hydrothermal growth technique used to make emeralds, was announced. About 2 years was required to produce these rubies, and they were made in batches of 3,000 to 4,000 carats. Emeralds could be manufactured in about a year.[55]

White sapphires reported to be more perfect than natural stones were produced by the Bell Telephone Laboratories.[56]

Studies were made on unusual star-beryl, which contained a multitude of crystal inclusions.[57]

A study was made of the directional variation of grinding hardness in strontium titanate.[58]

Chrysoberyl and its special optical properties were described.[59]

Care and restoration of pearl luster were explained. Scratch hardness of pearls, tested with a sceleroscope, is 58 to 64 compared with 178 for quartz, 304 for spinel, and 667 for ruby.[60]

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[50] Pough, F. H., New Low-Cost Dichroscope on Market—Or You Can Make Your Own: Jewelers' Circ.-Keystone, vol. 129, No. 11, August 1959, pp. 172, 174.

[51] Wedepohl, P. T., Why Diamonds Are So Hard: Jewelers' Circ.-Keystone, vol. 129, No. 11, August 1959, pp. 132–133, 188, 190, 192, 195.

[52] Jewelers' Circular-Keystone, More Gyps Now "Coat" Diamonds, JVC Warns: Vol. 129, No. 12, September 1959, p. 159.

[53] Deutcher Goldschmiede Zeitung (Stuttgart), [Re-cutting Diamonds]: Vol. 57, No. 9, September 1959, p. 499; Ind. Diamond Abs., vol. 16, November 1959, p. A212.

[54] Mandarino, J. A., Refraction, Absorption, and Biabsorption in Synthetic Ruby: Am. Mineral., vol. 44, No. 9–10, September–October 1959, pp. 961–973.

[55] Jewelers' Circular-Keystone, "Cultured" Rubies Shown to Jewelers by Chatham: Vol. 129, No. 12, September 1959, p. 158.

[56] Science Newsletter, Sapphires Brewed in "Pressure Cooker": Vol. 76, No. 10, Sept. 5, 1959, p. 152.

[57] Eppler, W. F., An Unusual Star-Beryl: Jour. Gemmology (London), vol. 7, No. 5, January 1960, pp. 183–191; Ind. Diamond Abs., vol. 17, March 1960, p. A61.

[58] Giardini, A. A., and Conrad, M. A., Directional Hardness of Strontium Titanate by Peripheral Grinding: Ceram. Abs., vol. 42, No. 4, April 1959, pp. 165–168.

[59] Webster, R., The Prized Chrysoberyl: Gemmologist (London), vol. 28, No. 339, October 1958, pp. 190–194.

[60] Jewelers' Circular-Keystone, Why Pearls Deserve Loving Care: Vol. 129, No. 9, June 1959, p. 68.

A conference on crystal growth was held at the Institute of Crystallography, Academy of Sciences, U.S.S.R., during 1959. Talks were given on hydrothermal synthesis of quartz and methods for crystallization at ultrahigh pressures.[61]

An apparatus for extracting diamond from concentrates was patented in the U.S.S.R.[62]

A method was patented for examining and classifying gem diamond, which also produced a record by means of which the diamond could be positively identified.[63]

A patent was issued on a process for manufacturing synthetic gems.[64]

Artificial gem stones were made by pulverizing colored ceramics, porcelain, and glass, pressing the powder into briquets with or without binders, and firing the briquets at 950° to 1,300° C. The fired material was then worked into finished gem stones by cutting, grinding, engraving, polishing, and boring.[65]

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[61] Central Intelligence Agency, A. U.S.S.R. Conference on the Growth of Crystals: Sci. Inf. Rept. PB131891 T–30, Sept. 18, 1959, pp. 37–39.

[62] Dubinskii, S. A., Shvetsov, G. F., and Khaidarov, A. A., Apparatus for Extraction of Diamonds from Concentrates: U.S.S.R. Patent 113,055, Aug. 15, 1958; Chem. Abs., vol. 53, No. 3, Feb. 10, 1959, col. 2511d.

[63] Samuels, A. S., Sr., Method of Examining and Classifying Diamonds: U.S. Patent 2,909,961, Oct. 27, 1959.

[64] Kato, Ichiro, Ultrahigh-Pressure Furnace for Manufacture of Synthetic Gems: Japanese Patent 9960, Nov. 19, 1958; Chem. Abs., vol. 53, No. 5, Mar. 10, 1959, col. 4619b.

[65] Weichel, Fritz, and Maurer, Karl, Gem Stones From Ceramics, Porcelain, and (or) Glass: German Patent 936,739, Dec. 22, 1955; Chem. Abs., vol. 53, No. 3, Feb. 10, 1959, col. 2511e.

Gem Stones

By John W. Hartwell [1] and Betty Ann Brett [2]

GEM materials and mineral specimens produced in the United States during 1960 were estimated at $1,188,000—a $3,000 increase over 1959.

During the year the U.S. Customs Bureau auctioned 8,014 carats of confiscated diamonds, realizing over $1 million for the Government.

The Federal Trade Commission approved the use of the term "Chatham-created emerald" to describe the gem stone produced by the Chatham Research Laboratories, San Francisco, Calif. This term was developed to replace the word "cultured" formerly used. The Commission emphasized that this phrase was to be used only in describing the gems and not the jewelry in which the stones were mounted.

DOMESTIC PRODUCTION

Production information was collected by the Bureau of Mines by canvassing amateur and professional producers of gem stones, but it was not possible to contact all operations. Therefore, facts are based on only a partial survey.

Forty-four States reported production of gem stones, compared with 45 in 1959. Oregon again was the leading State. Thirteen States—Oregon, California, Arizona, Nevada, Texas, Washington, Utah, Wyoming, Colorado, New Mexico, Arkansas, Montana, and South Dakota—produced 89 percent of the total value.

Agate.—About 200 tons of agate, valued at $175,000, was produced in 29 States in 1960. This was a large increase in value and quantity over 1959. Principal States, in decreasing order of production, were Oregon, Utah, New Mexico, Arizona, California, Wyoming, Colorado, and Texas.

A large agate weighing 237 pounds was discovered in Idaho. It was 14 inches in diameter, contained alternate bands of blue and white quartz, and had a small portion in the center containing quartz crystals.

Fire agate production was valued at $5,000; moss, plume, and Turritella agate production was valued at more than $33,000.

Diamond.—Diamonds were still being found at the "Crater of Diamonds" near Murfreesboro, Ark. Production in 1960 was 141 carats

[1] Commodity specialist, Division of Minerals.
[2] Statistical clerk, Division of Minerals.

valued at about $9,000. Kimberlite, valued at $7,500 and weighing 15,000 pounds also was sold.

Jade.—Production of jade from Alaska, California, Colorado, and Wyoming was 22,000 pounds, valued at $51,000. Wyoming was the leading State with 7,000 pounds, valued at $24,000. Some Alaskan jade was sent to West Germany for cutting and polishing; other jade was cut and polished locally by native craftsmen.

Petrified Wood.—Almost 150 tons of petrified wood valued at $90,000 was produced in 16 States during 1960. This was considerably less than in 1959. Arizona led with nearly 45 tons, followed by Utah, Oregon, Wyoming, and New Mexico. Twenty-five thousand pounds of petrified palm wood and petrified bone, valued at $20,000, was produced in 8 States. A large deposit of petrified wood, apparently buried under volcanic ash, was discovered in Crook County, Oreg.

Quartz Crystal.—An estimated 18 tons of quartz crystal, valued at $15,000, was produced in 15 States. Arkansas, with over 11 tons valued at nearly $7,000, was the principal producing State. Thirty-eight tons of rose quartz, valued at $5,000, was produced in 5 States. Arizona, with 35 tons, was the leading State. A small quantity of smoky quartz, valued at $1,500, also was produced.

Turquoise.—Production of turquoise from Arizona, Colorado, and Nevada was 16,000 pounds, valued at $60,000. The Villa Grove Turquois Lode, Saguache County, Colo., reported production of over 400 pounds, valued at $16,400. The American Gem Co. reported production from its Lone Mountain Turquois Mine, Esmeralda County, Nev., of 332 pounds, valued at $6,640.

Miscellaneous Gem Material.—Mineral specimens produced in the United States were estimated at nearly 300,000 pounds, valued at $125,000. Principal producing States were Arizona, Utah, California, Oregon, and Wyoming.

TABLE 1.—Estimated value of gem stone production in the United States

(Thousand dollars)

State	1959	1960	State	1959	1960
Alaska	$18	(1)	New Jersey	$6	$7
Arizona	88	$120	New Mexico	39	40
Arkansas	18	38	New York	8	9
California	150	150	North Carolina	9	4
Colorado	43	45	North Dakota	1	1
Connecticut	5	7	Ohio	2	3
Florida	3	----	Oklahoma	(1)	1
Hawaii	(1)	(1)	Oregon	(1)	(1)
Idaho	5	5	Pennsylvania	3	4
Illinois	1	1	South Dakota	20	20
Kansas	1	----	Tennessee	----	1
Maine	10	15	Texas	100	100
Maryland	2	2	Utah	134	72
Massachusetts	(1)	1	Vermont	1	1
Michigan	1	1	Virginia	4	5
Minnesota	----	2	Washington	75	75
Missouri	3	----	West Virginia	1	1
Montana	35	35	Wyoming	76	68
Nebraska	3	4	Other States	209	235
Nevada	100	100			
New Hampshire	10	15	Total	1,184	1,188

[1] Included with "Other States."

Rough garnet production was 4,500 pounds, valued at $5,000. The garnet mine, North Creek, N.Y., reported sales of 1,440 carats of cut and polished stones valued at $3,600.

Fire opal from Nevada was valued at over $5,000; quantity was not reported, but one producer at Virgin Valley, Nev., reported 20 pounds valued at $800.

Lapis lazuli production from the Caseade Mine, San Bernardino County, Calif., was 250 pounds. The value depended upon the quality and was priced from $3.50 to $200 per pound.

The quantity and value of some other gem stones and mineral specimens produced were: Amethyst, 1,600 pounds, $2,200; beryl specimens, 1,000 pounds, $500; copper minerals, 8,000 pounds, $5,000; fluorite, 5,000 pounds, $8,000; geodes, 50,000 pounds, $10,000; howlite, 3,000 pounds, $1,500; jasper, 100,000 pounds, $30,000; kunzite, 50 pounds, $1,500; lepidolite, 1,500 pounds, $1,000; marcasite, 1,500 pounds, $1,500; onyx, 16,000 pounds, $4,500; peridot, 440 pounds, $1,000; rhodonite, 20,000 pounds, $6,000; rhyolite, 21,000 pounds, $3,000; and vesuvianite, 2,500 pounds, $1,500.

CONSUMPTION

Consumption of diamond ($166 million) was 8 percent lower than in 1959; sales of synthetic and imitation stones ($6 million) were 40 percent lower; and sales of natural and cultured pearls ($14.6 million) were 6 percent higher.

Apparent consumption (domestic production plus imports minus exports) of gem stones in the United States in 1960 was over $164 million, compared with $189 million in 1959.

PRICES

Prices of colored precious stones and some semiprecious stones have increased in the past few years. Some gem stones were difficult to find in wholesale and retail stores in the United States because of a greater demand from European countries.

Emeralds were in demand everywhere, but especially in Italy where the green stones are highly esteemed. Most natural emeralds sold originated in Colombia and Africa (good quality stone but small or dark), Brazil (pale), and India, where the mines were nearly exhausted.

Deep blue aquamarines, produced in Brazil, were scarce and priced higher than wholesalers in New York were willing to pay.

Large rubies, always high-priced, were rare, whereas the prices of small cheap stones rapidly increased. The large flawed crystals, usually sold as mineral specimens, were cut and polished for the jewelry trade. Large quantities of dull, dark, and flawed star rubies from India were sold.

Sapphires also gained in popularity, and prices increased considerably above the unusual low prices of former years. Production of fancy sapphires from Ceylon continued to decrease.

Prices of Ceylon cat's eye and alexandrite increased, but these gems were almost nonexistent in the markets. No alexandrites were available in European markets in late 1960, but a few small Russian stones at prices higher than diamonds of the same size were offered.

Wholesale prices of black opal increased 50 percent or more. Red tourmaline, in short supply, and green and blue tourmaline, in good supply, increased only slightly in price. Most quartz gems were abundant, but fine amethysts were rare, and even average-quality stones were hard to find.

Most other semiprecious and synthetic gem stones increased in price only slightly despite the increased labor costs of cutting and polishing.

Zircon was the only gem whose price decreased.[3]

FOREIGN TRADE [4]

Imports.—Imports of gem stones decreased nearly 10 percent in value from 1959. Gem diamonds accounted for 86 percent of the total imports but decreased about $6.8 million in value from 1959.

The value of natural and cultivated pearls imported increased $900,000 over 1959.

Emerald imports, cut but not set, decreased $1 million. Imports from Switzerland increased nearly 400 carats, but the unit value per carat dropped from $725 in 1959 to $134 in 1960, resulting in an $861,000 drop in value. Imports from Colombia and Ceylon dropped 12 percent and 83 percent, respectively, in quantity. There were

TABLE 2.—U.S. imports for consumption of precious and semiprecious stones (exclusive of industrial diamonds)

Item	1959		1960	
	Carats	Value (thousands)	Carats	Value (thousands)
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty free	[1] 1,578,170	[1] $94,283	1,365,529	$87,510
Cut, but unset, suitable for jewelry, dutiable	[1] 916,824	86,366	801,945	78,037
Emeralds: Cut but not set, dutiable	88,875	2,450	81,207	1,463
Pearls and parts, not strung or set, dutiable:				
Natural		595		629
Cultured or cultivated		13,083		13,934
Other precious and semiprecious stones:				
Rough or uncut, duty free		678		620
Cut but not set, dutiable		3,990		3,967
Imitation, except opaque, dutiable:				
Not cut or faceted		64		74
Cut or faceted:				
Synthetic		243		334
Other		10,746		5,897
Imitation, opaque, including imitation pearls, dutiable		14		8
Marcasites: Real and imitation, dutiable		8		7
Total		[1] 212,520		192,480

[1] Revised figure.

Source: Bureau of the Census

[3] Pough, Frederick H., Precious Stones: Scarcer, Costlier; Jewelers' Circ.-Keystone, vol. 131, No. 6, March 1961, pp. 76, 93–94.

[4] Figures on imports and exports compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U.S. Department of Commerce, Bureau of the Census.

almost no imports from Thailand, whereas in 1959 nearly 2,500 carats were imported.

Imports of imitation gems, cut or faceted were nearly 55 percent under 1959.

TABLE 3.—U.S. imports for consumption of diamonds (exclusive of industrial diamonds), by countries

Country	1959				1960			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Carats	Value (thousands)	Carats	Value (thousands)	Carats	Value (thousands)	Carats	Value (thousands)
North America:								
Canada	13,322	$1,259	817	$61	13,751	$1,004	936	$74
Mexico			15	1			173	16
Total	13,322	1,259	832	62	13,751	1,004	1,109	90
South America:								
Argentina	508	11						
Brazil	22,032	725	213	18	26,811	907	34	8
British Guiana	7,461	241	67	5	22,102	743	23	1
Colombia	216	5						
Surinam			25	3				
Venezuela	47,518	1,411	19	2	41,220	1,161		
Total	77,735	2,393	324	31	90,133	2,811	57	9
Europe:								
Austria			220	28			753	47
Belgium-Luxembourg	898,790	20,003	538,811	50,786	207,225	14,354	435,284	44,462
France	24,373	1,257	13,981	1,461	45,965	1,803	13,337	1,181
Germany, West	2,418	57	49,400	3,438	553	13	59,703	3,974
Italy	1,152	28	58	14			66	15
Netherlands	6,900	546	35,782	3,987	22,512	1,432	33,869	3,762
Switzerland	3,134	91	918	433	2,501	138	99	10
United Kingdom	877,236	[1] 63,749	7,398	1,016	829,523	59,547	7,133	1,094
Total	1,314,003	[1] 85,731	646,568	61,163	1,108,279	77,287	550,244	54,545
Asia:								
India			1,970	331			86	15
Israel	6,625	158	[1] 228,677	17,497	54,894	1,801	213,013	17,453
Japan			1,828	159			6,398	81
Lebanon			3	1				
Singapore, Colony of			32	13				
Total	6,625	158	[1] 232,510	18,001	54,894	1,801	219,497	17,549
Africa:								
Congo, Republic of the, and Ruanda-Urundi [2]					22	1		
Western Africa, n.e.c. [3]	5,546	224			7,180	259		
Western Equatorial Africa, n.e.c. [4]	1,796	85			3,494	105		
Ghana	43,508	404			7,104	47		
Liberia	30,384	905			23,567	879		
Union of South Africa	[1] 85,251	[1] 3,124	36,590	7,109	56,185	3,198	30,955	5,843
Total	[1] 166,485	[1] 4,742	36,590	7,109	97,552	4,489	30,955	5,843
Oceania: Australia					920	118	83	1
Grand total	[1] 1,578,170	[1] 94,283	[1] 916,824	86,366	1,365,529	87,510	801,945	78,037

[1] Revised figure.
[2] Effective July 1960; formerly Belgian Congo.
[3] Effective July 1960; formerly French West Africa and Republic of Togo.
[4] Effective July 1960; formerly French Equatorial Africa.

SOURCE: Bureau of the Census.

Exports.—Exports of gem stones, precious and semiprecious, were $7.6 million in 1960, compared with $5.3 million (revised) in 1959; and reexports were $21.7, compared with $19.7 million (revised) in 1959.

WORLD REVIEW

World diamond production decreased 700,000 carats below 1959. This decrease was due to the political unrest in the Republic of the Congo where loss in production was 1.8 million carats. Increases in other countries brought the total production to 26.1 million carats.

Gem-diamond production increased 300,000 carats, principally because of increased production from Angola, Sierra Leone, and the Union of South Africa (De Beers' Group).

Sales of gem diamonds, reported by the Central Selling Organization, London, which sold about 90 percent of the world total, were a record $178 million, compared with $177 million in 1959.

TABLE 4.—World production of diamonds, by countries

(Thousand carats)

Country	1959		1960	
	Gem	Industrial	Gem	Industrial
Africa:				
Angola	516	500	658	400
Central African Republic [3]	40	60	30	45
Congo, Republic of the	655	14,200	413	13,040
Ghana	876	2,200	873	2,400
Guinea [1,4]	200	400	447	670
Ivory Coast [3]			80	120
Liberia [3]	470	500	577	400
Sierra Leone	644	650	912	1,050
South-West Africa	841	90	866	70
Tanganyika	274	350	287	250
Union of South Africa:				
Premier	323	950	309	1,000
De Beers Groupe	562	500	717	580
Other "pipe" Mines [2]	30	70	30	70
Alluvial [2,4]	250	150	240	160
Other regions:				
Brazil [3]	180	170	150	150
British Guiana	22	40	41	60
Venezuela	15	80	14	57
India, Borneo, Australia, U.S.S.R., and Others [2]	5	10	10	20
World total	5,903	20,920	6,700	20,500

[1] Formerly French Guinea.
[2] Estimate.
[3] Exports only.
[4] Including State-owned mines.

NORTH AMERICA

Dominican Republic.—Amber, containing numerous insect and plant inclusions, from deposits in Dominican Republic was described. Some references to other world deposits known to contain animal and vegetable inclusions were made.[5]

[5] Science, Amber With Insects and Plant Inclusions from the Dominican Republic: Vol. 131, No. 3409, Apr. 29, 1960, p. 1313.

SOUTH AMERICA

Brazil.—Exploracao de Mineros Brasilia Ltd., a partnership of two Canadian corporations, prospected for diamonds and gold in several areas in the State of Minas Gerais during 1960. An alluvial deposit was found in central Brazil, but the quantity of gold was considered too low to risk the development of the property solely for diamonds.[6]

British Guiana.—A new diamond deposit was reported found near Ekereku.[7]

EUROPE

Spain.—The history and present production of "Spanish Topaz" mines near Velas Buenas, Spain, were given. These "topaz" crystals (brown quartz crystals or citrine) were valued in 1958 at US$35 per kilogram.[8]

U.S.S.R.—Gem diamond produced by the U.S.S.R. was to be sold exclusively by the Central Selling Organization of the Diamond Corp., London, under an agreement whereby the diamonds produced from Siberian deposits would be marketed for the first time in the free world.

The diamond mines in Yakut ASSR and their industrial development were described.[9]

ASIA

Fine precious gems of Burma, Ceylon, and Thailand became scarce because mining almost ceased. Sapphires were still found in these countries, but the Ceylon stones were less valuable than those of Burma or Thailand. The Thailand sapphires were easier to cut and polish than Burma stones but had less value.

Ceylon.—Gem stone mines in Ceylon produced alexandrite, amethyst, aquamarine, cat's eye, garnet, moonstone, ruby, sapphire, spinel, topaz, tourmaline, and zircon. The average annual output was estimated at US$420,000.[10]

India.—The Geological Survey of India reported discovery of a rare variety of diamond in the Majhagawan diamond mines in the Panna district. Diamond also was reported to occur in a conglommerate bed near Banganapalle in Andhra Pradesh.[11]

Indonesia.—A new diamond field was discovered in South Kalimantan near the Ulin airport at Bandjarmas. One diamond that was found weighed 12 carats.

Israel.—The history and status of the diamond industry were reported.[12] Israel, with nearly 150 small factories employing 4,000 people, cutting and polishing gem diamonds ranging from 1/15 carat

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[6] Mining World, Latin America: Vol. 13, No. 12, November 1960, p. 70.
[7] Diamond News, Diamond Rush in British Guiana: Vol. 24, No. 3, December 1960, p. 13.
[8] Pough, Frederick H., The "Spanish Topaz" Mines: Jewelers' Circ.-Keystone, vol. 130, No. 4, January 1960, pp. 62, 64.
[9] Bureau of Mines, Mineral Trade Notes: Vol. 50, No. 5, May 1960, pp. 7–12.
[10] Mining Journal (London), Diamonds, Gemstones, and Abrasives: Annual Review, May 1960, pp. 71, 73, 75, 77.
[11] Mining World, India: Vol 22, No. 12, November 1960, pp. 78–79.
Mining Journal (London), Mineral Discoveries in India: Vol. 255, No. 6530, Oct. 14, 1960, p. 413.
[12] Bureau of Mines, Mineral Trade Notes: Vol. 51, No. 5, November 1960, pp. 18–24.

to ½ carat, was the third largest diamond center in the world. Diamond exports in 1959 were valued at nearly US$47 million, and 42 percent of the total was exported to the United States.

AFRICA

Congo, Republic of the.—Most diamond mining in the Congo was suspended for about 2 months during 1960 because of political conditions. The Bakwanga mine produced about 95 percent of the total output. It was closed on August 28, resumed operations late in October, and production was expected to become normal early in 1961. Most other smaller mines of the Forminiere were partially shut down during the last half of the year.[13]

Guinea, Republic of.—In the first part of 1960, Soguinex, a subsidiary of De Beers, and another French company, produced two-thirds of the Guinean diamonds; the other third was produced by a large number of individual miners. In November 1960 a Government resolution decreed that all private exploitation should be nationalized. Diamond exploitation was placed under the control of a new organization, Societe Nationale d'Exploitation de Diamonts, which was run for the Government by Russian mining engineers. In 1960, 1,116,500 carats of diamond was exported compared with 643,000 carats in 1959.[14]

Alluvial diamond mining deposits near the Sierra Leone border were described.[15]

Ivory Coast.—The output of diamond in 1959 by the two principal producers was about 188,000 carats, a 13-percent increase over 1958. One producer erected a plant to treat the 1960 production by a new process tried in a pilot plant during 1959. This new plant will recover about 250,000 carats from old tailings.[16]

Malagasy Republic.—During 1959, 24,740 pounds of precious and semiprecious stones, valued at nearly US$9,000, was exported. In the first half of 1960, exports were 21,800 pounds valued at US$19,000. Most valuable gems exported were citrine and labradorite.[17]

Rhodesia and Nyasaland, Federation of.—Rhodesia Chrome Mines, Ltd., discovered a deposit of nephrite jade in the midlands of Southern Rhodesia during 1960. This was the first discovery of this mineral in Southern Africa.[18]

Sierra Leone.—A program, called the Sierra Leone Revolving Loan Scheme, was instituted by the Department of Information, Ministry of Mines and Labor, to help native diamond miners improve mining methods and secure equipment. This program, financed by a free grant from American Aid released to the British Territories in Africa, allocated Sierra Leone $140,000.[19]

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[13] Foreign Commerce Weekly, Strife-Torn Congo Struggles To Keep Mineral Output at Normal Rate: Vol. 64, No. 22, Nov. 28, 1960, pp. 32, 34.
U.S. Embassy, Leopoldville, Republic of the Congo, State Department Dispatch 226: Jan. 23, 1961, p. 1.

[14] U.S. Embassy, Conakry, Republic of Guinea, State Department Dispatch 225; Mar. 13, 1961, p. 15.

[15] Bruton, M. E., Diamond Mining in Guinea: Gemmologist, vol. 29, No. 348, July 1960, pp. 121–131.

[16] Bureau of Mines, Mineral Trade Notes: Vol. 50, No. 6, June 1960, p. 10.

[17] Bureau of Mines, Mineral Trade Notes: Vol. 52, No. 2, February 1961, pp. 10–11.

[18] Industrial Diamond Review (London), News in Brief: Vol. 20, No. 238, September 1960, p. 175.

[19] Bureau of Mines, Mineral Trade Notes: Vol. 52, No. 2, February 1961, p. 10.

South-West Africa.—Most of the 18 varieties of gem stones produced in South Africa come from an area near Namaland, and include agate, amazonite, amethyst, aquamarine, emerald, garnet, jade, topaz, and tourmaline.

Production of gem diamond in 1959 was nearly 875,000 carats, compared with 834,000 in 1958. Output in 1960 was estimated at 4 percent more than in 1959.

The Central Selling Organization reported that South-West Africa contributed about 24 percent of the total value of gem diamonds sold on the world market in 1959.

Consolidated Diamond Mines, a subsidiary of De Beers Consolidated Mines, Ltd., accounted for about 99 percent of the diamonds produced in this country.[20]

Tanganyika.—Tanganyika Corundum Corp, Ltd., continued to develop a ruby-corundum deposit near Longido, but no significant production or sale of gem material was reported.

Ruby and Sapphire were reported discovered in deposits in the Lushoto district, Tanganyika.[21]

Union of South Africa.—Income from the sale of gem diamond during 1960 decreased 7 percent from 1959 owing to a decrease in the quantity of diamonds sold. Production of semiprecious gems was amethyst, 2,000 pounds, and tourmaline, 5,700 pounds. Tiger eye continued to be exported (2,000 pounds), but production figures were not available.[22]

OCEANIA

Australia.—Nullamanna Sapphires Pty., Ltd., about 10 miles north of Inverell, New South Wales, began producing sapphire during 1959. In 2 months, 221 ounces of material was produced.

Opal was discovered near Helen Springs Station 90 miles north of Tennant Creek. Some black opal was produced. The Cretaceous rock formations in western New South Wales were reported to be favorable for opal discoveries.

Opal production was expected to exceed US$2.8 million in 1960, compared with US$1.9 million in 1959. Exports to Japan in 1959 were valued at over US$1 million; to West Germany, over US$400,000.

Information concerning Australia's gem stone deposits and production was published by the Australian Bureau of Mineral Resources.[23]

In an area between Southern Cross and York in Western Australia, mineral deposits were staked by several large mining companies. Included was a 30-square-mile tract 40 miles northeast of Hall's Creek staked for agate and other gem stones.[24]

A new syndicate was licensed by the State of Western Australia to operate cultured pearl farms in two areas in King Sound at Malumbo

[20] Bureau of Mines, Mineral Trade Notes: Vol. 52, No. 1, January 1961, pp. 15–17.

[21] Mining Journal (London), Mining in Tanganyike in 1960: Vol. 256, No. 6559, May 5, 1961, pp. 505, 507.

[22] U.S. Consulate, Cape Town, Union of South Africa, State Department Dispatch 110: Mar. 30, 1961, pp. 2, 6, encl. 2, pp. 1, 2.

[23] Mining Journal (London), Australia's Gemstone Industry: Vol. 255, No. 6521, Aug. 12, 1960, p. 173.

[24] Financial Standard (Melbourne), Mineral Interest Widens: Vol. 117, No. 2920, Jan. 26, 1961, p. 27.

Anchorage. The services of a Japanese technician and cultured pearl expert were to be obtained.[25]

ANTARCTICA

Antarctica.—Petrified wood of low-grade gem quality was found by a Bureau of Mines field engineer in perhaps the world's most remote location near the head of Mackay glacier west of the Ross Sea.

TECHNOLOGY

Newly developed prospecting techniques were mentioned as possible methods of searching for the original source of diamonds found in the Great Lakes glacial drift areas.[26]

Two publications on Maine minerals and mineral locations were issued during the year.[27]

The occurrence and description of 63 gem and ornamental stones in Washington was published.[28]

Descriptions and occurrences of many Malagasy minerals and gem materials were given.[29]

Each monthly issue of the Mine and Quarry Engineering (London) journal beginning with October 1953 described a mineral, giving the synonyms, nomenclature, varieties, composition, crystallography, physical and optical properties, tests, diagnoses, occurrences, and uses. Each mineral was illustrated in color. In the 1960 issues the minerals in chronological order were: Crocoite, lazurite, erythrite, manganite, serpentine, scheelite, stilbite, ulexite, brochantite, brucite, mispickel, and agate.

Deposits of minerals in Arkansas and Oklahoma, including diamond in peridotite, were described.[30]

A historical review and the characteristics of Brazilian diamonds were given, and the diamonds were compared with diamonds from other countries.[31]

A Russian book on the diamond fields of Yakutia, northern Siberia, was published in 1959. It contained 525 pages, 41 colored plates, and 305 photographs, drawings, and diagrams. The book was reviewed and abstracted in a British publication.[32]

A history of African diamond mining and recovery of diamond from alluvial and underground deposits were published.[33]

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[25] Bureau of Mines, Mineral Trade Notes: Vol. 51, No. 5, November 1960, p. 28.
[26] Smith, Charles H., Diamonds in the Great Lakes Area—A Geological Enigma: Canadian Min. Jour., vol. 81, No. 7, July 1960, pp. 51–52.
[27] Morrill, Phillip, and others, Maine Mines and Minerals: Dillingham Natural History Museum, East Winthrop, Maine, vol. 1, Western Maine, 1960, 82 pp.; vol. 2, Eastern Maine, 1960, 82 pp.
Maine Geological Survey (Augusta), Maine Mineral Collecting: 1960, 23 pp.
[28] Valentine, G. M., and Huntting, M. J., Inventory of Washington Minerals, 2d Ed.: Wash. Dept. of Conserv., Div. of Mines and Geol., Bull. 37, vol. 1, pt. 1, 1960, pp. 43–46 (text); vol. 2, pt. 1, 1960, p. 35 (map).
[29] Behier, Jean, Madagascar Mineralogy: Rept. Malgache, Ann. Geol., Madagascar, No. 29, 1960, pp. 1–78; Chem. Abs., vol. 55, No. 2, Jan. 23, 1961, col. 1301e.
[30] Scull, B. J., The Age of Mineralization in the Ouachita Mountains of Arkansas and Oklahoma: Symposium on Geol. Ouachita Mts., Dallas Geol. Soc., Ardmore Geol. Soc. 1959, pp. 62–69; Chem. Abs., vol. 54, No. 1, Jan. 10, 1960, col. 178b.
[31] Reis, Esmaraldino, The Big Brazilian Diamonds: Brazil Dept. Natl. Prod. Mineral, Div. Geol. e Mineral., Rio de Janeiro, vol. 191, 1959, 65 pp.; Chem. Abs., vol. 54, No. 14, July 25, 1960, col. 13992i.
[32] Wilson, N. W., The Diamond Deposits of Yakutia: Min. Mag. (London), vol. 103, No. 4, October 1960, pp. 205–213.
[33] Daily, A. F., Africa's Key Role in Diamond Mining: World Mining, pt. 1, vol. 13, No. 10, September 1960, pp. 38–43; pt. 2, vol. 13, No. 11, October 1960, pp. 36–41; pt. 3, vol. 13, No. 12, November 1960, pp. 32–37.

Additional information on diamond mining, processing, and synthetic development may be found in the Abrasive Materials chapter of this volume.

Chemical, optical, and X-ray data on jadeite and associated minerals found in central Japan were given.[34] It was suggested that jadeite probably was formed under high pressure at a low temperature during metamorphism. Desilication of its host rock by the associated ultramafic rock might have promoted its formation.

The composition and structure of moonstones from Ceylon, Coimbatore, and Korea were studied, and results were given.[35]

The mechanism of quartz formation in the laboratory and some conclusions concerning the natural process was written.[36]

Equipment used by various research laboratories in the synthesis of diamond was described.[37]

The U.S. Air Force established a research laboratory at Bedford, Mass., to synthesize crystals, including diamonds. It was hoped that diamonds could be developed for making transistors that could be operated at high temperatures. Information on equipment used and results obtained was given.[38]

Diamond, kyanite, garnet, topaz, and jadeite were synthesized in the laboratory under ultra-high pressures.[39]

A new emerald substitute was manufactured in Austria. These emeralds, grown from a seed consisting of a faintly colored, faceted, beryl gem, were then coated with a thin layer of emerald by a hydrothermal or flux-fusion process. The result was an unpolished faceted gem.[40]

Star gem stones produced synthetically were described.[41]

Methods of producing quartz cat's eye,[42] garnet,[43] and unicrystalline bodies [44] were patented.

Cutting of jade minerals by diamond saws was compared with wire and disc cutting methods.[45]

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[34] Seki, Yôtarô. Aiba, Mizuo, and Kato, Chigusa, Jadeite and Associated Minerals of Metagabbroic Rocks in the Sibukawa District, Central Japan: Am. Mineral, vol. 45, Nos. 5 and 6, May–June 1960, pp. 668–679.

[35] Jayaraman, A., X-Ray Study of the Structure of Moonstones: Proc. Indian Acad. Sci., vol. 50A, 1959, pp. 349–357; Chem. Abs., vol. 54, No. 15, Aug. 10, 1960, col. 15107a.

[36] Corwin, James F., Natural Quartz From the Laboratory: Jour. Chem. Ed., vol. 37, No. 1, January 1960, pp. 11–14.

[37] Giardini, A. A., Tydings, J. E., and Levin, S. B., A Very High Pressure-High Temperature Research Apparatus and the Synthesis of Diamond: Am. Mineral., vol. 45, Nos. 1 and 2, January–February 1960, pp. 217–221.

Schwartz, C. M., and Wilson, W. B., Ultra High Pressure for Materials Research: Battelle Tech. Rev., vol. 8, No. 6, June 1959, pp. 3–8.

[38] Pough, Frederick H., The "Gem" Factory on Route 128: Jewelers' Circ.-Keystone, vol. 130, No. 7, April 1960, pp. 78, 80, 92–94, 128.

[39] Metal Progress, Ultra-High-Pressure Techniques: Vol. 77, No. 4, April 1960, pp. 170, 172, 174.

Birch, Francis, and Robertson, E. C., Report P.B. 128556: U.S. Govt. Research Rept., vol. 29, No. 2, 1958, 55 pp.

[40] Holmes, Ralph J., and Crowningshield, G. Robert, A New Emerald Substitute: Reprint from Gems and Gemology, Spring 1960, 22 pp.

[41] Pough, Frederick H., New Star Stones Break With Tradition: Jewelers' Circ.-Keystone, vol. 131, No. 2, November 1960, pp. 64, 78, 80, 82.

[42] Watson, John E., Method of Making Synthetic Quartz Cat's-eye Gem: U.S. Patent 2,948,082, Aug. 9, 1960.

[43] Nielsen, James W. (assigned to Bell Telephone Laboratories), Method of Making Single Crystal Garnets: U.S. Patent 2,957,827, Oct. 25, 1960.

Wentorf, Robert H. (assigned to Union Carbide Corp.), Method of Making Garnet: U.S. Patent 2,941,861, June 27, 1960.

[44] Kebler, Richard W., Dutchess, Elmer E., and Hutcheson, Ralph L. (assigned to Union Carbide Corp.), Method for Making Synthetic Unicrystalline Bodies: U.S. Patent 2,962,838, Dec. 6, 1960.

[45] Shreve, R. Norris, Jade Cutting Today: Gems and Gemology, vol. 10, No. 3, Fall 1960, pp. 81–89.

The need for lapidary diamond saws, less costly than the circular type now being used, was discussed. It was suggested that hacksaw blades, diamond-charged and adapted to lapidary work, would be a good substitute since power tools suitable for operating this type of blade were already on the market.[46]

Cutting, grinding, and polishing techniques used in producing kunzite gem stones were described.[47]

A machine for faceting gems was patented in Switzerland. The patent was illustrated and showed details of the gem holder which was angularly adjustable but limited by stops.[48]

A brilliant-cut diamond with a new shape called the trilliant, having 44 facets and a polished girdle, was developed.[49]

Methods of testing pearls to determine if they are natural or cultured were described.[50]

A simple, quick, and cheap method of determining whether a diamond is naturally or artificially blue was developed.[51]

The color changes in diamond bombarded with neutrons and electrons in a high voltage accelerator were described.[52]

A method of preventing gem opal from cracking during processing was patented in Japan.[53]

A foldable device for use in examining transparent or translucent gem materials with polarized light was patented.[54]

An electrical detector was invented to sort transparent and translucent gem diamond from opaque gangue materials. The optical property of gem diamond to reflect light was used to develop this apparatus.[55]

Lists of reference books for gem collectors and lapidaries were given.[56] Some books on gems and gem materials were published in late 1959 and during 1960.[57]

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[46] Mineralogist, New Lapidary Products: Vol. 28, Nos. 2–3, February–March 1960, pp. 39–40.

[47] Deane, N., Cutting a Kunzite: Jour. Gemology, vol. 7, No. 8, October 1960, pp. 294–295.

[48] Stachli, W., Machine for Faceting Series of Gems: Swiss Patent 343,829, Mar. 1, 1956.

[49] Gemmologist (London), Brilliant-Cut Diamond of New Shape Developed: Vol. 29, No. 345, April 1960, p. 63.

[50] Pough, Frederick H., Natural or Cultured? X-ray Will Tell All: Jewelers' Circ.-Keystone, vol. 130, No. 7, April 1960, pp. 74, 88–90.

[51] Custers, J. F. H., Dyer, H. B., and Raal, F. A., A Simple Method of Differentiating Between Natural Blue Diamonds and Diamonds Coloured Blue Artificially: Ind. Diamond Rev., vol. 30, No. 236, July 1960, pp. 134–135.

[52] Custers, J. F. H., and Wedepohl, P. T., Diamonds and the Atom: Jewelers' Circ.-Keystone, vol. 130, No. 13, September 1960, pp. 106, 125, 126.

[53] Nagao, C., Japanese Patent 311 (1960) Jan. 19, 1960.

[54] Chromy, Benjamin J., Device for Optical Examination of Gem Materials: U.S. Patent 2,934,993, May 3, 1960.

[55] Linari-Linholm, A. A., An Optical Method of Separating Diamond from Opaque Gravels: Inst. Min. and Met. (London), preprint 38, 1960, 11 pp.

[56] Pough, Frederick H., Basic Books and Tools for the Gem Specialist: Jewelers' Circ.-Keystone, vol. 130, No. 6, March 1960, pp. 80, 82, 115–116.
Pough, Frederick H., Information for Your Talks About Gems: Jewelers' Circ.-Keystone, vol. 130, No. 13, September 1960, pp. 108, 110, 127–128.
Pough, Frederick H., Good Source Material for Jeweler Lectures: Jewelers' Circ.-Keystone, vol. 130, No. 11, July 1960, pp. 66, 70, 72, 74, 76.
Jewelers' Circular-Keystone, Books: Vol. 130, No. 9, June 1960, p. 110.
Pough, Frederick H., Classic Gem Texts Stand Tests of Time: Jewelers' Circ.-Keystone, vol. 130, No. 8, May 1960, pp. 66, 68.

[57] Copeland, L., and others, The Diamond Dictionary: Gemological Inst. America, Los Angeles, Calif., 1960, 317 pp.
Lapham, Davis M., and Geyer, Alan R., Mineral Collecting in Pennsylvania: Pennsylvania Topographic and Geologic Survey Bull. G–33, 1959, 74 pp.
Sinkankas, John, Gemstones of North America: D. Van Nostrand Co., Inc., Princeton, N.J., 1959, 675 pp.
Northrop, Stuart A., Minerals of New Mexico, Rev. Ed.: Univ. of N. Mex. Press, Albuquerque, N. Mex., 1959, 665 pp.

Gem Stones

By John W. Hartwell [1] and Betty Ann Brett [2]

GEM materials and mineral specimens produced in the United States during 1961 were estimated at $1,309,000—a $121,000 increase over 1960.

According to the U.S. Department of Commerce, there were 326 lapidary plants in 25 States in 1958.[3] New York, N.Y., had the greatest number with 205, followed by Providence County, R.I., 37; and Los Angeles, Calif., 11. The average number of employees in each plant was 6. Four of the larger plants, located in the counties of Westchester, N.Y., Middlesex, N.J., Rolette, N. Dak., and Tarrant, Tex., employed 100 to 249 workers each. Also listed were 249 plants in 15 States manufacturing "jewelry findings and materials." Most plants were in Rhode Island, with 144, followed by New York, 41, Massachusetts, 23, and New Jersey, 20. One plant in Massachusetts employed more than 500 workers. The average plant employed 20 workers.

The Internal Revenue Service amended its regulations covering the Federal retail excise tax on jewelry. The new regulations added to, amended, or superseded sections of Regulation 51 as amended and printed in 1956. The following stones, whether real or synthetic, cut, polished, rough, or in their natural state, were taxable when sold at retail: Amber, beryl (aquamarine, emerald, golden beryl, heliodor, and morganite), chrysoberyl (alexandrite, cat's eye, and chrysolite), corundum (ruby and sapphire), diamond, feldspar (moonstone), garnet, jadeite (jade), jet, lapis lazuli, nephrite (jade), opal, pearl (natural and cultured), peridot, quartz (amethyst, bloodstone, citrine, moss agate, onyx, sardonyx, and tiger's eye), spinel, topaz, tourmaline, turquoise, and zircon. In addition to these stones, the tax applied to all articles commonly or commercially known as jewelry, regardless of the substance of which they were made. In determining the retail price for tax purposes, any charge for the coverings or containers in which the stones or jewelry were delivered to the customer were to be included.[4]

DOMESTIC PRODUCTION

Production data were collected by the Bureau of Mines by canvassing amateur and professional producers of gem stones, but it was not possible to contact all operators. Therefore, information is based on only a partial survey.

[1] Commodity specialist, Division of Minerals.
[2] Statistical clerk, Division of Minerals.
[3] U.S. Department of Commerce. 1958 Census of Manufacturers: Lapidary Work, 1961, p. 72.
[4] Burnstine, Bernard N. A Jeweler's Guide. Jewelers' Circ.–Keystone, v. 131, No. 7, April 1961, pp. 86–89, 102, 104.

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Gem material and mineral-specimen production was reported from 45 States, 1 more than in 1960. California, Oregon, and Texas were the leading States. Eleven States—California, Oregon, Texas, Arizona, Nevada, Wyoming, Washington, Utah, New Mexico, Colorado, and Montana—produced 85 percent of the total value.

An amethyst mine in Roberta, Cabarrus County, N.C., began operating in 1961. Two weeks after mining started, three bushels of amethysts in clusters and single crystals were recovered.[5]

TABLE 1.—Estimated value of gem stone production in the United States

(Thousand dollars)

State	1960	1961	State	1960	1961
Arizona	$120	$119	North Carolina	$4	$6
Arkansas	38	19	North Dakota	1	1
California	150	200	Ohio	3	4
Colorado	45	36	Pennsylvania	4	5
Connecticut	7	9	Rhode Island		1
Delaware		1	South Dakota	20	18
Hawaii	(1)	18	Tennessee	1	1
Maine	15	20	Texas	100	150
Maryland	2	3	Utah	72	73
Massachusetts	1	2	Vermont	1	2
Nebraska	4	5	Virginia	5	6
Nevada	100	100	West Virginia	1	1
New Hampshire	15	(1)	Wyoming	68	83
New Jersey	7	9	Other States [2]	355	361
New Mexico	40	46			
New York	9	10	Total	1,188	1,309

[1] Included with "Other States."
[2] Includes Alaska, Idaho, Illinois, Indiana (1961), Michigan, Minnesota (1960), Missouri (1961), Montana, Oklahoma, Oregon, and Washington with a value of $1,000 or more and those States indicated by footnote 1.

A pink sapphire weighing 14 ounces, estimated to contain 2,000 carats of cuttable material, was found in the Cowee Valley gem field, Macon County, N.C. A 24-ounce ruby weighing 3,400 carats also was found. The ruby contained many flaws, but from the unflawed material within the stone 800 to 1,200 carats may be cut.[6]

New synthetic emeralds were available to U.S. jewelers as a result of a contract between Linde Co. and a Brazilian gem stone dealer, a worldwide distributor of Austrian-manufactured synthetic emeralds. The new synthetics were to retail for $62 to $75 per 1-carat stone, compared with the Chatham-created emeralds priced at $50 to $280 for the same size.[7]

Agate.—Nearly 180 tons of agate valued at $130,000 was reported produced in 23 States in 1961. Estimates were that an additional 200 tons valued at $150,000 was produced in States from which no reports were received. Principal States, in decreasing order of production, were Oregon, South Dakota, New Mexico, Arizona, Washington, Utah, California, and Montana.

Moss agate production was valued at $6,000; turritella, $8,000; and fire agate, $4,000. Plume agate was not reported produced.

[5] Rocks and Minerals. Amethyst Mine Opens in North Carolina. V. 36, Nos. 9, 10, September–October 1961. p. 458.
[6] The Evening Star, Washington, D.C. Carolina Gem-Hunter Finds 2 Giant Stones. No. 205, July 24, 1961, p. 24.
[7] Jewelers' Circular-Keystone. The New Synthetic Emeralds. V. 131, No. 12, August 1961, pp. 156, 158, 160, 161.

Diamond.—Production of diamond at "Crater of Diamonds" near Murfreesboro, Ark., was 121 carats valued at $7,260. Kimberlite was still being sold, but production and value were not reported. The two largest diamonds found during 1961 weighed 3.42 and 3.27 carats.

A washing and concentrating plant, capable of processing 100 cubic yards of diamond-bearing kimberlite per day, was in operation during 1961 at the Arkansas Diamond Mine near Murfreesboro, Ark. A total of 9 carats valued at $320 was reported recovered during the year.

Jade.—Jade production from Alaska, California, Nevada, and Wyoming was 24,000 pounds valued at $73,000. Wyoming was the leading State with 9,000 pounds valued at $42,000. Jade was reported discovered in the Lake Huron region, Mich. No other information on this new source was given.

Outcroppings of green, yellow, blue, gray, and brown jade were discovered southwest of Twenty Nine Palms, Calif.

Obsidian.—Obsidian production, totaling 90,000 pounds valued at $25,000, was reported from six States. Utah was the leading State with 42,000 pounds valued at $13,000. Some of the obsidian varieties collected included rainbow, golden sheen, snowflake, black, and white.

Petrified Wood.—About 80 tons of petrified wood valued at $69,000 was produced in 12 States. South Dakota led with nearly 26 tons, followed by Arizona, Wyoming, Utah, Nebraska, and Nevada. Petrified palm wood production was 5,300 pounds valued at nearly $4,000, and petrified bone produced was 11,000 pounds valued at $6,600.

Quartz Crystal.—Reports indicated that about 35 tons of quartz crystal and miscellaneous quartz specimens, except smoky and rose, was produced, valued at $20,000. Arkansas was the leading producing State with 26 tons valued at $8,000.

Smoky and rose quartz production was 10,000 pounds valued at $8,000.

Tourmaline.—Production of tourmaline from Maine was reported to be over 4,000 carats valued at $500, and 10,000 pounds of tourmaline specimens valued at more than $1,000 were produced. Most of the material came from the Harvard Mine near Greenwood, Maine, and from areas around Newry. Specimens of apatite, cookeite with quartz, and lepidolite also were obtained from the Harvard Mine.

Turquoise.—Five States reported production of 5,300 pounds of turquoise valued at $40,000. Arizona produced 2,900 pounds valued at $12,000; Nevada, 1,800 pounds, at $20,000; and Colorado 100 pounds, at $5,000. Minor values were reported from California and New Mexico.

The Blue Star mine, north of Carlin, Nev., a producer of turquoise for 25 years with an output of about $400,000, was being developed into a gold-producing property during 1961.

Miscellaneous Gem Material.—Mineral specimens produced in the United States were estimated at 350,000 pounds valued at $200,000. Principal producing States were Texas, South Dakota, California, Colorado, and New Mexico.

Rough garnet production was 1,700 pounds valued at $2,100, principally from California. Sales of 458 carats of cut and polished stones valued at $916 were reported from a garnet mine at North Creek, N.Y.

A few pounds of gem opal valued at $3,000 were reported produced from the Rainbow Ridge and Bonanza opal mines in Virgin Valley, Nev. Another producer from a locality south of Yerington, Nev., reported production of 1,500 pounds.

Output of 100 pieces of jet valued at $200 was reported from New Mexico for the first time in many years.

Production of black coral, obtained by divers off the islands of Kauai, Lanai, Maui, and between Maui and Molokini Islands in Hawaii, was about 3,200 pounds valued at $18,000. Due to the depths to which divers were required to go to recover the coral, prices were expected to increase from $5 to $8 per pound in 1961 to $12 in 1962.

The quantity and value of some other gem stones and mineral specimens produced were: Amethyst, 1,000 pounds, $1,000; beryl specimens, 1,000 pounds, $6,000; copper minerals, 10,000 pounds, $12,000; feldspar gems, 15,000 pounds, $3,000; fluorite, 2,000 pounds, $1,500; fossils, 5,000 pounds, $3,000; geodes, 25,000 pounds, $15,000; gold nuggets, 2 pounds, $1,000; idocrase, 3,000 pounds, $2,500; jasper, 75,000 pounds, $25,000; lepidolite, 2,000 pounds, $1,000; marcasite, 2,000 pounds, $1,500; onyx, 50,000 pounds, $10,000; ornamental stone, 50,000 pounds, $8,000; peridot, 10,000 pounds, $15,000; rhodonite, 30,000 pounds, $10,000; rhyolite, 5,000 pounds, $1,500; topaz, 1,000 pounds, $2,000; and verd-antique, 15,000 pounds, $1,500.

CONSUMPTION

Diamond consumption, $193 million was 16 percent greater than in 1960; sales of synthetic and imitation gem stones, $5.3 million were 12 percent lower; and sales of natural and cultured pearls, $17 million were 16 percent higher.

Apparant consumption (production plus imports minus exports and reexports) of gem stones in the United States was over $181 million, compared with $164 million in 1960.

PRICES

Prices quoted during October 1961 for cut and polished gem diamonds were: ¼ carat, $70 to $295; ½ carat, $170 to $540; 1 carat, $400 to $1,680; and 2 carats, $1,090 to $4,000. The range in price of each size depended upon quality (cut, clarity, and color).

The price of medium-grade, rough, green opal from Australia increased from US$45 per ounce in 1959 to US$90 in 1960, and to US$135 in 1961. Best-grade, rough, black opal was selling at US$448 or more per ounce in mid-1961.

A report on the diamond industry was published. This publication contained information on diamond marketing and world prices of gem and industrial diamonds during 1960.[8]

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[8] Switzer, George. Thirty-Sixth Annual Report on the Diamond Industry—1960 Jewelers' Circ.-Keystone, 1961, 53 pp.

FOREIGN TRADE [9]

Imports.—Gem stone imports increased 16 percent in value over 1960. Gem diamonds accounted for 87 percent of the total imports and increased 947,000 carats in quantity and $28 million in value over 1960.

Diamonds, cut but unset, were principally imported from Israel and Belgium-Luxembourg, with 51 percent from the latter. The average values per carat of diamond imports from the principal exporting countries were Belgium-Luxembourg, $98.02; France, $96.24; Israel, $78.97; Netherlands, $112.46; Union of South Africa, $179.18; United Kingdom, $129.82; and West Germany, $66.73. Average value of all imports of these cut but unset diamonds was $93.67.

Imports of emeralds, cut but not set, increased 146,000 carats over 1960; 89 percent came from India. The average values per carat of emerald imports from the principal exporting countries were Brazil, $23.12; Ceylon, $48.53; Colombia, $78.35; France, $30.29; Hong Kong, $86.34; India, $5.36; Italy, $84.78; Pakistan, $87; Switzerland, $138.13; Union of South Africa, $114.64; United Kingdom, $16.91; and West Germany, $37.47.

The value of imported cultured pearls increased about $2.5 million over 1960, but the value of natural pearls decreased $129,000.

Rubies and sapphires, cut but not set, valued at $675,000 were imported from 13 countries. Imports from Colombia, the principal source, were valued at $506,000.

TABLE 2.—U.S. imports for consumption of precious and semiprecious stones, exclusive of industrial diamonds

Stones	1960		1961	
	Carats	Value (thousands)	Carats	Value (thousands)
Diamonds:				
Rough or uncut, suitable for cutting into gemstones, duty free	1,365,529	[1] $87,518	2,274,923	$114,670
Cut, but unset, suitable for jewelry, dutiable	801,945	78,037	839,150	78,605
Emeralds: Cut but not set, dutiable	81,207	1,463	227,284	2,090
Pearls and parts, not strung or set, dutiable:				
Natural		629		500
Cultured or cultivated		13,934		16,425
Other precious and semiprecious stones:				
Rough or uncut, duty free		620		1,169
Cut but not set, dutiable		3,967		3,899
Imitation, except opaque, dutiable:				
Not cut or faceted		74		54
Cut or faceted:				
Synthetic		334		346
Other		5,897		4,907
Imitation, opaque, including imitation pearls, dutiable		8		14
Marcasites: Real and imitation, dutiable		7		36
Total		[1] 192,488		222,715

[1] Revised figure.

Source: Bureau of the Census.

[9] Figures on imports and exports compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U.S. Department of Commerce, Bureau of the Census.

TABLE 3.—U.S. imports for consumption of diamonds (exclusive of industrial diamonds), by countries

Country	1960				1961			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Carats	Value (thousands)	Carats	Value (thousands)	Carats	Value (thousands)	Carats	Value (thousands)
North America:								
Canada	13,751	$1,004	936	$74	7,772	$833	79	$10
Mexico			173	16	257	3	160	14
Panama							23	3
Total	13,751	1,004	1,109	90	8,029	836	262	27
South America:								
Brazil	26,811	907	34	8	42,962	759	706	36
British Guiana	22,102	743	23	1	26,150	686	93	8
Venezuela	41,220	1,161			111,700	3,151		
Total	90,133	2,811	57	9	180,812	4,596	799	44
Europe:								
Austria			753	47				
Belgium-Luxembourg	207,225	14,354	435,284	44,462	210,419	15,391	428,054	41,957
France	45,965	1,808	13,337	1,181	47,857	1,522	10,578	1,018
Germany, West	553	13	59,703	3,974	896	28	52,154	3,480
Italy			66	15			541	59
Netherlands	22,512	1,432	33,869	3,762	50,563	2,360	28,756	3,234
Switzerland	2,501	138	99	10	6,526	269	349	205
U.S.S.R.							1,023	85
United Kingdom	829,523	[1] 59,555	7,133	1,094	1,561,423	81,702	5,238	680
Total	1,108,279	[1] 77,295	550,244	54,545	1,877,684	101,272	526,693	50,718
Asia:								
Hong Kong							1	(2)
India			86	15			9	3
Iran							56	4
Israel	54,894	1,801	213,013	17,453	50,744	1,938	278,229	21,971
Japan			6,398	81	244	26	942	91
Singapore, Colony of							38	11
Thailand							83	1
Total	54,894	1,801	219,497	17,549	50,988	1,964	279,358	22,081
Africa:								
Congo, Republic of the, and Ruanda-Urundi [3]	22	1			10,860	228	10	1
Western Africa, n.e.c. [4,5]	7,180	259			80,243	2,097		
Western Equatorial Africa, n.e.c. [6]	3,494	105			3,863	51		
Ghana	7,104	47						
Liberia	23,567	879			8,113	280		
Union of South Africa	56,185	3,198	30,955	5,843	54,331	3,346	31,951	5,725
Total	97,552	4,489	30,955	5,843	157,410	6,002	31,961	5,726
Oceania: Australia	920	118	83	1			77	9
Grand total	1,365,529	[1] 87,518	801,945	78,037	2,274,923	114,670	839,150	78,605

[1] Revised figure.
[2] Less than $1,000.
[3] Effective July 1960; formerly Belgian Congo.
[4] Effective July 1960; formerly French West Africa and Republic of Togo.
[5] N.e.c.—not elsewhere classified.
[6] Effective July 1960; formerly French Equatorial Africa.

Source: Bureau of the Census.

Exports.—Exports of gem stones, precious and semiprecious, were $14.8 million, compared with $7.6 million in 1960. Diamonds, cut but unset, accounted for 76 percent of the total.

The value of gem stones exported, except diamonds, was over $2 million, of which 50 percent went to Switzerland and West Germany.

Reexports of gem stones, precious and semiprecious, were $28 million, compared with $21.7 million in 1960. Diamonds, rough, uncut, and suitable for cutting into gem stones, accounted for 80 percent of the total.

WORLD REVIEW

Gem and industrial diamond sales through the Central Selling Organization (London) were a record $268 million. No breakdown between gem and industrial sales was given. The previous sales record was $255.2 million, set in 1959.

TABLE 4.—World production of diamonds, by countries

(Thousand carats)

Country	1960		1961	
	Gem	Industrial	Gem	Industrial
Africa:				
Angola	658	400	688	460
Central African Republic	30	[1] 50	41	70
Congo, Republic of the	413	13,040	405	17,738
Ghana	[1] 773	[1] 2,500	740	2,300
Guinea [2]	447	670	490	730
Ivory Coast	80	120	219	330
Liberia [3]	577	400	595	500
Sierra Leone	912	1,050	887	1,050
South-West Africa	[1] 885	[1] 50	816	90
Tanganyika	287	250	340	345
Union of South Africa:				
Pipe mines:				
Premier	309	1,000	360	1,200
De Beers Group	717	580	953	760
Other "pipe" mines [2]	[1] 40	[1] 100	35	80
Alluvial mines [2] [4]	240	160	240	160
Other regions:				
Brazil [2]	[1] 175	[1] 175	175	175
British Guiana	[1] 61	[1] 40	68	45
Venezuela	14	57	60	74
India, Borneo, Australia, U.S.S.R., and Others [2]	[1] 60	[1] 360	80	420
World total	[1] 6,700	[2] 21,000	7,200	26,500

[1] Revised figure.
[2] Estimate.
[3] Exports only.
[4] Including State-owned mines.

NORTH AMERICA

Canada.—The possibility of finding diamond in Canada was reported to be good because of the similarity between the diamond-bearing rocks in Siberia and those of northern Canada.[10]

SOUTH AMERICA

Brazil.—A deposit of tourmaline was discovered in pegmatites at Serra da Cacunda, Minas Gerais. Three other tourmaline mines were registered with the Government, one each in the States of Minas Gerais, Ceara, and São Paulo.[11] The quantity produced was unknown.

[10] Jewelers' Circular-Keystone. Diamond Finds in Canada Likely. V. 131, No. 7, April 1961, p. 134.
[11] Mining Journal (London). Mining News from Brazil. V. 257, No. 6593, Dec. 29, 1961, p. 675.

Reactivation of an old diamond mine, the Boa Vista, in the State of Minas Gerais, was planned by a group of investors from the United States. The new company's name was Diamonds of Brazil, Inc.[12]

Exports of semiprecious stones in 1960 were 533 tons valued at US$481,321, compared with 317 tons valued at US$27,173 in 1959. These figures were compiled from export licenses issued by the Brazilian Department of Mineral Production.[13]

British Guiana.—Diamond production was 112,679 carats in 1961, of which 67,600 was gem material. This was an increase of about 12,000 carats over 1960. A new diamond deposit was discovered during 1961 at Kurupung.

Chile.—Exports of lapis lazuli in 1961 were 1.8 short tons valued at US$6,400, compared with 4.4 tons valued at US$2,840 in 1960. In both years West Germany was the leading customer.[14]

Colombia.—A new company, Empresa de Esmeraldas, was formed by the Banco de la Republica to take over and work the existing emerald mines. Reports were received that new deposits of emerald were found in the western Department (State) of Boyaca.[15]

Venezuela.—Diamond production in 1961 was 134,000 carats, of which 60,500 carats was gem quality. Exports of 54,000 carats were to Bermuda and the United States. The discovery of several large deposits in the Caroni River bed resulted in increased production of all types of diamonds during the year.[16]

EUROPE

U.S.S.R.—After the discovery of the first kimberlite pipe in Yakutia in 1954, about 200 pipes and dikes were reported found. Only seven or eight had a diamond content high enough for economic exploitation. Two of these were in southern Yakutia; the rest were in the north or near the Arctic Circle.

It was estimated that 900,000 carats was produced in Yakutia and about 50,000 carats in the Ural Mountain region in 1960. Of the total produced, about 5.5 percent was gem diamond. Gem diamonds were being cut and polished in Leningrad and Sverdlovsk.[17]

ASIA

Bahrain.—Expectations were that the 1961 pearl harvest from the Persian Gulf would exceed the 1960 production of US$210,000. The pearling fleet consisted of 11 boats with 450 divers, compared with over 1,800 boats used 30 years ago. Most of the pearls were polished and drilled in India before being made into jewelry.[18]

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[12] Jewelers' Circular-Keystone. American Investors Seek Diamonds in Brazil Mine. V. 131, No. 9, June 1961, pp. 95–96.

[13] Mining Journal. Notes on the Mineral Potential of Brazil. V. 256, No. 6560. May 12, 1961, p. 535.

[14] U.S. Embassy, Santiago, Chile. State Department Dispatch 645. Apr. 17, 1962, p. 31.

[15] Mining Journal (London). Mining Miscellany. V. 257, No. 6580, Sept. 29, 1961, p. 317.

[16] Bureau of Mines. Mineral Trade Notes. V. 54, No. 5, May 1962, p. 10.

[17] Kowalewski, Jan. Mineral Resources Development in U.S.S.R.—II. Min. J., v. 257, No. 6571, July 28, 1961, p. 94.

[18] Foreign Commerce Weekly. Forecast for Bahrain Pearl Harvest Appears Optimistic. V. 67, No. 2, Jan. 8, 1962, p. 60.

Hong Kong.—The Colonial Government with the help of Japanese consultants was reviving its pearl industry. Although it was still in the experimental stage, the developers hoped to produce cultured pearls within a few years.[19]

India.—The National Mineral Development Corp., owned by the Government of India, proved a diamond deposit in the Panna region and planned production of 40,000 to 50,000 carats by 1963. It was estimated that 65 percent of total production would be gem diamonds.[20]

Emerald deposits in the Udaipur region at Gamgudha, Kalouman, and Tikhi had yielded high-grade gems in past years, and the possibilities of again producing in these areas were being explored.[21]

Israel.—A new diamond center, sponsored by the Government-controlled Diamond Development Corp. and the Jerusalem Economic Corp., was opened in Jerusalem in November 1960. The Israel diamond industry in 1961 employed about 8,000 people, with an expansion of an additional 4,000 people expected in the near future.

In 1960, Israel imported nearly 1.5 million carats of rough diamonds valued at US$51 million and exported about 618,000 carats valued at US$61 million, of which US$18 million were sent to the United States.[22]

The value of exports of polished gem diamonds increased 425 percent in the 10-year period, 1951–60. Total carats exported increased 365 percent in the same period. The United States was the largest customer for the cut stones.[23]

The finding of malachite in the King Solomon mine was reported. Some of the copper ores found in the mine contained blebs of minerals with a coloring of turquoise, beige, blue, and black with specks of white, and they were used for decorative purposes. Some of the softer nuggets were broken up and cemented together in a mosaic pattern for jewelry.

The entire gem stone industry was controlled by the Government, and those wishing to purchase malachite or other gem materials for jewelry were required to obtain a license from the Ministry of Development.[24]

AFRICA

British East Africa.—Tanganyika's production of diamond in 1961 was valued at US$17 million. Crude ruby and ruby-bearing corundum were sold for US$41,000.

Federal Ventures, Ltd., Tanganyika, finished preliminary examination of the ruby and sapphire occurrence in the Umba River area, Lushoto district in 1960. A processing plant was planned, and production was expected to start in 1962.

Specimens of semiprecious stones found by prospectors during 1961 included quartz, garnet, zircon, sphene, beryl, chrysoberyl, and tourmaline.

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[19] Foreign Trade (Ottawa). Commodity Notes. V. 116, No. 7, Sept. 23, 1961, p. 14.
[20] Engineering and Mining Journal. In India. V. 162, No. 10, October 1961, p. 182.
[21] Mining Journal (London). Udaipur's Mineral Wealth. V. 257, No. 2572, Aug. 4, 1961, p. 108.
[22] Bureau of Mines. Mineral Trade Notes. V. 53, No. 4, October 1961, pp. 19–21.
[23] Bureau of Mines. Mineral Trade Notes. V. 53, No. 4, October 1961, pp. 19–21.
[24] Gold, Gertrude. King Solomon's Mine Produces Riches Again. Jewelers' Circ.–Keystone, v. 131, No. 10, July 1961, pp. 48, 50.

Tanganyika Crystals, Ltd., at Anusha, was reported to be producing high-quality cut stones, especially amethysts.

Overseas companies were investigating opportunities for investments in the local precious and semiprecious gem stone industry.[25]

British West Africa.—During 1961 a report from Kenya indicated that 1,000 carats of sapphire valued at US$846 was produced.[26]

Cameroun, Republic of.—Three diamonds, the largest of which was 1.7 carats, were discovered in the Méré and Vina regions during 1960. Extensive prospecting during 1961 was proposed by the Government of Cameroun.[27]

Ivory Coast.—Ivory Coast Diamond Company, State-owned, was to be formed to mine diamond in the Ivory Coast and to help stop illegal mining. Exports of gem diamond for the first 11 months of 1961 were valued at US$2 million.[28]

Malagasy Republic.—One of the outstanding characteristics of the mineralization in Malagasy is the occurrence of a wide variety of semiprecious gem stones. The most highly prized gems came from deposits in the Sahatany Valley and from Antsirabe, Ankazobe, and Ikalamavony pegmatite fields. Domestic production during 1961 was sporadic and barely supplied local lapidaries. Some of the more important gems mined were beryl (morganite, aquamarine, and heliodor), tourmaline (rubellite, indicolite, and others having colors of green, brown, violet, and pink), spodumene (kunzite and others of yellow and greenish yellow color), garnet (spessartite and almandite), topaz (colors range from water clear to a slightly greenish tint), sapphire (cordierite), feldspar (amazonite, moonstone, and others water white to golden yellow in color), and quartz (rock crystal, citrine, smoky, amethyst, chalcedony, and jasper).

Other varieties of gems found in Malagasy that may be cut and polished are alabaster, chrysoberyl, danburite, diopside, epidote, ferropecotite, kornerupite, labradorite, opal, rhodonite, rhodizite, scapolite, serpentine, spinel, and turquoise.

Other mineralogical specimens highly prized by collectors included ampangabeite, befanamite, betafite, and grandidierite.

Rhodesia and Nyasaland, Federation of.—The Sandawana emerald deposits, owned by Rio Tinto Co., Ltd., were reported producing high-quality gems during 1960. Production and values were unknown. Two new emerald deposits were reported in the Fort Victoria district.[29] Another emerald discovery was reported in the Mazoe district 20 miles north of Salisbury.[30]

South-West Africa.—In June 1961, Marine Diamond Corp., Ltd., was formed to mine diamond by dredging in a coastal area extending from the mouth of the Orange River north 172 miles and extending from the low-water mark on the coast to the 3-mile limit.[31] Also, Atlantic

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[25] Mining Journal (London). Tanganyika's Mining Industry in 1961. V. 258, No. 6605, Mar. 23, 1962, pp. 288–289.

[26] U.S. Consulate, Nairobi, Kenya. State Department Dispatch 400. Mar. 26, 1962, p. 2.

[27] Bureau of Mines. Mineral Trade Notes. V. 53, No. 3, September 1961, p. 16.

[28] Mining Journal (London). Mining Miscellany. V. 258, No. 6600, Feb. 16, 1962, p. 173.

[29] Rhodesian Mining and Engineering (Salisbury). News Concentrates. V. 26, No. 6, June 1961, pp. 30, 50.

[30] Bureau of Mines. Mineral Trade Notes. V. 53, No. 5, November 1961, p. 17.

[31] Bureau of Mines. Mineral Trade Notes. V. 53, No. 5, November 1961, pp. 14–15.

TABLE 5.—Production, exports, and value of gem stones from South-West Africa during 1961

Gem	Production	Exports	
	Quantity	Quantity	Value
Diamonds ... carats	816	787,949	US$47,267,567
Amethyst ... pounds	6,658	658	111
Chalcedony ... do	30,200	2,600	1,960
Rose quartz ... do	980	980	140
Tourmaline ... do	73	11	4,900
Aragonite ... do	400	400	280

Diamond Corp., Ltd., was seeking an 8-mile concession north of the Orange River along the coast to the 3-mile limit.[32]

Union of South Africa.—Emerald production from northeastern Transvaal increased to 3,600 pounds in 1960 from 1,800 pounds in 1959. African Emerald Mining Company (Pty.) Ltd., African Gem Company, and Gravelotte Emerald Mine were the only producers. Virtually all of the emerald was exported to Switzerland and the United Kingdom. Tiger's eye production was about 3 tons.[33]

Plans were made for reopening the famous de Beers' diamond mine at Kimberley.[34] This mine, also known as the "Big Hole," was mined to a depth of 3,520 feet and produced over 14 million carats before mining stopped in 1908.[35]

OCEANIA

Australia.—The value of opal reported in official statistics was the amount buyers reported to the Government as the price paid for rough material. Opal production in 1960 was valued at US$1.5 million, and exports were US$2.3 million.[36]

TECHNOLOGY

A list of mineral species, some of which were found only in California, was published.[37]

Information on jade gem material in Washington was given.[38]

A new book on opal, published in Australia, contained information on the history of opal mining and discussed modern methods of extraction. It was illustrated with drawings and photographs of different types of opal.[39]

Gem stones of South Africa and their locations were described.[40]

[32] Mining Journal (London). Mining Miscellany. V. 257, No. 6586, Nov. 10, 1961, p. 485.

[33] U.S. Consulate, Johannesburg, Union of South Africa. State Department Dispatch 7. July 7, 1961, p. 14, encl. 3, pp. 1, 2.

[34] Mining World and Engineering Record (London). De Beers Well Equipped to Meet Difficult Times Ahead in Africa. V. 177, No. 4551, June 1961, p. 243.

[35] Rocks and Minerals. Kimberley Diamond Mine May Reopen. V. 36, Nos. 1 and 2, January–February 1961, p. 41.

[36] Bureau of Mines. Mineral Trade Notes. V. 54, No. 1, January 1962, pp. 40, 41.

[37] Stinson, Melvin C. The Mineral Kingdom. Miner. Inf. Service, California Div. of Mines, San Francisco, Calif., v. 14, No. 8, August 1961, 16 pp.

[38] Waskey, Frank H. Washington State Jade. Rocks and Minerals, v. 36, Nos. 1 and 2, January–February 1961, pp. 30–31.

[39] Leechman, Frank. The Opal Book. Ure Smith Pty. Ltd., Sydney, Australia, 1961, 255 pp.

[40] Blignaut, Adi. Gemstones of Southern Africa. Geol. Museum of Johannesburg, Transvaal, South Africa, 1961, 28 pp.

Each monthly issue of Mine and Quarry Engineer (London) beginning with October 1953 described a mineral, giving the synonyms, nomenclature, varieties, composition, crystallography, physical and optical properties, tests, diagnoses, occurrences, and uses. Each mineral was illustrated in color. In the 1961 issues the minerals in chronological order were strontiamite, wavellite, cryolite, aurichalcite, datolite, hemimorphite, adularia, diopside, gibbsite, topaz, rutile, and opal.

A series of articles on quartz as a gem material were published.[41]

Data on gem stones having dichroism, the property of presenting different colors in two directions by transmitted light, were given.[42]

The origin of jadeite and experimental studies on its synthesis were described.[43]

Recent developments in the synthesis of gem material for jewelry and industrial applications were reviewed.[44]

Single crystals of corundum made by the Verneuil method were investigated to determine the quantity, color, and degree of oxidation of manganese which they contained. The crystals contained from 0.1 to 20 mole-percent manganese oxide. Chemical and microscopic examinations were reported.[45]

A Russian publication reviewed the history of emerald synthesis in Germany. Past and recent methods used to manufacture emeralds were described. The synthesis of phenakite, zircon, garnet, titanite, and rutile also was mentioned.[46]

Methods of growing crystals of synthetic ruby in a closed system[47] and of producing garnet synthetically were patented.[48]

An improvement in the color of pale yellow or brown gem diamonds by exposure to gamma radiation was described.[49]

The design of an apparatus for use in extraction of diamonds was patented in Russia.[50]

A method of producing diamonds by explosive force was described.[51]

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[41] Pough, Frederick H. The Many Faces of Quartz. Jewelers' Circ.–Keystone, v. 132, No. 1, October 1961, pp. 80, 82, 102–103; No. 2, November 1961, pp. 68, 70, 77–78; No. 3, December 1961, pp. 50, 52, 54, 56.

[42] Pough, Frederick H. Bi-Color, Parti-Color and Dichroic Stones. Jewelers' Circ.–Keystone, v. 131, No. 10, July 1961, pp. 52, 54.

[43] Moskaleva, V. N. The Problem of Jadeite. Econ. Geol., v. 56, No. 8, December 1961, p. 1480.

[44] Chemical Engineering. Flame-Grown Gem Stones Enjoy Broadened Use in Optics and Fashion Jewelry. V. 68, No. 26, Dec. 25, 1961, pp. 26–28.

[45] Baumgärtel, Rolf. (Investigations on Corundum Single-Crystals Containing Manganese.) Chem. Tech., No. 10, 1961, 615 pp.

[46] Espig, Hermann. (Emerald Synthesis.) Chem. Tech., No. 6, 1960, pp. 327–331.

[47] Ballman, Albert A., Anthony J. Caporaso, and Robert A. Laudise (assigned to Bell Telephone Laboratories, Inc.). Method of Growing Corundum Crystals. U.S. Pat. 2,979,413, Apr. 11, 1961.

[48] Van Uitert, L. G. G. (assigned to Bell Telephone Laboratories, Inc.). Polycrystalline Garnet Materials. U.S. Pat. 3,003,966, Oct. 10, 1961.

[49] Custers, J. F. H., H. B. Dyer, and R. W. Ditchburn (assigned to Industrial Distributors Ltd. (1946)). Treatment of Diamonds. U.S. Pat. 2,998,365, Aug. 29, 1961.

[50] Lomakin, G. A. Russian Pat. 129,146, June 15, 1960.

[51] Van Tilburg, J. Australian Pat. 226,337, Nov. 27, 1959.

Gem Stones

By John W. Hartwell[1] and Betty Ann Brett[2]

PRODUCTION of gem materials and mineral specimens in the United States during 1962 was valued at approximately $1,296,000, a $13,000 decrease from 1961.

Public Law 87–713, passed by Congress in 1962, stated that deposits of petrified wood were excluded from appropriation under the mining laws. Petrified wood was no longer to be considered a mineral that could be used to establish a valid mining claim. It was defined as "agatized, opalized, petrified, or silicified wood, or any material formed by the replacement of wood by silica or other matter."

DOMESTIC PRODUCTION

Production data were collected by the Bureau of Mines by canvassing amateur and professional producers of gem stones, but it was not possible to contact all operators. Therefore, information was based on a partial survey.

Gem material and mineral-specimen production was reported from 45 States, the same as in 1961. During both years California, Oregon, and Texas were the leading producing States. Twelve States, with production valued at $25,000 or over, produced 89 percent of the total value. These States were Arizona, California, Colorado, Maine, Montana, Nevada, New Mexico, Oregon, Texas, Utah, Washington, and Wyoming.

The reported find of a 14-ounce pink sapphire and a 24-ounce ruby in North Carolina during 1961 was discovered to be a hoax.[3]

Gem grade pollucite was reported mined during 1962 at the Walden Gem mine, Portland, Conn. A cut and polished gem of more than 12 carats and a 49 carat uncut stone of gem quality were some of the larger pieces produced. Many 1 to 4 carat pieces were recovered and offered for sale.

Agate.—About 125 tons of agate valued at $92,000 was reported produced in 18 States. The variety and quantity of agate included in the total was classified as: Moss, 4,300 pounds; turritella, 5,100 pounds; and fire agate, 1,400 pounds; the balance were miscellaneous types. Principal States, in decreasing order of production, were Oregon,

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[1] Commodity specialist, Division of Minerals.
[2] Statistical assistant, Division of Minerals.
[3] The Knoxville News-Sentinel. Rockhounds Go To "Gem Fields." Aug. 13, 1961, p. B–9.

707–626—63——38

Arizona, New Mexico, Washington, California, South Dakota, Texas, and Utah.

Diamond.—Diamond production at Crater of Diamonds near Murfreesboro, Ark., was reported at 200 carats valued at $8,850. A frosty-white diamond was reported weighing 4.39 carats and valued at $3,000.

Jade.—Production of jade from Alaska, California, and Wyoming was 45,600 pounds valued at nearly $100,000. California was the leading State with 23,000 pounds valued at nearly 25,000. A 2,250-pound jade rock discovered in 170 feet of water off Catalina Island, Calif., was valued at $75,000.

Mineral Specimens.—About 140,000 pounds of mineral specimens were produced and valued at nearly $50,000. Arizona, Colorado, and New Mexico were the leading States; each produced more than 25,000 pounds. Copper mineral specimens production, not included in the above total, was reported at 21,900 pounds valued at $12,700. Most of the copper minerals came from Arizona.

Obsidian.—Production, totaling 122,000 pounds valued at $24,000, was reported from five States. California was the leading State with nearly 83,000 pounds valued at $17,000.

Petrified Wood.—Production of 174 tons valued at $92,000 was reported from 11 States during 1962. Utah led with nearly 32 tons followed in descending order by Arizona, Wyoming, South Dakota, California, Colorado, New Mexico, and Texas. Petrified palm wood production was only 138 pounds valued at $138, and petrified bone produced was 3,000 pounds valued at $2,000.

Quartz Crystal.—Output from 18 States was reported at 72,100 pounds valued at $30,200. Rose quartz production was estimated at 37,000 pounds with a value of $1,200. Smokey quartz production was 570 pounds valued at about $1 per pound.

Turquoise.—Production in 1962 was reported at 11,500 pounds valued at $44,500. Arizona was the leading turquoise-producing State with 7,400 pounds valued at nearly $17,000. New Mexico followed with 2,250 pounds valued at $6,000. Two other States that also reported production were Nevada and California. Nevada material was rated more valuable with values ranging from $5 to $20 per pound.

Miscellaneous Gem Material.—Jasper production was estimated at nearly 59,000 pounds valued at $15,000. Principal production was reported from Arizona. All grades of opal mined during the year were reported at 104,000 pounds valued at about $13,000. Only 10 pounds of fire opal valued at $150 was declared. Nevada was the leading-producing State with an estimated 101,000 pounds valued at $8,000. Most of this material was produced in Virgin Valley. Garnet production was 2,400 pounds valued at $1,200. Sales of 196 carats of cut and polished stones valued at nearly $500 were reported from a garnet mine at North Creek, N.Y. Black coral obtained by divers off the island of Maui was valued at $6,000 with a production of 1,200 pounds. No production was reported from the ocean near the other islands. Peridot gems from Arizona and New Mexico were reported to be valued at $14,000 with a production of 22,300 pounds.

The quantity and value of some other gem and ornamental stone reported produced were: Amethyst, 3 pounds, $180; beryl specimens, 1,300 pounds, $3,200; feldspar gems, 3,900 pounds, $1,500; fluorite, 23,100 pounds, $8,200; fossils, 1,600 pounds, $800; geodes, 1,100 pounds, $560; gold nuggets, 20 ounces, $700; idocrase, 4,500 pounds, $1,400; marcasite, 1,000 pounds, $700; onyx, 32,000 pounds, $8,000; ornamental stone, 73,100 pounds, $4,400; rhodonite, 6,300 pounds, $3,400; rhyolite, 42,000 pounds, $4,900; sapphire, 14 pounds, $2,100; topaz, 600 pounds, $1,500; and vesuvianite, 1,400 pounds, $280.

CONSUMPTION

Gem diamond consumption, $192 million, was nearly the same as in 1961; sales of imported imitation and synthetic gem stones, $4.3 million, were 20 percent lower; and sales of natural and cultured pearls, $18.9 million, were 12 percent higher.

Apparent consumption (production plus imports minus exports and reexports) of gem stones in the United States was $167 million, compared with $181 million in 1961.

PRICES

Prices quoted during January for cut and polished unmounted gem diamonds were: 0.25 carat, $65 to $318; 0.5 carat, $200 to $550; 1 carat, $525 to $1,500; 2 carats, $1,200 to $4,364; and 3 carats, $2,400 to $8,162. The price range of each size depended upon quality (cut, clarity, and color).

A report on the diamond industry contained information on diamond marketing and world prices of gem and industrial diamonds during 1961.[4]

FOREIGN TRADE [5]

Imports.—Gem stone imports increased less than 1 percent in value, compared with 1961. Gem diamonds accounted for 85 percent of total imports but decreased 711,352 carats in quantity and $1.6 million in value, compared with 1961.

Diamonds, rough or uncut, were principally imported, by quantity, from the United Kingdom (53 percent), followed by Venezuela (9 percent), British West Africa (9 percent), and the Republic of South Africa (8 percent). Diamonds, cut but unset, were principally imported from Belgium-Luxembourg (49 percent) and Israel (36 percent). The average values per carat of cut but unset diamond imports were Belgium-Luxembourg, $95.49; Israel, $79.36; the Netherlands, $103.58; Republic of South Africa, $182.43; the United Kingdom, $129.64; and West Germany, $71.63.

Imports of emeralds, cut but unset, decreased 30,600 carats under 1961; 93 percent came from India, 2 percent each from Colombia and Switzerland, 1 percent from West Germany, and the balance from 18 other countries. The average value per carat of emerald imports

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[4] Switzer, George. Thirty-Seventh Annual Report on the Diamond Industry—1961. Jewelers' Circ.-Keystone, 1962, 48 pp.

[5] Figures on imports and exports compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U.S. Department of Commerce, Bureau of the Census.

from the principal exporting countries were Colombia, $124,28; India, $10.95; Switzerland, $45.64; and West Germany, $10.87.

Rubies and sapphires, cut but unset, valued at $1,207,700 were imported from 15 countries, principally from Colombia (86 percent), the United Kingdom (4 percent), India (3 percent), and Republic of South Africa (3 percent). Imports from Colombia, the principal source, were valued at $1,033,000—more than a 100-percent increase, compared with 1961.

Cultured pearl imports were about $1.8 million more than 1961, and imports of natural pearls were $237,000 more. The principal countries from which natural pearls were imported were Japan (49 percent) and India (41 percent).

The largest quantity of rough or uncut and cut but unset gem stones imported into the United States came from Hong Kong ($658,000) and Brazil ($285,000).

TABLE 1.—U.S. imports for consumption of precious and semiprecious stones, exclusive of industrial diamonds

Stones	1961		1962	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Diamonds:				
Rough or uncut, suitable for cutting into gem stones, duty free ... carats	2,274,928	$114,670	1,420,443	$102,446
Cut, but unset, suitable for jewelry, dutiable ... carats	839,150	78,605	982,278	89,188
Emeralds: Cut but not set, dutiable ... do	227,284	2,090	196,649	2,798
Pearls and parts, not strung or set, dutiable:				
Natural	(1)	500	(1)	737
Cultured or cultivated	(1)	16,425	(1)	18,198
Other precious and semiprecious stones:				
Rough or uncut, duty free	(1)	1,169	(1)	1,765
Cut but not set, dutiable	(1)	[2] 3,900	(1)	5,098
Imitation, except opaque, dutiable:				
Not cut or faceted	(1)	54	(1)	61
Cut or faceted:				
Synthetic ... number	664,932	[2] 345	1,176,058	457
Other	(1)	4,907	(1)	3,740
Imitation, opaque, including imitation pearls, dutiable	(1)	14	(1)	18
Marcasites: Real and imitation, dutiable	(1)	36	(1)	(3)
Total	(1)	222,715	(1)	224,506

[1] Quantity not recorded.
[2] Revised figure.
[3] Less than $1,000.

Source: Bureau of the Census.

Exports.—Precious and semiprecious gem stones exported were $18.8 million, compared with $14.8 million in 1961. Diamonds, cut but unset, accounted for 74 percent of the total. The value of gem stones exported, except diamonds, was over $3 million.

Reexports of gem stones, precious and semiprecious, were $40 million, compared with $28 million in 1961. Diamonds, rough, uncut, and suitable for cutting into gem stones, accounted for 86 percent of the total.

TABLE 2.—U.S. imports for consumption of diamonds (exclusive of industrial diamonds), by countries

Country	1961				1962			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Carats	Value (thousands)	Carats	Value (thousands)	Carats	Value (thousands)	Carats	Value (thousands)
North America:								
Canada	7,772	$833	79	$10	5,128	$655	217	$16
Mexico	257	3	160	14			198	22
Panama			23	3				
Total	8,029	836	262	27	5,128	655	415	38
South America:								
Brazil	42,962	759	706	36	996	39	1,469	121
British Guiana	26,150	686	93	8	9,852	346	133	10
Venezuela	111,700	3,151			128,264	4,025		
Total	180,812	4,596	799	44	139,112	4,410	1,602	131
Europe:								
Austria							130	13
Belgium-Luxembourg	210,419	15,391	428,054	41,957	39,877	2,381	478,795	45,721
France	47,857	1,522	10,578	1,018	4,902	413	14,291	1,459
Germany, West	896	28	52,154	3,480	2,144	59	75,301	5,394
Ireland							1	(1)
Italy			541	59			201	66
Malta and Gozo							169	16
Netherlands	50,563	2,360	28,756	3,234	22,367	1,652	23,786	2,463
Portugal							12	1
Spain							7	5
Switzerland	6,526	269	349	205	503	95	526	66
U.S.S.R.			1,023	85			2,640	262
United Kingdom	1,561,423	81,702	5,238	680	752,905	67,087	5,901	765
Total	1,877,684	101,272	526,693	50,718	822,698	71,687	601,760	56,231
Asia:								
Hong Kong			1	(1)			46	12
India			9	3			38	50
Iran			56	4			74	6
Israel	50,744	1,938	278,229	21,971	20,001	949	351,306	27,881
Japan	244	26	942	91			831	70
Malaya, Federation of							7	10
Singapore, Colony of			38	11				
Thailand			83	1				
Total	50,988	1,964	279,358	22,081	20,001	949	352,302	28,029
Africa:								
British West Africa and Sierra Leone					125,407	4,622		
Cameroon, Federal Republic of					2,218	28	321	38
Congo, Republic of the and Ruanda-Urundi	10,860	228	10	1	34,945	1,309		
Ghana					23,962	253		
Liberia	8,113	280			10,456	1,211		
Nigeria					778	190		
South Africa, Republic of [2]	54,331	3,346	31,951	5,725	120,213	12,255	25,878	4,721
Western Africa, n.e.c.[3]	80,243	2,097			57,030	2,772		
Western Equatorial Africa, n.e.c.[3]	3,863	51			58,495	2,105		
Total	157,410	6,002	31,961	5,726	433,504	24,745	26,199	4,759
Oceania: Australia			77	9				
Grand total	2,274,923	114,670	839,150	78,605	1,420,443	102,446	982,278	89,188

[1] Less than $1,000.
[2] Effective Jan. 1, 1962; formerly Union of South Africa.
[3] Not elsewhere classified.

Source: Bureau of the Census.

WORLD REVIEW [6]

NORTH AMERICA

Canada.—De Beers Consolidated Mines, Ltd., an associate of Anglo-American Corporation of South Africa, Ltd., acquired the exploration license that was granted to W. G. Wahl, Ltd., to explore for diamonds in Ontario.[7] Mineral sources in eastern Ontario that could be easily reached by collectors were reported.[8] Boulders of jade were reported discovered in Vital Creek, near Takla Landing, British Columbia. Two stones weighing 5,000 and 3,000 pounds each were shipped to Vancouver for display. Vancouver dealers in jade were reported to be exporting about 40 tons a year, the greater portion being destined for West Germany.[9]

TABLE 3.—World production of diamonds, by countries

(Thousand carats)

Country	1961		1962	
	Gem	Industrial	Gem	Industrial
Africa:				
Angola	688	460	701	380
Central African Republic	41	70	80	185
Congo, Republic of the	405	17,738	[1 2] 456	[1 2] 17,700
Ghana	[3] 654	[3] 1,560	628	2,580
Guinea [2 4]	490	730	140	210
Ivory Coast	219	330	102	182
Liberia [4]	[3] 596	500	225	680
Sierra Leone [2 4]	[3] 799	[3] 1,497	707	1,200
South Africa, Republic of:				
Pipe mines:				
Premier	360	1,200	425	1,260
De Beers Group	953	760	883	750
Other pipe mines [2]	35	80	36	84
Alluvial mines [2]	240	160	290	190
South-West Africa	816	90	800	227
Tanganyika	340	345	323	324
Other regions:				
Brazil	175	175	175	175
British Guiana	68	45	60	40
Venezuela	60	74	94	83
U.S.S.R., India, and others [2]	80	420	75	425
World total	[3] 7,019	[3] 26,234	6,200	26,675

[1] Including exports reported from Congo (excluding French).
[2] Estimate.
[3] Revised figure.
[4] Exports.

SOUTH AMERICA

Brazil.—New diamond deposits were reported discovered near Grao Mogol, Minas Gerais,[10] and at Chapada dos Guimarees, Mato Grosso.[11]

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[6] Values in this section are U.S. dollars, based on the average rate of exchange by the Federal Reserve Board unless otherwise specified.
[7] Northern Miner (Toronto). De Beers Comes to Canada Looking for Diamonds. V. 48, No. 11, June 7, 1962, p. 16, sec. 1.
[8] Marshall, John W., Jr. Mineral Collecting in Eastern Ontario, Canada. Rocks and Minerals, v. 37, Nos. 5–6, May–June 1962, pp. 229–232, 328.
[9] Western Miner and Oil Review (Vancouver). Jade Boulders in Omineca. V. 35, No. 12, December 1962, p. 52.
[10] Engineering and Mining Journal. V. 163, No. 10, October 1962, p. 154.
[11] Mining Journal (London). Diamond Find in Brazil. V. 259, No. 6624, Aug. 3, 1962, p. 110.

A large-scale diamond-prospecting program by the Pacific Tin Co. near Diamantina, Minas Gerais, on the Rio São Francisco was in progress, and about 65 to 70 men were employed. An amethyst discovery was reported. Production was estimated at 3 tons, 10 percent of which was faceting grade. The available varieties of colors and sizes were described.[12]

British Guiana.—Diamond production decreased 12 percent from 1961. Bad weather at midyear, hampering the individual prospectors, was blamed for the reduced production.[13]

Venezuela.—Three gem-mining concessions were granted by the Government: One for rubies, another for precious stones in the State of Merida, and the third was for diamonds in the State of Bolivar.[14]

EUROPE

Belgium.—Imports of cuttable diamonds were reported to be about 3.4 million carats valued at $95 million in 1961. Nearly 192,000 carats of this quantity came from the United States. Polished diamond imports were 221,000 carats valued at $36 million. Polished diamond exports were 916,000 carats valued at $102 million.[15]

Switzerland.—Data on gem stone and jewelry imports for 1960 and 1961 were reported. Statistics on output of manufactured and semimanufactured precious and semiprecious stones were not available. Tariff rates and import duties were given.[16]

ASIA

Burma.—The Kachin State Supreme Council announced plans to develop and nationalize the jade industry, which was centralized about 65 miles west of Mogaung, Myitkyina District, where the mining and trading was monopolized by the Chinese. Plans included development of abandoned mines and establishment of plants to manufacture household articles of low-grade jade.[17]

Ceylon.—Gem stone mining followed the same pattern as in previous years. Value of exports which was the only figure published was $420,000. The principal varieties produced were ruby, sapphire, cat's eye, topaz, zircon, aquamarine, and moonstone.[18]

Hong Kong.—Jewelry and gem stones available, prices, methods of manufacturing and processing, and items for sale that should be avoided by U.S. buyers were described. Nearly 700 jewelry stores and lapidaries flourished in this British island colony. Jewelry manufacture was limited to small, simple articles of jade and ivory; no figure carving was attempted. Every carved stone object originated

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[12] Bookstone, Harry. New Brazilian Amethyst Find. Jewelers' Circ.-Keystone, v. 132, No. 11, July 1962, pp. 66, 68, 78.

[13] U.S. Consulate, Georgetown, British Guiana. State Department Dispatch A-231. Feb. 17, 1963, p. 14.

[14] Mining World. World Wide Mining Activities. V. 25, No. 5, Apr. 25, 1963, p. 124.

[15] U.S. Consulate, Antwerp, Belgium. State Department Airgram 37. Nov. 2, 1962, encl. 8, p. 1; encl. 10, pp. 1, 2.

[16] Nelson, John H. What's Current in Commodities? Jewellery, Switzerland. Foreign Trade, v. 118, No. 3, Aug. 11, 1962, pp. 8, 9.

[17] Bureau of Mines. Mineral Trade Notes. V. 55, No. 4, October 1962, p. 18.

[18] Mining World. World Wide Mining Activities. V. 25, No. 5, Apr. 25, 1963, p. 107.

in China and could not be purchased for import into the United States.[19]

India.—Crude emerald production in 1960 and 1961 was 321,000 and 304,000 carats, respectively, and no value was given. In 1960 trimmed or processed emeralds, weighing 59,000 carats, were valued at $12,200, and in 1961, 14,000 carats were processed valued at $2,700.[20] The diamond mines in the Ramkherya and Majhgawan areas in the Panna District, Madhya Pradesh, were expected to start producing in 1963. Recovered during the prospecting of these areas in 1960–62 were 540 gems and 284 industrial diamonds. Surveys of other diamond deposits in the Kurnool, Anantpur, Mahboobnagar, and Krishna Districts were planned.[21]

Japan.—During 1962 exports of pearls from the extensive pearl-forming area in Mie Prefecture was reported to be 62,850 kilograms valued at $41,850,000. The quantity exported was 2,000 kilograms more than during 1961. The United States was still the leading customer, followed by Switzerland.[22] Cultured pearl exports in 1961, reported by the All Japan Pearl Culture Cooperative, reached a record of 27,350 pounds valued at $35.8 million, an increase of 20 percent over 1960.[23] The Japanese jewelry industry was reviewed. Pearls, opal, and coral ranked high in gem stone sales. Quantities of jade were sold at prices higher than in the United States. Carved ivory was also offered for sale. Prices for pearls, opals, coral, and jade were quoted.[24]

AFRICA

Angola.—Diamond production was normal in the Lunda District. Following several years of exploration, a new diamond field in the Guango Basin was expected to start producing in 1963. Diamond output in 1962 was 1,081,100 carats, of which 65 percent was gem quality.[25]

British East Africa.—Tanganyika Corundum Corp., Ltd., continued to work the ruby-corundum deposit near Longido during 1961. Exports to Germany of green zoisite matrix and rough ruby were reported for the first time. Federal Ventures, Ltd., completed a preliminary examination of the ruby and sapphire deposits of the Umba River in the Lushoto District and applied for a mining lease. Negotiations were underway for the sale of these gem materials. One prospecting license for zircon in the Lushoto District was granted. The zircons found were described as suitable for use as gem stones. An important development for the semiprecious stone industry was the establishment of a lapidary by Tanganyika Crystals, Ltd., at Arusha.[26] Owners of the Williamson Diamond mines made an agreement with the Tan-

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[19] Pough Frederick H. A Glance at Jewelry Scene in Hong Kong, Jeweler's Circ.-Keystone, v. 133, No. 1, October 1962, pp. 88, 90, 103–105; Hong Kong Hokus Pokus, No. 2, November 1962, pp. 66, 68, 85–86.

[20] Bureau of Mines. Mineral Trade Notes. V. 55, No. 6, December 1962, p. 10.

[21] Journal of Mines, Metals and Fuels (Calcutta). V. 10, No. 8, August 1962, p. 30.

[22] U.S. Consulate, Nagoya, Japan. State Department Airgram A–92. Mar. 12, 1963, pp. 1, 2.

[23] Bureau of Mines. Mineral Trade Notes. V. 55, No. 3, September 1962, p. 29.

[24] Pough, Frederick H. The Japanese Jewelry Scene. Jeweler's Circ.-Keystone, v. 133, No. 3, December 1962, pp. 48, 50, 56.

[25] Mining World. World Wide Mining Activities. V. 25, No. 5, Apr. 25, 1963, p. 114.

[26] Mining Magazine (London). Tanganyika Mining Industry, 1961. V. 106, No. 6, June 1962, pp. 337–340.

ganyikan Government to examine new ruby and sapphire deposits found near the Umba River.[27]

Ivory Coast.—Two government corporations were formed to prospect for diamonds in the vicinity of Seguela. Other organizations to which the government considered granting concessions were consolidated African Selection Trust, Diamond Distributors, Inc., and Harry Winston, Inc. The Israeli Government was granted exclusive diamond prospecting rights for 1 year in two large areas.[28]

Mozambique.—Tourmaline was produced in 1961 by Empresa Mineira do Alto Ligonha, Lda., from the pegmatite area of the Zambezia District. Production in 1961 was estimated at 500,000 carats, compared with 70,000 carats in 1960. Most of the production was exported to West Germany.[29]

Rhodesia and Nyasaland, Federation of.—Progress continued in the development of the Sandawana emerald deposit. Drilling indicated that emeralds may be found in some areas at deeper levels than was expected.[30] Four exclusive precious stone prospecting licenses were granted by the Southern Rhodesian Government to Sandawana Mines (Pvt.), Ltd., in July 1962.[31] Amethyst veins discovered southeast of Kalomo, Northern Rhodesia, were described. Mining was done by manual selection of gem quality stones from weathered vein material. Reserves of quality material were estimated at over 2 million pounds.[32] According to the Central Statistical Office, Salisbury, amethyst production in Northern Rhodesia was nearly 10,000 pound valued at $22,400. Agate output in Southern Rhodesia in 1961 was 3,700 pounds valued at $1,500.[33] A report on Rhodesian gem-stone production and problems in marketing was published.[34]

South Africa, Republic of.—Exports of emerald crystals decreased to 353 pounds valued at $311,500, compared with 1,200 pounds valued at $145,000 in 1961 and 2,880 pounds at $113,000 in 1960. The crystals exported in 1961 and 1962 went principally to the United Kingdom. Tiger's eye production was 206,000 pounds in 1962 and 34,000 pounds in 1961. Exports were 126,000 pounds valued at $37,500 in 1962 and 12,000 pounds valued at $760 in 1961. The only producer of tiger's eye was P. C. Beukes, Niekerkshope, Cape Province.[35] A 32-carat gem diamond and several 10-carat stones were found by miners at Windsorton.[36] The Treasure Trove Diamond mine on the West Rand near Postmasburg was expected to resume production. This mine, which was closed in 1930, produced principally gem quality stones.[37]

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[27] Mining Journal (London). Ruby Deposits in Tanganyika. V. 259, No. 6627, Aug. 24, 1962, p. 175.
[28] Mining Journal (London). Diamond Prospecting in the Ivory Coast. V. 258, No. 6618, June 22, 1962, p. 652.
[29] Bureau of Mines. Mineral Trade Notes. V. 55, No. 3, September 1962, p. 29.
[30] South African Mining & Engineering Journal (Johannesburg). V. 73, pt. 1, No. 3616. May 25, 1962, pp. 1145.
[31] Mining Journal (London). V. 259, No. 6624. Aug. 3, 1962, p. 110.
[32] Brown, A. G. The Amethyst Deposits of Mwakambiko. Rhodesian Min. and Eng. (Salisbury, Southern Rhodesia), v. 27, No. 12, November 1962, p. 28.
[33] Bureau of Mines. Mineral Trade Notes. V. 55, No. 3, September 1962, p. 29.
[34] Broeksma, J. B. A. Rhodesia May Be on the Way to "Gem Country" Status. Rhodesian Min. and Eng. (Salisbury, Southern Rhodesia), v. 27, No. 10, October 1962, pp. 19–20, 30.
[35] U.S. Consulate, Johannesburg. State Department Airgram A–362. Mar. 28, 1963. 5 pp.
Bureau of Mines. Mineral Trade Notes. V. 55, No. 2, August 1962, pp. 28, 29.
[36] Engineering and Mining Journal. V. 163, No. 10, October 1962, p. 161.
[37] Mining Journal (London). V. 259, No. 6633, Oct. 5, 1962, p. 321.

South-West Africa.—Marine Diamond Corp., Ltd., dredged for diamonds off the South-West African coast. By July, 9,000 carats were produced and 250 carats per day were expected to be recovered during the balance of the year. Southern Diamonds Corporation, Ltd., was formed to operate off the Atlantic coast near the Cape of Good Hope. Fifty percent of the operating expenses were being furnished by the owner of Marine Diamond Corp., and the balance, from two other companies.[38] Ocean diamond mining was still considered to be in the experimental stage, and no official estimate of the payable reserves of diamondiferous gravel was made. Diamond and mineral deposits were discovered along the Skeleton coast between the dry beds of the Ugab and Unjab Rivers. Over 800 diamonds, 90 percent being of gem quality, were reported recovered in this area.[39] Semiprecious stone production in 1961 was reported to be about 38,000 pounds; principally amethyst, chalcedony, rose quartz, and tourmaline. Exports were 14,000 pounds valued at $10,300, almost all of which was shipped to West Germany. Producers of semiprecious stones were listed.[40]

TABLE 4.—South-West Africa: Production and exports of gem stones in 1962

Gem	Production	Exports	
	Quantity	Quantity	Value
Diamonds ...carats..	[1] 1,027,233	800,497	$40,000,000
Amethyst ...pounds..	312,000	9,560	9,800
Chalcedony ...do....	8,000	4,740	2,150
Rose quartz ...do....	500		
Tourmaline ...do....	11		
Aragonite ...do....	98,000	8,000	1,120

[1] Industrial and gem diamonds combined.

Source: U.S. Consulate, Johannesburg, Republic of South Africa. State Department Airgram A-334. Mar. 13, 1963, pp. 1–2.

OCEANIA

Australia.—Opal exports were about $900,000 per year from the producing areas of Coober Pedy and Andamooka, South Australia, and Lightning Ridge, New South Wales. The Australian Government considered the industry to be of sufficient importance to station officials full time at the fields and to incur expenditures to provide water for the areas.[41] Rise in prices of sapphire caused an increased interest in mining this gem. The sapphire mining district of Inverell in New South Wales and the Anakie District of Queensland reported increased activity.[42] The potential of sapphire and opal mining was discussed in a report by the Queensland Government.[43]

[38] Mining Magazine (London). Diamonds Mined Off the Seabed. V. 107, No. 1, July 1962, p. 40.
[39] Mining Journal (London). Diamonds and Salt in South West Africa. V. 258, No. 6610, Apr. 27, 1962, p. 419.
[40] Bureau of Mines. Mineral Trade Notes. V. 55, No. 2, August 1962, pp. 29, 30.
[41] Mining Magazine (London). Opals. V. 107, No. 3, September 1962, p. 167.
[42] Mining Magazine (London). Gems. V. 106, No. 3, March 1962, p. 158.
[43] Queensland Government Mining Journal (Australia). Gemstones. V. 63, No. 729, July 1962, p. 334.

TECHNOLOGY

Nineteen gem and mineral localities in Kern County, Calif., were described. The names and locations of the deposits and the materials found were published.[44]

Opal occurrences in New Mexico were described and identification and infrared absorption data were given.[45]

A world-wide review of emerald deposits was published.[46]

A report on the diamond industry contained information on diamond marketing, and the prices of gem and industrial diamonds throughout the world during 1961.[47]

Each monthly issue of The Mineralogist Magazine, beginning with November–December 1960, described methods of mineral identification. In the 1960 through 1962 issues the titles of the articles in chronological order were Introduction, Physical Characteristics of Minerals, Chemistry and the Blowpipe, Heat Tests for Elements, The Native Elements, The Sulfides and Sulfosalts, The Halides and Oxides, The Carbonates, The Anhydrous Silicates, The Hydrous Silicates, The Oxygen Salts Part I, The Oxygen Salts Part II, and Evaluation and Tests for Unknowns.

A series of articles on quartz minerals starting in October 1961 was concluded. The gem variety of quartz minerals described were formed by hot and cold solutions and included rock crystal, smoky and rose quartz, cairngorm, and amethyst.[48]

Analyses and physical properties were given for three types of garnets found in a mine near Gabbs, Nev.[49]

Each monthly issue of Mine and Quarry Engineer (London) beginning with October 1953 described a mineral, giving the synonyms, nomenclature, varieties, compositions, crystallography, physical and optical properties, tests, occurrences, and uses. Each mineral was illustrated in color. In the 1962 issues the minerals in chronological order were spheene, rosasite, petalite, silver, marcasite, descloizite, cobaltite, anhydrite, willemite, zircon, pyrolusite, and covellite.

Black coral found in Hawaii was softer than red coral, took a good polish, could be cut with a wood saw or a knife before drying, was soft and pliable in warm water, shrank when it dried and hardened, and developed concentric separation cracks in sections through the trunk and limbs on shrinkage.[50]

Orange (natural and synthetic) gem stones were described. Yellow and golden natural gems are common but orange gems, which include diamond, opal, scapolite, and sapphire, were considered the rarest of all colors in the gem world. The makers of synthetic orange sapphires

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[44] Troxel, Bennie W., and Paul K. Morton. Mines and Mineral Resources of Kern County, Calif. California Div. of Mines, County Rept. No. 1, 1962, pp. 90–92.

[45] Sun, Ming-Shan. Tridymite (Low Form) in Some Opal of New Mexico. Am. Miner., v. 47, No. 11–12, November–December 1962, pp. 1453–1455.

[46] Rhodesian Mining and Engineering (Salisbury, Southern Rhodesia). Emeralds: Where and How They Occur. V. 27, No. 1, January 1962, pp. 23–24.

[47] Switzer, George. Thirty-Seventh Annual Report on the Diamond Industry—1961. Jewelers' Circ.-Keystone, 1962, 48 pp.

[48] Pough, Frederick H. The Many Faces of Quartz. Jewelers' Circ.-Keystone, v. 132, No. 4, January 1962, pp. 60, 62, 64.

[49] Lee, Donald E. Grossularite-Spessartite Garnet From the Victory Mine, Gabbs, Nevada. Am. Miner., v. 47, No. 1–2, January–February 1962, pp. 147–151.

[50] Pough, Frederick H. Black Beauty in Hawaii. Jewelers' Circ.-Keystone, v. 132, No. 13, September 1962, pp. 100, 102, 129.

produced the change in color by adding nickel oxide to the formula.[51]

Methods and devices used in prospecting for gem stones were described. To facilitate the recognition of water-worn gems in gravel deposits, 12 gem stones were described and data on what to look for when prospecting given.[52]

A system of prospecting for kimberlite pipes from the air was described. Prepared and coordinated supplemental data from an aeromagnetic survey provided a basis for final ground operation.[53]

A method of cleaning bedrock for the recovery of diamonds was described.[54]

The Diamond Research Laboratory in Johannesburg, Republic of South Africa, discovered a method whereby diamonds can be separated optically from waste rock or gravel.[55]

Methods of cutting and polishing semiprecious gems in cabochon form were described.[56]

Methods employed in Hong Kong for cutting and polishing jade were described.[57]

A brilliant silicon carbide gem of about 0.5 carat required special techniques for cutting and polishing.[58]

Calcium titanate boules approximately 1 inch long and 0.5 inch in diameter were grown by the flame fusion technique then heat-treated to produce untwinned crystals. This colorless crystal had an index of refraction of 2.40, slightly less than diamond; a hardness of 6.5 to 7, slightly less than quartz; conchoidal fracture, melting point of 1,960° C, and a specific gravity of 4.10, about as heavy as zircon—one of the heaviest gem stones.[59]

A process of producing large emerald crystals synthetically by Bell Laboratories was described. Even though the temperature during crystallization was about 1,000° C, the crystals could be removed quickly from the furnace for cooling, because of their high resistance to thermal shock.[60]

The artificial growth of oxide crystals was described as a method of providing insight into the forces that hold solids together and of furthering understanding of how to use solids in technology.[61]

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[51] Jewelers' Circ.-Keystone. The Padparadschah: A Color for Collectors. V. 132, No. 12, August 1962, pp. 140, 160–161.

[52] Goldberg, I. Hints for Prospectors on Recognition of Gemstones. Rhodesian Min. and Eng. (Salisburg, Southern Rhodesia), v. 27, No. 10, October 1962, pp. 26–27, 30.

[53] Barygin, V. M. Polski kimberlitovykh trubok aërometodami (Prospecting for Kimberlite Pipes from the Air). Trud. yakutskogo filiala sibirskogo otdel. Akad. Nauk U.S.S.R., No. 6, 1961, pp. 172–179; trans. by N. W. Wilson, Min. Mag. (London), v. 107, No. 2, August 1962, pp. 73–78

[54] Mining Magazine (London). Cleaning Bedrock by Vacuum. V. 107, No. 1, July 1962, p. 28.

[55] Mining Magazine (London). Optical Sorting of Diamonds. V. 106, No. 4, April 1962, pp. 246–248.

[56] Rhodesian Mining and Engineering (Salisbury, Southern Rhodesia). Give 'Cabochon Charm' to our Semi-Precious Stones. V. 27, No. 10, October 1962, pp. 20–21.

[57] Shreve, R. N. How Jade Is Cut Today. Gemmologist (London), v. 31, No. 369, April 1962, p. 63.

[58] Mitchell, R. K. A Rare Synthetic. J. Gemmology (London), v. 8, No. 6, April 1962, pp. 218–220.

[59] Merker, Leon. Synthesis of Calcium Titanate Single Crystals by Flame Fusion Technique. J. Am. Ceram. Soc.: Ceram. Abs., v. 45, No. 8, Aug. 1, 1962, pp. 366–369.

[60] Chemistry. Growing Emeralds. V. 36, No. 2, October 1962, pp. 23, 26.

[61] Laudise, R. A. Growing Oxide Crystals. Bell Laboratories Record, v. 40, No. 7, July–August 1962, pp. 244–250.

A method of growing crystals, similar to the Verneuil method but adding supplementary heat to all portions of the crystalline mass before shutting off the burner, was patented.[62]

A process of growing a pegmatitic crystal by thermally inducing a circulation of nutrient solution in the seed-growing region was described.[63]

Several patents were granted for methods of producing diamonds synthetically.[64]

The changes of coloration, transparency, and origin of beryls during heating to 1,200° C were studied. Coloration usually increased during heating. At temperatures above 600° C, transparency and glassy luster disappeared, and refractive indicies and birefringence decreased.[65]

A series of articles on the Brazilian gem market described the discovery of kunzite, tourmaline, and aquamarine deposits, what the tourist or jeweler can see in Brazil, and the difficulties of the Brazilian miners in producing gem stones.[66]

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[62] Merker, Leon (assigned to National Lead Co., New York). Method for Growing Crystals. U.S. Pat. 2,012,374, Dec. 12, 1961.

[63] Sawyer, Charles B. (assigned to Sawyer Research Products, Inc., Eastlake, Ohio). Production of Artificial Crystals. U.S. Pat. 3,013,867, Dec. 19, 1961.

[64] Bovenkerk, Harold P. (assigned to General Electric Co.). Method for Producing Improved Diamond Crystals. U.S. Pat. 2,992,900, July 18, 1961; Method of Diamond Growth and Apparatus Therefor, U.S. Pat. 3,031,269, Apr. 24, 1962.

Custers, J. F. H., H. B. Dyer, B. W. Senior, and P. T. Wedepohl, Canadian Pat. 643,290, June 19, 1962.

Eversole, William G. (assigned to Union Carbide Corp., Kenmore, N.Y.). Synthesis of Diamond. U.S. Pat. 3,030,187, Apr. 17, 1962; U.S. Pat. 3,030,188, Apr. 17, 1962.

[65] Gavrusevich, B. S., and F. Ya. Sarapulov. (Concerning the Change of Color and Optical Properties of Beryls on Heating.) Trans. Akad. Nauk S.S.S.R., Doklady, v. 31, No. 8, 1941, pp. 771–774; Tech. Trans. (Dept. of Commerce), v. 7, No. 9, May 15, 1962, p. 637.

[66] Pough, Frederick H. Brazilian Gem Market, 1962. Jewelers' Circ.-Keystone, v. 132, No. 5, February 1962, pp. 70, 75, 93–94; No. 6, March 1962, pp. 74, 76, 91–92; No. 7, April 1962, pp. 76, 78, 80, 144; No. 8, May 1962, pp. 78, 80, 82, 90–91; No. 9, June 1962, pp. 50, 52 60–61.

Gem Stones

By Benjamin Petkof [1]

PRODUCTION of gem materials and mineral specimens was estimated at $1.4 million, an increase of 9 percent from the previous year. Production of these materials still remained largely in the hands of individual collectors.

DOMESTIC PRODUCTION

The Bureau of Mines collected production data by direct canvass of known amateur and professional gem stone producers. All producers are not known to the Bureau and the data presented are based on a partial survey.

For the third consecutive year, production of gem material and mineral specimens was reported from 45 States. California, Oregon, Texas, Arizona, Wyoming, and Nevada, the leading producing States, accounted for almost 62 percent of the total production in value.

Crystals of beryl, ranging in size from 1/16 inch in diameter and length to 2 feet in diameter and 4 feet in length, have been found in Coosa County, Ala. Much of the material is gem quality, and colors range from white to green, brown, and yellow. Most of the crystals are fractured and weathered, but fragments have been cut and polished into attractive gem stones.[2]

Emeralds of beautiful color and good quality have been found in Montana. The emeralds are very bright green and are similar to those of Chivor, Colombia. While most of the crystals are opaque, some have clear green portions.[3]

The Four Peaks amethyst mine was expected to begin production. The mine is located over a mile up on the western slope of the Four Peaks mountain range in Arizona. Mining equipment and construction material have been transported to the site by helicopter, and the amethyst crystals will be brought out in the same way.[4]

Agate.—Production of almost 106 tons of agate valued at $92,000 was reported in 23 States. Production included moss, turritella, fire, and other miscellaneous varieties of agate. Wyoming, New Mexico, Utah, and Arizona were the principal producers, in decreasing order of production.

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[1] Commodity specialist, Division of Minerals.
[2] Mining World. V. 25, No. 6, May 1963, p. 40.
[3] California Mining Journal. A.H. Welling Finds Valuable Emerald Deposits Near Superior, Montana. V. 33, No. 2, October 1963, p. 7.
[4] Mining World. V. 25, No. 3, March 1963, p. 38.

747-149—64——35

Diamond.—Production was reported only in Arkansas. The recovery of 100 carats valued at $38,000 was reported.

Jade.—Jade production of 45,000 pounds valued at $90,000 was reported in five States. Wyoming and California accounted for 92 percent of the total production. Smaller quantities were produced in Nevada, Alaska, and North Carolina.

Mineral Specimens.—Production of various materials for mineral specimens was reported at almost 203,000 pounds valued at about $63,000. Production in varying quantities was reported from 31 States. The largest producing States, in decreasing order of rank, were California, Colorado, Michigan, Utah, and South Dakota. Production of copper mineral specimens, not included in the previously quoted total, was reported as 19,500 pounds valued at $8,800. The bulk of the production came from Michigan.

Obsidian.—Production of over 85,000 pounds valued at over $29,000 was reported in five States. Arizona, California, and Utah were the largest producers, accounting for 96 percent of total production.

Petrified Wood.—Petrified wood production of all varieties was reported as 115 tons valued at $78,000. Of this total, 1,400 pounds was petrified palm wood. The major producers of this commodity, in decreasing order, were Utah, Wyoming, and Arizona. These States were responsible for about 75 percent of total production. Eleven other States produced petrified wood.

Quartz Crystal.—Arizona and South Dakota provided 62 percent of total quartz crystal production, which was reported as 81,000 pounds valued at $30,000. Twenty other States also reported some production, but seven of these produced under 100 pounds of quartz crystal each. Approximately 4,000 pounds of the total production was of the smoky and rose quartz varieties.

Tourmaline.—About 220 pounds of tourmaline valued at almost $12,000 was produced. Half of this originated in Maine. The next largest producer was Minnesota, with lesser quantities from Alabama, California, Colorado, and South Carolina.

Turquoise.—The greatest quantity of turquoise was produced in Arizona. Wisconsin, California, Colorado, Wyoming, Nevada, and New Mexico produced lesser quantities. Total production was 14,750 pounds valued at $81,600.

Miscellaneous Gem Material.—Production of jasper was 36,600 pounds valued at $20,158, with Arizona and California producing two-thirds of the total. Opal production was about 7,400 pounds valued at almost $8,300. In addition, 12 pounds of fire opal valued at $180 was produced. New Mexico was the leading producing State with 3,100 pounds valued at $2,033. Garnet production was 4,800 pounds valued at $4,300. Coral production was primarily from Hawaii, with smaller quantities from a few other States. Total production was 9,100 pounds valued at $40,000. Peridot production occurred primarily in Arizona. About 1,500 pounds valued at $4,000 was produced.

The quantities and values of other gem and ornamental materials, for which production was reported, were amethyst, 470 pounds, $560; beryl specimens, 1,400 pounds, $1,480; feldspar gems, 7,400 pounds, $4,000; fluorite, 2,200 pounds, $800; fossils, 17,900 pounds, $8,900;

geodes, 1,500 pounds, $4,000; idocrase, 2,300 pounds, $4,700; marcasite, 620 pounds, $580; onyx, 68,500 pounds, $19,100; ornamental stone, 46,700 pounds, $10,300; rhodonite, 42,800 pounds, $11,200; sapphire, 18 pounds, $140; topaz, 470 pounds, $420.

CONSUMPTION

Consumption of gem diamond was valued at $224 million, an increase of about $32 million over 1962; imported imitation and synthetic gem stones was $5.1 million, an increase of $0.8 million over 1962; and natural and cultured pearls was $17.9 million, $1 million less than 1962.

Apparent consumption (domestic production plus imports, minus exports and reexports) of gem materials in the United States was $170 million, compared with $167 million in 1962.

PRICES

Prices ranges of cut and polished unmounted diamonds rose, compared with those of the previous year, because of increased demand. Estimated price ranges were 0.25 carat, $72 to $340; 0.5 carat, $220 to $600; 1 carat, $575 to $1,650; 2 carats, $1,380 to $5,000; 3 carats, $2,880 to $9,900.

FOREIGN TRADE

Imports.—Total precious and semiprecious gem stone imports were valued at about $256 million. About 2.8 million carats of rough

TABLE 1.—U.S. imports for consumption of precious and semiprecious stones, exclusive of industrial diamond

Stones	1962		1963	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Diamonds:				
Rough or uncut, suitable for cutting into gem stones, duty-free ... carats	[1] 1,421,143	[1] $102,548	1,749,641	$129,870
Cut but unset, suitable for jewelry, dutiable ... carats	982,278	89,188	1,017,620	93,977
Emeralds: Cut but not set, dutiable ... do	196,649	2,798	190,933	2,081
Pearls and parts, not strung or set, dutiable:				
Natural	(2)	737	(2)	479
Cultured or cultivated	(2)	18,198	----------	17,427
Other precious and semiprecious stones:				
Rough or uncut, duty-free	(2)	1,765	(2)	1,708
Cut but not set, dutiable	(2)	[1] 5,102	(2)	5,183
Imitation, except opaque, dutiable:				
Not cut or faceted	(2)	61	(2)	28
Cut or faceted:				
Synthetic ... number	1,176,058	457	754,236	398
Other	(2)	[1] 3,730	(2)	4,487
Imitation, opaque, including imitation pearls, dutiable	(2)	18	(2)	154
Marcasites: Real and imitation, dutiable	(2)	(3)	(2)	(3)
Total	(2)	[1] 224,602	(2)	255,792

[1] Revised figure.
[2] Quantity not recorded.
[3] Less than $1,000.

Source: Bureau of the Census.

(uncut) and cut gem diamonds was imported and represented almost 88 percent of total imports by value.

Rough diamonds were principally imported by quantity from the following countries: United Kingdom, 52 percent; British West Africa, 18 percent; and Republic of South Africa, 6 percent. Cut but unset diamonds, by quantity, were imported principally from Belgium-Luxembourg (51 percent) and Israel (37 percent). Average values per carat of cut but unset diamond imports were Belgium-Luxembourg, $96.78; Israel, $79.42; Netherlands, $110.06; Republic of South Africa, $174.83; United Kingdom, $163.32; West Germany, $76.11.

Over 92 percent, by weight, of the cut but unset emeralds imported were from India. Of the remainder, 7 percent was imported from Switzerland, Belgium-Luxembourg, Colombia, and France. Twelve other countries supplied varying small amounts. The average values per carat of emerald imports from principal exporting countries were India, $9.11; Switzerland, $16.21; and Belgium-Luxembourg, $15.43.

Japan supplied almost the entire quantity of imported cultured pearls. Natural pearl imports were primarily from India (66 percent), Japan (14 percent), and Switzerland (7 percent); the remainder were from France, Iran, Hong Kong, Venezuela, and West Germany.

In addition, about $6.9 million of other precious and semiprecious stones, both rough and cut but unset, were imported. However, no classification information on varieties was available.

Exports.—Precious and semiprecious gem stone exports were valued at $40.5 million, compared with $18.8 million in 1962. Doubling of exports of cut but unset diamonds accounted for the increase. Cut but unset diamonds accounted for 81 percent of total exports. The value of gem stones, other than diamond, was over $5 million.

Reexports of all varieties of gem stone were valued at $46.7 million, compared with $40.0 million in 1962. Diamonds in the rough but uncut category accounted for 84 percent of total reexports.

TABLE 2.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by countries

Country	1962				1963			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Carats	Value (thousands)	Carats	Value (thousands)	Carats	Value (thousands)	Carats	Value (thousands)
North America:								
Canada	5, 128	$655	217	$18	9, 110	$918	847	$66
Mexico			198	22			12	3
Total	5, 128	655	415	38	9, 110	918	859	69
South America:								
Brazil	996	39	1, 469	121	1, 911	191		
British Guiana	9, 852	346	133	10	1, 011	43	84	6
Columbia					124	6		
Venezuela	128, 264	4, 025			55, 905	1, 971		
Total	139, 112	4, 410	1, 602	131	58, 951	2, 211	84	6
Europe:								
Austria			130	13				
Belgium-Luxembourg	39, 877	2, 381	478, 795	45, 721	33, 537	3, 282	522, 383	50, 556
France	4, 902	413	14, 291	1, 459	7, 169	633	16, 746	1, 776
Germany, West	2, 144	59	75, 301	5, 394	7	(1)	46, 015	3, 502
Gibraltar							7	(1)
Ireland			1	(1)				
Italy			201	66			152	103
Malta and Gozo			169	16	519	14	660	56
Netherlands	22, 367	1, 652	23, 786	2, 463	26, 539	1, 583	19, 299	2, 124
Portugal			12	1			105	14
Spain			7	5				
Switzerland	503	95	526	66	37, 402	1, 549	501	205
U.S.S.R.			2, 640	262			411	23
United Kingdom	[2] 753, 533	[2] 67, 176	5, 901	765	906, 340	86, 977	4, 280	699
Total	[2] 823, 326	[2] 71, 776	601, 760	56, 231	1, 011, 513	94, 038	610, 559	59, 056
Asia:								
Hong Kong			46	12			227	50
India			38	50			207	16
Iran			74	6				
Israel	20, 001	949	351, 306	27, 881	69, 671	3, 404	374, 199	29, 719
Japan			831	70	283	5	4, 381	321
Lebanon							15	4
Malaya, Federation of			7	10				
Thailand					3	(1)		
Total	20, 001	949	352, 302	28, 020	69, 957	3, 409	379, 029	30, 110
Africa:								
British West Africa and Sierra Leone	125, 407	4, 622			320, 845	8, 725		
Cameroon, Federal Republic of	2, 218	28	321	38				
Congo, Republic of the, and Ruanda-Urundi	34, 946	1, 309			8, 811	368		
Ghana	23, 962	253			1, 963	49		
Liberia	10, 456	1, 211			19, 061	1, 395		
Nigeria	778	190			4, 329	185		
South Africa, Republic of	[2] 120, 285	[2] 12, 268	25, 878	4, 721	112, 448	11, 558	27, 089	4, 736
Western Africa, n.e.c.[3]	57, 030	2, 772			71, 096	4, 148		
Western Equatorial Africa, n.e.c.[3]	58, 495	2, 105			61, 637	2, 916		
Total	[2] 433, 576	[2] 24, 758	26, 199	4, 759	600, 110	29, 294	27, 089	4, 736
Grand total	[2] 1, 421, 143	[2] 102, 548	982, 278	89, 188	1, 749, 641	129, 870	1, 017, 620	93, 977

[1] Less than $1,000.
[2] Revised figure.
[3] Not elsewhere classified.

Source: Bureau of the Census

WORLD REVIEW [5]

SOUTH AMERICA

Brazil.—A large emerald deposit, claimed to be the largest in South America, has been located at Polao Arcado, in the State of Bahia. Shafts have been sunk and exploitation has begun.[6] About 503,000 pounds of semiprecious gem stone material was exported during the year. The material consisted primarily of agate, with lesser amounts of amethyst, citrine, garnet, aquamarine, tourmaline, and topaz. A valuation cannot be placed on these materials due to the wide variation of Brazilian currency during the year.

Chile.—Lapis lazuli was produced by only one company during 1962. Compañía Minera Caren mined the stone from a deposit high in the Andes Mountains in Coquimbo Province. Exports of about 22,000 pounds were reported for 1962. The bulk of the exports went to the United States, with smaller quantities going to West Germany, France, Japan, and Italy.[7]

TABLE 3.—World production of diamonds, by countries

(Thousand carats)

Country	1962		1963	
	Gem	Industrial	Gem	Industrial
Africa:				
Angola	[1] 762	[1] 319	759	325
Central African Republic	80	185	121	282
Congo, Republic of the	256	14,400	296	14,468
Congo, Republic of [2]	[1] 158	[1] 2,471	341	5,343
Ghana	628	2,580	536	2,142
Guinea, Republic of	[3] 140	[3] 210	[4] 22	[4] 32
Ivory Coast	102	182	63	117
Liberia [5]	225	680	249	508
Sierra Leone	[1] 707	[1] 1,200	555	833
South Africa, Republic of:				
Pipe mines:				
Premier	425	1,260	522	1,565
De Beers Group [6]	883	750	921	754
Others	36	84	37	86
Alluvial mines	290	190	294	196
South-West Africa	800	227	1,076	119
Tanganyika	[1] 323	324	276	313
Other regions:				
Brazil [4]	175	175	175	175
British Guiana	60	40	60	40
India	1	----------	1	----------
Venezuela	94	83	38	31
U.S.S.R.[3]	[1] 200	[1] 2,300	240	2,760
World total [7]	[1] [8] 6,347	[1] [8] 27,659	[8] 6,572	30,089

[1] Revised figure.
[2] Probable origin, Republic of the Congo.
[3] Estimate.
[4] Data known to be low, no sure basis for an upward revision.
[5] Exports, most production from adjacent nations.
[6] Includes some alluvial diamond from De Beers' properties.
[7] Countries producing minor quantities of gem diamonds not included.
[8] Data do not add to total because of rounding.

[5] Values in this section are U.S. dollars based on the average rate of exchange by the Federal Reserve Board unless otherwise specified.
[6] Mining Journal (London). V. 261, No. 6681, Sept. 6, 1963, p. 218.
[7] Bureau of Mines. Mineral Trade Notes. V. 57, No. 5, November 1963, p. 13.

Venezuela.—Production of gem diamond increased from 60,495 carats in 1961 to 93,970 carats in 1962. Exports of all qualities of diamond in 1962 totaled 82,189 carats, valued at $2.6 million. The major portion of exports was destined for the United States and Bermuda, with quantities consigned to Israel, the United Kingdom, and West Germany.[8] Production of gem diamond for 1963 was 38,400 carats.

EUROPE

Belgium.—Cuttable diamond imports increased 8 percent, from about 3.4 million carats in 1961 to about 3.7 million carats in 1962. Polished diamond imports decreased from 221,000 carats in 1961 to 212,000 in 1962. Israel and the Republic of South Africa were the principal suppliers. Exports during 1962 of cuttable and polished diamonds totaled 1.1 million carats and were valued at $120 million. Slightly over 500,000 carats of this material valued at about $53.8 million was sent to the United States.[9]

ASIA

Afghanistan.—The Afghan Ministry of Mines and Industries announced that about 3,600 pounds of lapis lazuli was produced in the year ending March 1962. About 1,800 pounds valued at $250,000 was exported.[10]

Burma.—The jade mining industry in the Kachin State has been nationalized by the Kachin State Affairs Council. Nationalization primarily affected Chinese nationals who own more than half of the 1,000 jade mines in the area. Chinese-owned mines have stopped operations, and the unemployed workers have been informed by the Council that they may have these mines if they work them on a collective or cooperative basis.[11]

India.—During the financial year of 1963–64, India's exports of precious stones were expected to reach a value of about $30.5 million. The Ramkheria mine in the Panna area was not in operation because of lack of equipment and was expected to be in operation in 1964. The Majhgawan, in the same area, was expected to be operative at the end of 1963. By December 1962, 1,070 carats were discovered.[12] The Indian State Geological Survey investigated diamond deposits and sampled pipe rocks of Vajrakarpur, in the Anantapur district of Andhra Pradesh.[13] Production of crude and dressed emeralds during 1962 was reported as about 306,000 and 52,700 carats, respectively, valued at about $12,000 and $37,800, respectively. India imported emeralds valued at about $2 million.

Israel.—Exports of $103 million worth of polished diamond in 1963 made Israel the world's second largest processor of diamond.[14] During 1962, about 838,000 carats of polished diamond valued at about

[8] Bureau of Mines. Mineral Trade Notes. V. 56, No. 6, June 1963, p. 13.
[9] Bureau of Mines. Mineral Trade Notes. V. 56, No. 6, June 1963, pp. 8, 11.
[10] Bureau of Mines. Mineral Trade Notes. V. 57, No. 5, November 1963, p. 13.
[11] Bureau of Mines. Mineral Trade Notes. V. 56, No. 5, May 1963, pp. 14–15.
[12] Mining Journal (London). V. 260, No. 6661, Apr. 19, 1963, p. 373.
[13] Mining Journal (London). V. 260, No. 6653, Feb. 22, 1963, p. 184.
[14] Mining Journal (London). V. 262, No. 6699, Jan. 17, 1964, p. 55.

$82.3 million were exported, compared with about 699,000 carats valued at about 26 percent less in 1961.[15]

Japan.—The Japanese cultured pearl industry has formed an organization to supervise the quality of exports. One of the aims of the 19-member group is to prevent very thinly coated pearls from reaching the consumer market.[16]

AFRICA

Angola.—A newly formed company has been granted a concession to exploit stone deposits containing precious and semiprecious stones. This company will concern itself primarily with rubies, sapphires, topazes, and aquamarines that occur in the riverbeds of southern and southeastern sections of the country. Previously, the only large-scale concessionaire, the Companhia de Diamantes, exploited only high-value precious stones.[17] Diamond production in 1963 was about 1.1 million carats, of which 70 percent was gem variety.

Central African Republic.—The Central African National Assembly enacted legislation to establish a State-owned diamond-mining firm, to be known as the Société Nationale de Recherches et d'Exploitations Minières. This legislation was expected to increase diamond production and to control the activities of non-Central African diamond buyers. Within the next 2 years this organization plans to establish several small diamond-mining centers in the southwestern section of the Nation. These centers will be staffed with 2 to 3 mining engineers and 15 to 30 laborers. Villages will be established with such facilities as retail stores and licensed buying offices. It is expected that these centers will attract the large number of "diggers" scattered throughout the area, and that licensed buying offices will purchase their production. These offices will resell to buying offices in Bangui. The Government will sell its production directly to buying offices in Bangui.

The Israel-Central African Republic diamond export monopoly was dissolved on December 31, 1963.[18]

Diamond production during 1963 was reported as 403,000 carats, of which 30 percent was gem quality.

Gabon.—A Government decree issued November 16, 1963, stopped exploitation of diamond resources by all persons, except those of Gabonese origin who are registered artisans under the direct control of the Government-owned mining company. Little interest has been shown in diamond mining owing to the small size of the deposits and exploitation difficulties.[19]

Ghana.—The Ghana Diamond Marketing Board was established January 1, 1963, for the purpose of purchasing, grading, and appraising diamonds produced within the country. Subject to the prior approval of the Minister of Finance and Trade, the Board has the power to control and fix prices paid to producers, to license agents to purchase diamonds from the Board, and to control exports of diamonds.

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[15] Mining Journal (London). V. 260, No. 6651, Feb. 8, 1963, p. 134.
[16] Jewelers' Circular-Keystone. V. 134, No. 2, November 1963, p. 121.
[17] Mining Journal (London). V. 260, No. 6669, June 14, 1963, p. 600.
[18] Bureau of Mines. Mineral Trade Notes. V. 58, No. 5, May 1964, pp. 17–18.
[19] Bureau of Mines. Mineral Trade Notes. V. 58, No. 3, March 1964, p. 49.

Previously licensed agents were to be relicensed to buy from the Board.[20] Diamond production of 2.7 million carats was reported for 1963. Twenty percent was gem quality.

Kenya.—About 48,000 pounds of semiprecious gem stone material, valued at about $4,000 was produced during 1963. The bulk of this material was rose quartz; smaller quantities of such materials as augite and corundum were also produced.

Rhodesia and Nyasaland, Federation of.—Amethysts have been discovered in the Gwaai section of Southern Rhodesia and development of the claim has begun. The stones are considered of excellent quality.[21] Gem stone production for 1963 was reported as follows: Southern Rhodesia, 4,000 pounds of jade valued at about $1,120, and 36 pounds of chrysoberyl valued at about $58; Northern Rhodesia, 34,000 pounds of amethyst valued at about $286,000. No gem stone production was reported in Nyasaland.

South Africa, Republic of.—The old De Beers mine, which was closed in 1908, has been prepared for reopening. A new shaft has been sunk to the 412-foot level and connected to the old shaft. Mining is to be done by dropping ore from upper levels through existing ore passes to the crushing plant on the 1,720-foot level, for crushing to minus 5 inches. From here the ore would be hoisted to the 412-foot level, carried to a new surface crusher by a 1,700-foot inclined conveyor, and crushed to 1.5 inches. Then the crushed material would travel by another conveyor to the central treatment plant.[22]

During 1962, the Premier diamond mine completed its $7 million plant expansion program to increase production to 2.5 million carats per year. New facilities were installed to treat 400,000 tons per month of tailings remaining from previous mining operations. These tailings contained small industrial diamonds for which there was small demand in the past.[23]

Rich diamond deposits have been found in Namaqualand, and it has been claimed that they may be larger than the Kimberly fields. The statement has been made that these deposits are the source of the diamonds found off the Namaqualand coast.[24] Production of emerald crystals was reported as 527 pounds. A like amount valued at $412,000 was exported. Production of tiger's-eye was reported as 129 tons. Exports were listed as 150 tons valued at $49,000.

South-West Africa.—The Marine Diamond Corp., Ltd., has sunk three boreholes in the offshore diamond-bearing gravel deposits located north of Plum Pudding Island. High-quality diamonds averaging in excess of one-half carat in size were found. This yield rivals that of the Chamels Reef deposit, where more than 150 carats per day, mostly of gem quality, is recovered.[25] During 11 months prior to June 1963, the Marine Diamond Corp. recovered 116,369 diamonds weighing 51,917 carats valued at $1.7 million.[26] The Diamond Mining & Utility

[20] Bureau of Mines. Mineral Trade Notes. V. 56, No. 4, April 1963, pp. 14–15.
[21] Mining Journal (London). Amethyst in Southern Rhodesia. V. 261, No. 668, Oct. 11, 1963, p. 341.
[22] Mining Engineering. Famous Diamond Mine Comes to Life Again. V. 15, No. 9, September 1963, pp. 44–45.
[23] Skillings' Mining Review. Premier Diamond Mine Expands Plant. V. 52, No. 14, Apr. 6, 1963, p. 8.
[24] Engineering and Mining Journal. V. 164, No. 3, March 1963, pp. 155, 157.
[25] Bureau of Mines. Mineral Trade Notes. V. 56, No. 3, March 1963, p. 11.
[26] Bureau of Mines. Mineral Trade Notes. V. 58, No. 4, April 1964, pp. 11–12.

Co. agreed to lease its concessions and rights, granted by the South-West African Government, to the Tidewater Oil Co. The latter company thereby acquired diamond mining rights on land and from the highwater mark to the 6-mile limit. The lease will run for 25 years and includes an option to buy the grant after 5 years.[27]

In April the South-West Africa Administration granted a marine diamond mining concession to Terra Marina, a newly formed company composed of various financial interests in the Republic of South Africa. Their concession is off the South-West Africa coast and extends from Diaz Point at Lüderitz northward to Hottentot Bay.[28] Gem diamond production decreased about 15 percent from that of 1962. Semiprecious gem stone production decreased from about 419,000 pounds in 1962 to 155,000 pounds. Production for 1963 appears in table 4.

TABLE 4.—South-West Africa: Production and exports of gem stones in 1963

Gem	Production (quantity)	Exports	
		Quantity	Value
Diamond.......carats..	1,076,000	1,329,644	$57,800,000
Amazonite.......pounds..	18,000		
Amethyst.......do....	134,000	56,000	8,200
Chalcedony.......do....	1,940		
Rose quartz.......do....	500		
Tiger's-eye.......do....		5,860	1,550
Tourmaline.......do....	140	33	4,300

Tanganyika.—A total of 588,870 carats of diamonds valued at about $13.9 million were exported. This compared with 647,177 carats valued at $15.1 million in 1962.[29] About 46 pounds of rough ruby and sapphire, valued at about $46,800, were exported in 1962.[30]

OCEANIA

Australia.—The value of opal and sapphire produced in 1961 was reported as $1.9 million and $18,000, respectively.[31]

The Capricornia Mineral Development Co. Pty., Ltd., has been formed to mine crysoprase, which is available in the Marlboro ranges, near Rockhampton. This material has a marked similarity to Chinese jade. Crysoprase has been shipped to the United States, West Germany, Japan, and Hong Kong.[32] An access road has been constructed, and crysoprase veins have been exposed.[33]

French Pacific Islands.—Mother-of-pearl prices have been dependent on the economic conditions of both the United States and Europe, which are the chief markets. Prices have varied from a low of $0.25 per pound in 1951 to a high of $1 per pound in 1963. Previously, uncontrolled collection and export of shell depleted many collecting

[27] Bureau of Mines. Mineral Trade Notes. V. 57, No. 1, July 1963, p. 11.
[28] Bureau of Mines. Mineral Trade Notes. V. 57, No. 2, August 1963, p. 20.
[29] Mining Journal (London). V. 262, No. 6705, Feb. 21, 1964, p. 139.
[30] South African Mining and Engineering Journal (Johannesburg, Republic of South Africa). V. 74, pt. 1, No. 3656, Mar. 1, 1963, p. 497.
[31] Bureau of Mines. Mineral Trade Notes. V. 56, No. 6, June 1963, p. 17.
[32] World Mining. V. 17, No. 3, March 1964, p. 67.
[33] Queensland Government Mining Journal (Australia). V. 64, No. 746, December 1963, p. 797.

areas. However, rigid government controls have been applied. The Government is presently financing a program to repopulate the pearl shell beds and develop the culture of pearls. Seeding of pearls is being carried out experimentally. During 1961, 565 short tons of mother-of-pearl was exported.[34]

TECHNOLOGY

Each monthly issue of Mine and Quarry (London) beginning with October 1952 has described a mineral, giving the synonyms, nomenclature, varieties, composition, crystallography, physical and optical properties, tests, diagnosis, occurrences, and uses. In the February and May 1963 issues brazilinite and turquoise were described.

Spectrolite, the new gem form of labradorite coming from Finland, is described. The Finnish material occurs in isolated large to medium individual crystals, in contrast to the material from Labrador, which occurs in coarse-grained chunks with each crystal unit several inches across. Blue is the commonest sheen of the spectrolite, but other hues of equal intensity are common.[35] The tumbling method for evolving the irregularly shaped semiprecious stones (baroques) is reviewed.[36]

An article was written on gem mineral occurrences in Colorado that have been found and lost. Topaz, turquoise, sapphire, and jade are mentioned.[37]

Methods of developing "synthetic emeralds" were discussed, and products made by the Lechleitner method and the Chatham process were compared. The principle of the Lechleitner system, like Chatham's, is one of making an approximation of natural conditions in which a crystal is able to enlarge itself. The additional growth is crystallographically continuous.[38]

An article on turquoise reviewed the traditions of the celebrated historical mines of Persia (now Iran).[39]

The origin of Colorado gold stone was described. The product does not contain gold nor is it a stone. The process involved in producing this material is discussed.[40]

The techniques of the lapidary industry of Japan are discussed. Japanese stone carving is relatively new and expanded after German sources were cut off in 1939. The popular materials are rose quartz, rock crystal, aventurine, sodalite, lapis, tiger's-eye, gold stone, amethyst, and agate.[41]

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[34] Bureau of Mines. Mineral Trade Notes. V. 56, No. 5, May 1963, p. 15.
[35] Jewelers' Circular-Keystone. Spectrolite a New and Exciting Gem Stone. V. 133, No. 12, August 1963, pp. 138, 140, 159, 162.
[36] Rhodesian Mining and Engineering (Salisbury, Southern Rhodesia). How "Baroque" Gem Stones Are Polished. V. 27, No. 13, December 1962, p. 27.
[37] Pearl, Richard M. Colorado Minerals Lost and Found. Rocks and Minerals, v. 38, Nos. 3–4, March–April 1963, pp. 129–130.
[38] Pough, Frederick H. A Unique "Synthetic," the Linde-Lechleitner Stone. Jewelers' Circular-Keystone, v. 133, No. 11, July 1963, pp. 52, 54, 62, 64, 66.
[39] King, Frank A. Turquoise-Mining and Traditions of the Past. Canadian Min. J. (Quebec, Canada), v. 84, No. 1, January 1963, pp. 48–49.
[40] Pough, Frederick H. The True Story of Colorado Gold Stone. Jewelers' Circular-Keystone, v. 133, No. 5, February 1963, pp. 92, 98, 100, 101.
[41] Pough, Frederick H. The Lapidaries of Kofu. Jewelers' Circular-Keystone, v. 133, No. 4, January 1963, pp. 60, 62, 72–74.

Methods of irradiating diamonds with charged particles are described. A brief history of irradiation is given, problems are discussed, and results are evaluated.[42]

The practice of raising the color grade of certain diamonds to near colorless by disguising the true light-yellow or brown body color by applying a foreign substance to the surface of the stone was discussed for the first time. Guides are listed for detecting coating when examining diamonds.[43]

An article on the production of cultured pearls described the basic anatomy of the oyster, growing pearl oysters, color and luster of the pearl, chemical analysis of the pearl, and synthetic pearl essence.[44]

An unusual use of antibiotics was reported from Japan, where a scientist on the staff of the Fisheries School of Mie Prefecture described tests over 4 years in which the antibiotic chlortetracycline raised production of top-quality cultured pearls by 30 percent.[45]

A method for improving the color and quality of natural or cultured pearls was patented. The pearls are subjected to high-energy, ionizing radiation.[46]

A patent was issued in Australia on an improved method for manufacturing synthetic diamonds, wherein graphite or a carbide is dissolved in molten nickel or nickel alloy solvent to form a saturated solution.[47]

A cigarette filter tip consisting of tourmaline particles dispersed in a nontoxic carrier was patented.[48]

A French patent was granted on a method for producing blue diamonds by chemically coloring white natural diamonds.[49]

A description was given of simple tests that can be made to distinguish genuine precious and semiprecious stones from paste stones. The use of the spectroscope and specific gravity tests with heavy liquids such as bromoform, methylene iodide, and clerici's solution were discussed.[50]

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[42] Pough, Frederick H. Recent Diamond Irradiation Techniques. Jewelers' Circular-Keystone, v. 134, No. 3, December 1963, pp. 54, 56, 58, 60.
[43] Miles, Eunice Robinson. Coated Diamonds. Jewelers' Circular-Keystone, v. 133, No. 8, May 1963, pp. 66–69, 82, 84, 86, 88, 90, 92.
[44] Critides, Leon. Producing Cultured Pearls. Chemistry, v. 36, No. 11, December 1963, pp. 6–12, 31.
[45] Chemical Trade Journal and Chemical Engineer (London). Antibiotics in Pearl Production. V. 153, No. 3977, Aug. 30, 1963, p. 305.
[46] Chow, K. T. Process for Irradiating Pearls and Product Resulting Therefrom. U.S. Pat. 3,075,906, Jan. 29, 1963.
[47] Custers, J. F. H., H. B. Dyer, B. W. Senior, and P. T. Wedepohl. Australian Pat. 239,176, June 26, 1962.
[48] Jacobson, G. Cigarette Filters. U.S. Pat. 3,087,500, Apr. 30, 1963.
[49] Duchaine, M. P. J. French Pat. 1,316,489, Dec. 26, 1963.
[50] Parkinson, Kenneth. Test That Stone. Rocks and Minerals, v. 38, Nos. 3–4, March–April 1963, pp. 131–135, 216.

Gem Stones

By Benjamin Petkof[1]

ESTIMATE of 1964 production of gem materials and mineral specimens reached $1.5 million, an increase of 7 percent over 1963. Individual collectors continued to account for the bulk of domestic production.

Regulations controlling the collection of petrified wood on public lands were issued by the Bureau of Land Management of the Department of the Interior.[2]

DOMESTIC PRODUCTION

The Bureau of Mines discontinued its collection of data by direct canvass of known amateur and professional gem stone producers. Estimates of production indicated that 38 States produced gem stone. Of these, California, Oregon, Texas, Arizona, and Wyoming were the leading producers.

A deposit of black jade was discovered 62 miles southwest of Douglas, Wyo., by a rock hobbyist who leased his claim to the Eloxite Corp. Similar jade is known only in Siberia. The domestic stone is claimed to be of a better quality because it polishes to a more lustrous sheen. The mining company was selling the material for $8,000 per ton. Material has been shipped to Japan for cutting and carving and to the Federal Republic of Germany for jewelry.

The California Division of Mines and Geology announced the discovery of nephrite jade in 1962 by its personnel in the Bagby district 2½ N.-N.E. of Bagby, Calif. The jade occurs in veins along the east contact of the serpentine belt and ranges up to 5 feet thick and 150 feet long. The best quality jade occurs in various shades of green without any flaws and changes into rock of less desirable color perfection and hardness. The jade is generally within a thick shell of partially nephritized serpentine.[3]

The Himalaya Mine of San Diego County, Calif., which won its fame as a producer of gem tourmaline between 1903 and 1913, was sold to new owners who plan to open it for organized groups to hunt for tourmaline and other minerals that can be found on the mine dump.

A ruby weighing almost 87 carats was found at the old Shuler corundum mine in Cowee Valley near Franklin, N.C. The stone was valued in excess of $4,000.

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[1] Commodity specialist, Division of Minerals.

[2] Bureau of Land Management, U.S. Department of the Interior. Subchapter C—Minerals Management. Circ. 2147, July 1, 1964, pp. 5–6.

[3] California Mineral Information Service, Division of Mines and Geology. New Jade Deposit Found by Division . . . . V. 17, No. 2, February 1964, p. 21.

CONSUMPTION

Consumption of gem diamond reached $259 million, an increase of almost 16 percent over 1963; imported imitation and synthetic gem stones including imitation pearl was $6.1 million, an increase of 20 percent over 1963; and natural and cultured pearls were $19.7 million, an increase of 10 percent over 1963.

Apparent consumption (domestic production plus imports minus exports and reexports) of gem material in the United States was $189 million, up 11 percent over 1963.

PRICES

Prices quoted during the year for cut and polished, unmounted gem diamonds were 0.25 carat, $70 to $275; 0.50 carat, $185 to $600; 1 carat, $500 to $1,800; 2 carat, $1,200 to $5,600.

FOREIGN TRADE

Over 90 percent of the cut but unset emerald was imported from India. Nineteen other countries supplied the remaining quantity. The average value of emerald imports from India was $11.50 per carat.

Japan supplied the bulk of the pearl imports. Cut but unset rubies and sapphires, valued at $4.1 million, were imported. In addition, about $6.9 million of other precious and semiprecious stones were imported. However, no classification information on the latter was available.

TABLE 1.—U.S. imports for consumption of precious and semiprecious stones, exclusive of industrial diamonds

Stones	1963		1964	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Diamonds:				
Rough or uncut, suitable for cutting into gem stones, duty-free ----- carats	1,749,641	$129,870	1,547,955	$149,729
Cut but unset, suitable for jewelry, dutiable ----- carats	1,071,620	93,977	1,096,795	108,805
Emeralds: Cut but not set, dutiable ----- do	190,933	2,081	180,069	3,218
Pearls and parts, not strung or set, dutiable:				
Natural	(1)	479	(1)	474
Cultured or cultivated	(1)	17,427	(1)	19,204
Other precious and semiprecious stones:				
Rough or uncut, duty-free	(1)	1,708	(1)	2,514
Cut but not set, dutiable	(1)	5,183	(1)	7,057
Imitation, except opaque, dutiable:				
Not cut or faceted	(1)	28	(1)	(2)
Cut or faceted:				
Synthetic ----- number	[r] 1,054,236	398	1,218,326	623
Other	(1)	4,487	(1)	5,825
Imitation, opaque, including imitation pearls, dutiable	(1)	154	(1)	337
Marcasites: Real and imitation, dutiable	(1)	(3)	-----	-----
Total	(1)	255,792	(1)	298,386

[r] Revised.
[1] Quantity not recorded.
[2] No longer separately classified.
[3] Less than ½ unit.

Source: Bureau of the Census.

Precious and semiprecious gem stone exports were valued at $46.8 million compared with $40.5 million in 1963. Diamonds, both rough and uncut, accounted for almost 89 percent of total exports.

Reexports of all varieties of gem stone were valued at $64.3 million compared with $46.7 million in 1963. Diamond in the rough but uncut category accounted for 85 percent of total reexports.

TABLE 2.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by countries

Country	1963				1964			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Carats	Value (thousands)	Carats	Value (thousands)	Carats	Value (thousands)	Carats	Value (thousands)
Austria							584	$35
Belgium-Luxembourg	33,537	$3,282	622,383	$50,555	77,728	$9,264	583,207	60,155
Brazil	1,911	191			1,329	196	5	3
British Guiana	1,011	43	84	6	10,156	383		
Canada	9,110	918	847	66	7,753	1,200	227	28
Central African Republic					102,919	5,451		
Columbia	124	6						
Congo (Léopoldville)	8,811	368			236	71		
France	7,169	633	16,746	1,775	6,066	435	15,781	1,678
Germany, West	7	(1)	46,015	3,502			18,040	1,335
Ghana	1,993	49			858	53		
Guinea					2,774	418		
Hong Kong			227	50			329	41
India			207	16			535	111
Ireland					3,616	464		
Israel	69,671	3,404	374,109	29,719	49,011	3,800	426,052	36,800
Italy			152	103			84	17
Japan	283	5	4,381	321			1,541	95
Liberia	19,051	1,395			8,417	806		
Malta and Gozo	519	14	660	56			205	16
Netherlands	26,539	1,583	19,299	2,124	39,265	4,179	14,358	1,896
Nigeria	4,329	135						
Sierra Leone	320,845	8,725			72,153	2,867		
Republic of South Africa	112,448	11,558	27,089	4,736	138,015	12,162	23,721	4,918
Switzerland	37,402	1,549	501	205	33,748	2,192	783	364
U.S.S.R.			411	23			5,590	503
United Kingdom	906,340	86,977	4,280	699	894,260	100,928	5,387	754
Venezuela	55,905	1,971			78,486	2,960		
Western Africa, n.e.c.[2]	71,096	4,148			20,995	1,868		
Western Equatorial Africa	61,537	2,916						
Total [3]	1,749,641	129,870	1,017,620	93,977	1,547,955	149,729	1,096,795	108,805

[1] Less than ½ unit.
[2] Not elsewhere classified.
Includes imports valued at less than $25,000 for following countries: Barbados, 1964; Jamaica, 1964; Mexico, 1963; Netherlands Antilles, 1964; Trinidad and Tobago, 1964; Gibraltar, 1963; Portugal, 1963-64; South Korea, 1964; Lebanon, 1963; Thailand, 1963; Senegal, 1964; Australia, 1964; New Zealand, 1964.

Source: Bureau of the Census.

WORLD REVIEW

Brazil.—Mineração Tejucana S.A. has been given the right to develop previously uneconomic alluvial diamond deposits along the Jequitinhonha River in the area of Diamantina and Bocaiuba, Minas Gerais. Economic exploitation is expected by dredging with equipment that can treat 3 million cubic meters per year for the recovery of about 30,000 carats, valued at about $600,000.[4]

A large crystal of gem beryl weighing about 15 pounds was found near Padre Paraiso, Municipality of Caraí, Minas Gerais and was valued at $143,000.[5]

Cameroon.—The Ivory Coast Diamond Corp. has been awarded diamond prospecting rights by the Ministry of Transportation, Mines, and Post and Communication.[6]

TABLE 3.—World production of gem diamond by countries

(Thousand carats)

Country	1963	1964
Africa:		
Angola	759	804
Central African Republic	121	221
Congo, (Brazzaville) Republic of [1] [e] [2]	341	316
Congo, (Léopoldville) Republic of the	296	295
Ghana	536	267
Guinea [1] [e]	22	22
Ivory Coast	63	120
Liberia [1]	240	298
Sierra Leone	555	516
Republic of South Africa:		
Pipe mines:		
Premier	522	556
DeBeers group [3]	921	928
Others	[r] 15	18
Alluvial	[r] 338	288
South-West Africa	1,076	1,373
Tanzania	276	12
Other Countries:		
Brazil [e]	175	175
British Guiana	60	60
India	1	2
U.S.S.R. [e]	240	240
Venezuela	38	58
World total	[r] 6,594	6,570

[e] Estimated. [r] Revised.
[1] Exports.
[2] Probable origin, Republic of the Congo.
[3] Includes some alluvial from DeBeers properties.

Canada.—Rock blasted from a quarry on Ile Ronde, Montreal, showed a similarity to South African kimberlite. This indicated a possibility that diamonds are embedded in the rock far below the surface.

Ceylon.—The Government formed the State Gem Mining Corporation to control internal and external trade in precious stones within the country. The corporation was expected to eliminate smuggling, thereby improving the Government's revenue and foreign exchange position in addition to insuring a reasonable return to the miner. The corporation shall have the authority to set license fees on all gem pits and impose taxes on all sections of the industry. The industry reforms caused a large number of gem dealers in Ratnapura to close their businesses.[7]

Chile.—Compañía Minera Caren continued to operate the only active lapis lazuli mine near the Argentine border in Coquimbo Province.

[4] Mining Journal (London). V. 263, No. 6729, Aug. 7, 1964, p. 93.
[5] Bureau of Mines. Mineral Trade Notes. V. 59, No. 5, November 1964, pp. 4–5.
[6] Bureau of Mines. Mineral Trade Notes. V. 59, No. 4, October 1964, p. 17.
[7] Mining Journal (London). V. 263, No. 6731, Aug. 21, 1964, p. 137.

About 8,800 pounds, valued at $12,000, was produced during 1963. The bulk of this material was exported to Italy, France, United States, Germany, and Switzerland. Greater production was planned during 1964 to meet the increasing market created by hobbyists who are cutting and polishing lapis lazuli.[8]

Colombia.—During 1963 the Muzo, Coscuez, and Chivor emerald mines produced 50,560 carats of gem quality emerald. In addition, these mines produced 140,556 carats of low-grade emerald (morralla.)[9]

Czechoslovakia.—A northern area of the country where gem quality pyrope was formerly found has shown a similarity to the Siberian kimberlites. Studies of the pyrope rock have been made and it was concluded that further exploration for diamond was warranted.[10]

India.—The National Mineral Development Corporation of India undertook development of two new diamond mines at Majgawar and Ramkhiria. The yield of these mines was estimated at 30,000 and 12,500 carats per year respectively.[11]

Ivory Coast.—Three companies, Société Anonyme de Recherches et d'Exploitations Minière en Côte d'Ivoire, Société Diamantifere de Côte d'Ivoire, and Société Minière de Bandama produced diamonds during 1963. The Société Waston and the Diamond Corporation of the Ivory Coast prospected but did not begin operation in 1963. Government enforcement of its ban on clandestine operations eliminated the production of native prospectors.[12]

Sierra Leone.—The Government and Templesman and Bros., an American firm, have signed an agreement to set up a factory to cut and polish rough and uncut diamonds within the country. Operation of the facility is anticipated by the end of 1965.[13] A detailed article describing licensed diamond mining in the country was published.[14]

South Africa, Republic of.—Mining began at the Finsch Mine, the first new diamond mine in 50 years, in December. The mine, at Potmasburg on a claim discovered by A. T. Fincham was purchased by DeBeers Consolidated Mines for over $6 million in 1963. The area was being stripped of overburden to reach the diamond-bearing "blue ground." Treatment of the "yellow ground" in the overburden for the recovery of diamond has begun. Pilot plant experience will determine the design of the treatment and recovery plant to be built. The area will be mined by open pit methods to a depth of 300 feet. Operating results will then determine whether to continue open pit methods or begin underground mining.[15]

A special court in Pretoria opened hearings on the General Electric Co.'s application to patent the process for manufacturing diamond. The Transvaal and Orange Free State Chamber of Mines opposed the application by claiming that the synthesis of diamond is an obvious

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[8] Bureau of Mines. Mineral Trade Notes. V. 59, No. 2, August 1964, p. 34.
[9] Bureau of Mines. Mineral Trade Notes. V. 60, No. 1, January 1965, pp. 12–13.
[10] Mine and Quarry Engineering (London). Czech Diamond Prospects. V. 30, No. 2, February 1964, p. 96.
[11] Mining Journal (London). V. 262, No. 6709, Mar. 20, 1964, p. 216.
[12] Bureau of Mines. Mineral Trade Notes. V. 59, No. 1, July 1964, p. 13.
[13] Mining Journal (London). Sierra Leone Diamond Factory. V. 264, No. 6752, Jan. 15, 1965, pp. 43, 45.
[14] Fairbairn, W. C. Licensed Diamond Mining in Sierra Leone. Min. Mag. (London), v. 112, No. 3, March 1965, pp. 166–167, 169, 171, 173, 175, 177.
[15] Mines Magazine. New Diamond Mine. V. 55, No. 3, March 1965, pp. 23–24.

process and not an invention. The legal dispute was expected to be lengthy because of the affidavits entered by affected parties and the legal efforts by the Chamber of Mines to require deponents to give evidence in person.[16]

South-West Africa.—Diamond dredging activities continued in the offshore marine sediments. Offshore prospecting was underway by several mining companies. Notable among these was the *Rockeater*, a ship specifically designed for underwater mineral sampling, whose sampling operations were supported by the DeBeers Consolidated Mines, Ltd.

Marine Diamond Corp., Ltd., continued to recover diamonds from its offshore concession. During the period of January 1 to May 31, 1964, the company mined almost 102,000 carats of diamonds.

Mining activities continued along the territory's coastal belt. Consolidated Diamond Mines' Vacu-Veyor, essentially a large vacuum cleaner, proved successful for removing sand and gravel from bed rock.[17] An article provided a description of Consolidated Diamond Mines diamond mining practices.[18]

South-West Africa continued to produce and export semiprecious gem materials such as agate, amazonite, quartz (amethyst, green and rose), chalcedony, jasper, and tourmaline.

Thailand.—During 1963 about 13 million carats of precious and semiprecious materials was imported and over 11 million carats was exported. The bulk of the material imported consisted of synthetic or reconstructed precious or semiprecious stones.[19]

Upper Volta.—Diamond exploration rights were awarded to the West African Selection Trust, Ltd., for 1 year commencing at the beginning of 1964 and to be renewable for 2 years. The organization agreed to spend $62,000 per year for exploration. Geological surveys had been completed for only 20 percent of the territory involved, and traces of diamond were found near the Ghanaian border.[20]

U.S.S.R.—Both industrial and gem diamonds were mined at Mirny in Yakutia, Eastern Siberia, by opencast methods. A new concentrating plant capable of operating the entire year was being built. Finds of new kimberlite pipes were reported north of Mirny on the Olenck River.[21]

Zambia.—Rio Tinto, Ltd., discontinued exports of higher grade emerald from the Sandawana mine near Belingwe in order to form a domestic cutting industry that will export cut emerald. Rio Tinto planned to continue to export lower grade uncut emerald.[22]

TECHNOLOGY

Detection by loupe or Gemolite that a diamond was coated to enhance its color was reported. The coating, a foreign substance, is applied to

[16] Bureau of Mines. Mineral Trade Notes. V. 58, No. 5, May 1964, p. 18.
[17] South African Mining & Engineering Journal (Johannesburg). Mining Activities in S.W.A. V. 75, Pt. 2, No. 3725, June 26, 1964, pp. 187–188, 191.
[18] South African Mining & Engineering Journal (Johannesburg). 26-million to 1 Concentration Operation at Cons. Diamonds. V. 76, Pt. 1, No. 3759, Feb. 19, 1965, pp. 410–416.
[19] Bureau of Mines. Mineral Trade Notes. V. 59, No. 6, December 1964, pp. 18–19.
[20] Bureau of Mines. Mineral Trade Notes. V. 58, No. 5, May 1964, p. 23.
[21] Mining & Minerals Engineering (London). Diamond Mining in Yakutia. V. 1, No. 7, March 1965, p. 277.
[22] Bureau of Mines. Mineral Trade Notes. V. 60, No. 3, March 1965, p. 7.

the surface of certain diamonds to raise their color by neutralizing their true yellow color. Recent application of the phase microscope has brought the nature of coated surfaces of diamond into critical focus and photographic records were made under 500 to 1,000 magnification. The pictures reveal clearly where coatings were applied. They confirm earlier findings of characteristic markings that were seen with use of 10X loupe or a Gemolite.[23]

The development of an ultramodern automatic diamond sorting machine was reported. The machine was based on techniques in various scientific fields that electronics coordinated effectively, as X-rays, precision mechanics, vacuum, and compressed air.[24]

Steps taken to improve gem diamond production at the operations of the leading gem diamond producer was briefly described. The installation of two Wedag medium scoop wheel separators by Consolidated Diamond Mines of South-West Africa Ltd., should contribute considerably in increasing production.[25]

Advanced equipment used in diamond prospecting on the sea-floor sampling program conducted on behalf of the DeBeers group off the coast of South-West Africa was described.[26]

Method and equipment used in the production of diamonds in the U.S.S.R. were described.[27]

Tests for identifying artificial and improved turquoise were reported. Many substitutes are offered in place of genuine turquoise. The offerings are of three types: Compacted poor quality turquoise, colored and soaked with plastic; other natural substances similarly treated; and wholly artificial aggregates.[28]

An article was written on the misleading use of names on maps indicating turquoise locations in the Turquoise Mountains east of Baker, Calif.[29]

The use of synthetic sapphire jewel bearings in gas flow meters was discussed. Synthetic sapphires are nonmagnetic, corrosion-resistant, easily obtainable, and have miniature dimensions within critical tolerances.[30]

The occurrence of needle-like structures and some color phases in quartz are described.[31]

A guide on gems, minerals, crystals, and ores was written for professional mineralogists, gem cutters, collectors, and hobbyists. The

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[23] Miles, Eunice R. First Close-Up Shots of Coated Diamonds. Jewelers' Circular-Keystone, v. 75, No. 1, October 1964, pp. 70–73, 104–108.

[24] Mining Journal (London). Automatic Rough Diamond Sorter. V. 263, No. 6743, November 1964, p. 355. Mining Magazine (London). Automatic Rough Sorter. V. III, No. 6, December 1964, p. 391.

[25] Mining Magazine (London). Dense Medium Separators for Diamonds. V. III, No. 6, December 1964, pp. 381–383.

[26] Mining Magazine (London). Sea-Floor Sampling. V. III, No. 6, December 1964, pp. 403, 405. South African Mining & Engineering Journal (Johannesburg). Prospecting For Diamonds Off South-West Africa. V. 75, Pt. 2, No. 3743, October 1964, pp. 1208–1209.

[27] World Mining. How Russia Mines More Diamonds. V. 17, No. 13, December 1964, p. 34.

[28] Pough, F. H. Turquoise and Its Substitutes. Jewelers' Circular-Keystone, v. 84, No. 4, January 1964, pp. 78, 80 and 81.

[29] Pemberton, H. E. Place Names in the Turquoise Mountains. The Mineralogist, v. 32, No. 5, October 1964, pp. 10–13.

[30] Chemical Engineering. Synthetic Jewel Bearings Make Accurate Gas Flow Meter. V. 71, No. 22, October 1964, p. 146.

[31] Pough, F. H. Quartz Jewelry Stones. Jewelers' Circular-Keystone, v. 75, No. 1, October 1964, pp. 86–90, 98–100.

book describes where to find them, methods of identification, cutting, and displaying.[32]

The cultivation of high-quality pearls in fresh-water mussels was described. The fresh-water mussel often is larger and has a thicker shell than the Japanese salt-water oyster. Fresh-water mussels yield two crops of non-nucleated pearls.[33]

The surface structures of crystal faces of natural and synthetic emeralds were reported. By using a reflection and phase contrast microscope, a clear distinction can be made between natural and synthetic emeralds.[34]

The geologic occurrence, variations, color zoning, and inclusions were discussed in an article on tourmaline.[35]

Goldmanite, a new garnet, has been identified as a constituent of a metamorphosed uranium-vanadium deposit in the Sandy (or South Laguna) mine area, about 4 miles southeast of Laguna, N. Mex. Occurrence, separation, properties, composition, and analytical procedures are described.[36]

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[32] Pearl, R. M. Gems, Minerals, Crystals and Ores. The Odyssey Press, New York, 1964, pp. 320.

[33] Pough, F. H. Cultured Pearls—Shape and Luster Distinguish Fresh-Water Cultured Pearls. Jewelers' Circular-Keystone, v. 84, No. 11, July 1964, pp. 72–76, 92.

[34] Sunagawa, I. A Distinction Between Natural and Synthetic Emeralds. The American Mineralogist, v. 49, Nos. 5 and 6, May–June 1964, pp. 785–792.

[35] Ransom, J. E. Tourmaline—The Geological Saga of a Crystal. The Mineralogist, v. 32, No. 4, August 1964, pp. 2–9.

[36] Moench, R. H. and R. Meyrowitz. Goldmanite, a Vanadium Garnet from Laguna, New Mexico. The American Mineralogist, v. 49, Nos. 5 and 6, May–June 1964, pp. 644–655.

Gem Stones

By Benjamin Petkof [1]

Gem stone production during 1965 was estimated at $2.2 million, an increase of 50 percent over last year. Amateur collectors continued to be the principal collectors of domestic gem material.

DOMESTIC PRODUCTION

Production estimates show that 38 States produced gem material during the year. Oregon, California, Texas, Idaho, Arizona, Wyoming, and Nevada were the leading producing States. The estimated value of production was 50 percent more than in 1964.

During the year the excise tax on gem materials was removed. This appeared likely to promote increased sales of gems and gem materials.

Very well-formed augite crystals were found on the west rim of the Haleakala Crater, Island of Maui, Hawaii. Most of the crystals were single but contact and penetration twins were also found. The largest one found was eleven-sixteenth of an inch long.[2] Wavellite was identified in the King turquoise mine in the San Luis Valley, Colo.[3]

CONSUMPTION

Gem diamond consumption reached $307 million, an increase of almost 19 percent over that of 1964. Value of imported synthetic and imitation gem stones including imitation pearl was $7.1 million, an increase of 16 percent over that of 1964 and value of natural and cultured pearls was $22.2 million, an increase of 13 percent over that of 1964.

Apparent consumption (domestic production plus imports minus exports) was $248 million, an increase of 31 percent over that of 1964.

PRICES

At midyear, prices for cut and polished, unmounted gem diamond were 0.25 carat $75 to $275; 0.50 carat $200 to $725; 1 carat $400 to $1,900; and 2 carats $1,250 to $5,500.

FOREIGN TRADE

Precious and semiprecious gem stone exports were valued at $47.1 million, compared with $46.8 million in 1964. Diamond, both rough and uncut, accounted for the bulk of the exports.

Reexports of all varieties of gem stone were valued at $60.5 million, compared with $64.3 million in 1964. Diamond made up the major portion of total reexports.

India provided 73 percent of the emerald (cut but unset) imported during the

[1] Commodity specialist, Division of Minerals.
[2] Pemberton, Earl H. Augite Crystals at Haleakala Crater, Hawaii. Gems and Minerals, No. 331, April 1965, p. 42.
[3] Rock Products. Rare Wavellite Found in King Mine. V. 68, No. 4, April 1965, p. 122.

Table 1.—U.S. imports for consumption of precious and semiprecious stones, exclusive of industrial diamond

Stones	1964		1965	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Diamond:				
Rough or uncut, suitable for cutting into gem stones, duty-free ... carats	1,547,955	$149,729	1,900,936	$175,457
Cut but unset, suitable for jewelry, dutiable ... do	1,096,795	108,805	1,258,745	131,828
Emerald: Cut but not set, dutiable ... do	180,069	3,218	189,828	5,397
Pearls and parts, not strung or set, dutiable:				
Natural	NA	474	NA	592
Cultured or cultivated	NA	19,204	NA	21,674
Other precious and semiprecious stones:				
Rough or uncut, duty-free	NA	2,514	NA	2,728
Cut but not set, dutiable	NA	r 7,441	NA	8,901
Imitation, except opaque, dutiable:				
Cut or faceted:				
Synthetic ... number	1,218,326	623	2,526,418	1,007
Other	NA	5,825	NA	5,429
Imitation, opaque, including imitation pearls, dutiable	NA	337	NA	415
Marcasites: Real and imitation, dutiable	NA	r 2	NA	3
Total	NA	r 298,172	NA	353,431

r Revised. NA Not available.

year. The remainder was supplied by 25 other countries. Indian emerald imports had an average value of $16.20 per carat.

Ruby and sapphire (cut but unset) were imported from 20 countries, with India and Thailand supplying over 50 percent of the total value of almost $4.8 million.

Japan supplied 97 percent of the cultured-pearl imports by value but only 8 percent of the natural pearl imports. India supplied 66 percent by value of the natural pearl imports.

Table 2.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by countries

Country	1964				1965			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Carats	Value (thousands)	Carats	Value (thousands)	Carats	Value (thousands)	Carats	Value (thousands)
Argentina							15	$18
Australia	24	$10						
Austria			584	$35			255	40
Barbados			81	11	925	$14		
Belgium-Luxembourg	77,728	9,264	583,207	60,155	74,979	7,597	679,614	73,923
Brazil	1,329	196	5	3	4,185	293	1,014	97
British Guiana	10,156	383			19,295	742	40	5
Canada	7,753	1,200	227	28	7,139	1,138	349	44
Central African Republic	102,919	5,451			144,209	8,365		
Ceylon							177	20
Congo (Léopoldville)	236	71			928	63		
Denmark							2	(1)
France	6,066	435	15,781	1,678	1,642	70	15,675	1,665
Germany, West			18,040	1,335			18,507	1,370
Ghana	858	53			2,883	146	183	16
Guinea	2,774	418			2,065	205		
Hong Kong			329	41	15	3	4	1
India			535	111			2,469	342
Iran							23	55
Ireland	3,616	464			4,114	71	47	3
Israel	49,011	3,800	426,052	36,800	56,681	3,310	472,602	42,134
Italy			84	17			13	9
Ivory Coast					188	29		
Jamaica	18	5					178	13
Japan			1,541	95	46	8	1,276	142
Korea, South			61	3				
Lebanon							28	8
Liberia	8,417	806			6,598	674		
Malaysia					67	4		
Malta and Gozo			205	16				
Netherlands	39,265	4,179	14,358	1,896	33,524	4,094	20,772	2,835
Netherlands Antilles			22	18			7	4
New Guinea					349	38		
New Zealand			74	7				
Nigeria					961	108		
Panama							2	1
Peru							55	6
Poland							158	11
Portugal			33	4				
Senegal	128	17						
Sierra Leone	72,153	2,867			44,161	2,818		
South Africa, Republic of	138,015	12,162	23,721	4,918	158,539	15,330	27,223	6,166
Switzerland	33,748	2,192	783	364	104,044	9,879	1,142	633
Trinidad and Tobago			95	13				
U.S.S.R.			5,590	503			11,289	1,410
United Kingdom	894,260	100,928	5,387	754	1,141,833	113,481	5,626	857
Venezuela	78,486	2,960			54,448	1,950		
Western Africa, n.e.c.[2]	20,995	1,868			34,973	4,903		
Western Portuguese Africa, n.e.c.[2]					2,145	124		
Total	1,547,955	149,729	1,096,795	108,805	1,900,936	175,457	1,258,745	131,828

[1] Less than ½ unit.

[2] Not elsewhere classified.

WORLD REVIEW

Angola.—The Angolan Diamond Company produced diamond in excess of 1 million carats during the year. During 1964 the company produced almost 1.15 million carats. Rubble processed in 1964 yielded 0.37 carat per cubic meter. The company intends to contract for additional prospecting teams to mark and map claims for exploitation when its present contract terminates in 1971.

Basutoland.—Two large diamonds, weighing 103 and 527 carats were found at the Letseng-la-Terae native diamond diggings in northeast Basutoland. They

Table 3.—World production of diamond, by countries

(Thousand carats)

Country	1964 Gem	1964 Industrial	1965 Gem	1965 Industrial
Africa:				
Angola	804	345	878	277
Central African Republic	221	221	268	268
Congo (Brazzaville) [1] [2] [e]	316	4,949	318	4,982
Congo (Léopoldville)	295	14,457	14	12,490
Ghana	267	2,402	225	2,023
Guinea [1]	[r] 21	[r] 51	[e] 21	[e] 51
Ivory Coast	120	80	116	77
Liberia [1]	298	272	277	263
Sierra Leone	[r] 585	[r] 878	[e] 658	[e] 804
Republic of South Africa:				
Pipe mines:				
Premier	556	1,668	[e] 654	[e] 1,963
De Beers group [3]	928	759	[e] 1,119	[e] 916
Others	18	41	[e] 18	[e] 42
Alluvial	288	192	[e] 188	[e] 126
South-West Africa	[r] 1,387	154	1,432	158
Tanzania	[r] 338	326	[e] 414	[e] 414
Total Africa	[r] 6,442	[r] 26,795	6,600	24,854
Other countries:				
Brazil [e]	175	175	175	175
British Guiana	60	49	45	68
India	2	1	4	1
U.S.S.R. [e]	240	2,760	300	3,200
Venezuela	58	58	46	45
World total [4]	[r] 6,977	[r] 29,838	7,170	28,343

[e] Estimated. [r] Revised.
[1] Exports.
[2] Probable origin, Republic of the Congo.
[3] Includes some alluvial from De Beers Properties.
[4] Does not include minor world production.

were found by native Africans, using hand methods.[4]

Bechuanaland.—Kimberlite Searches Ltd., a De Beers Consolidated Mines Ltd. subsidiary has found indications of diamond in northern Bamangwato Tribal Territory, west of Francestown.[5]

Belgium.—About 4.93 million carats of rough cuttable diamond was imported during 1964, an increase of about 11 percent over 1963 imports. Polished diamond imports reached 304,000 carats, an increase of 2 percent over 1963 imports. During the first 9 month of 1965 about 3.72 million carats of cuttable and 241,000 carats of polished diamond had been imported.

Exports of cuttable and polished diamond reached 1.02 million and 1.33 million carats, respectively, in 1964. During the first 9 months of 1965, 762,000 carats of cuttable and 1.04 million carats of polished diamond were exported. The major portion of polished diamond went to the United States, the United Kingdom, and Hong Kong.[6]

Chile.—The only producer, Compañia Minera Caren, mined about 36,400 pounds of lapis lazuli during 1964. The company has arranged to sell about 22,000 pounds of material to a New York importing firm. Deliveries are expected to extend into 1966. About 12,000 pounds of lapis lazuli, valued at $15,492, was exported to West Germany, Hong Kong, Italy, and the United States.[7]

Dahomey.—The Government issued the first license for diamond pospecting to De Beers Consolidated Mines Ltd., London. Plans include prospecting in the Dassa-Zoumé foothills and the area to the north.[8]

Indonesia.—A Netherland firm will assist the Indonesian Government in developing the Kalimantan diamond fields. Reports indicated that these deposits contain primarily gem quality diamond.[9]

[4] Bureau of Mines. Mineral Trade Notes. V. 62, No. 1, January 1966, pp. 8–9.
[5] Mining Journal (London). V. 264, No. 6763, Apr. 2, 1965, p. 251.
[6] Bureau of Mines. Mineral Trade Notes. V. 62, No. 3, March 1966, pp. 8–9.
[7] Bureau of Mines. Mineral Trade Notes. V. 61, No. 4, October 1965, p. 29.
[8] Bureau of Mines. Mineral Trade Notes. V. 62, No. 2, February 1966, p. 9.
[9] Bureau of Mines. Mineral Trade Notes. V. 61, No. 3, September 1965, p. 24.

Israel.—Imports of raw diamond material reached about \$96.7 million in 1965. Exports of polished diamond were valued at \$131.76 million.[10]

Sierra Leone.—The Parliament approved the agreement between the Sierra Leone Government and the New York firm of Leon Tempelsman & Son to establish a diamond cutting and polishing industry. The firm will have a 10-year monopoly of diamond cutting and polishing in the country. Complete details of this agreement have been published.[11]

South Africa, Republic of.—Late in 1964, the Commissioner of Patents awarded four patents to the General Electric Co. relating to the manufacture of synthetic diamond. The Transvaal and Orange Free State Chamber of Mines has requested permission to appeal the patent award.[12]

South-West Africa.—In May 1965, De Beers Consolidated Mines Ltd. announced through its subsidiary, Consolidated Diamond Mines of South-West Africa Ltd. (CDM), that a 29-percent interest in the Marine Diamond Corp. Ltd. (MDC), had been acquired. MDC recovered diamond from shallow water concessions of the South-West African coast. In addition, CDM transferred its coastal strip concession between high and low water mark to MDC.[13]

In October, Orama Holding Ltd. was formed by CDM and other MDC stockholders. Ownership of 58 percent of CDM's stock gave Orama controlling interest.

The exploration vessel "Rockeater" was purchased by De Beers to continue evaluation of offshore mineral concessions. This vessel was previously used to evaluate MDC offshore concessions for De Beers.

During 1964, MDC recovered 286,651 carats of diamond. During 1965 production of almost 219,000 carats of diamond was lower because of bad weather and accidents.[14]

TECHNOLOGY

A method was developed to grow single alumina crystals by vapor-deposition. For constant gas compositions and flow rates, the growth rate varied directly with temperature. Crystal growth rate varied up to 90 milligram per square centimeter per hour. Analysis showed impurities to be less than 30 parts per million. Substrate temperature, total pressure, and reactant gas partial pressures controlled crystal structure.[15]

A new theory has been published about the origin of the diamonds found in the glacial drift in Ohio, Indiana, Michigan, and Wisconsin. The theory proposes that the diamonds had been carried south from an ancient meteorite crater located in an area in southeastern Hudson Bay. When the meteorite impacted, the deep mantle rock breccia, containing diamonds, was brought to the surface in a central uplift as found in lunar craters. After the crater formed, it was filled with sediments which lithified. It is conjectured that these rocks slid by gravity from the crater center as it was uplifted, reexposing the diamond-bearing rocks.[16]

Volume compression measurements were made on sapphire, rutile, and spinel to a maximum pressure of 10,000 atmospheres. The data were reported as the constants of an empirical equation.[17]

Methods were developed to produce gem-quality synthetic emerald. Material was grown by hydrothermal techniques in a high-pressure bomb on seed plates cut parallel to a pyramid face. The techniques used were similar to those used for quartz crystal synthesis.[18] Gem material was crystallized in 2 minutes from beryl powder at pressures in excess of 10,000 atmospheres. Color was controlled by the quan-

[10] Mining Journal (London). V. 266, No. 6805, Jan. 21, 1966, p. 51.

[11] Bureau of Mines. Mineral Trade Notes. V. 61, No. 1, July 1965, p. 13.

[12] Bureau of Mines. Mineral Trade Notes. V. 61, No. 6, December 1965, p. 12.

[13] Bureau of Mines. Mineral Trade Notes. V. 61, No. 2, August 1965, pp. 24–26.

[14] Bureau of Mines. Mineral Trade Notes. V. 62, No. 2, February 1966, pp. 9–12.

[15] Schaffer, Philip S. Vapor-Phase Growth of Alpha Alumina Single Crystals. J. Am. Ceram. Soc., v. 48, No. 10, October 1965, pp. 508–511.

[16] Schwarcz, H. P. The Origin of Diamonds in Drift of the North Central United States—Geological Notes. J. of Geol., v. 73, No. 4, July 1965, pp. 657–663.

[17] Weir, C. E. Compressibility of Eleven Inorganic Materials. NBS J. of Res., v. 69A (Phys. and Crem.), No. 1, January–February 1965, pp. 29–31.

[18] Pough, Frederick H. The New Linde Synthetic Emerald. Jewelers' Circular-Keystone, v. 135, No. 12, August 1965, pp. 126–142.

tity of metallic oxides in the beryl powder.[19]

Ruby crystals have been grown experimentally from solution in molten lead fluoride. The solvent was chosen from a group having preferred properties. Crystals were grown under three sets of experimental conditions in a sealed platinum crucible that was in a high-temperature furnace. The results of the experiments were discussed.[20]

Structure was determined by studying etch patterns on polished diamond surfaces. The surfaces were etched at an elevated temperature with potassium nitrate. Several etch patterns were obtained. Rectilinear structures corresponded to a layered growth. Curved lines indicated growth interference. Additional conclusion concerning growth were derived based on observed patterns.[21]

Various microstructure patterns have been observed concurrently on the surfaces of diamonds obtained from the Panna mines in India. Observations indicate that these diamonds may have been subjected to solution in nature.[22]

A more efficient method to make girdles on precious and semiprecious gem stones has been described. Two rough stones are arranged to work the edges of each other's table while their axes of rotation are at right angles. While working against each other, round girdles are formed on both stones simultaneously.[23]

A method was reported to convert a used garbage disposal unit in an efficient lapping and grinding unit.[24]

Waste has been reduced in cutting cabachons from semiprecious material. A slab of material is faced with gem-defining patches. These patches are sawed off with straight line cuts. The edges are ground off to the patch. The patch is removed, and the cabachon is completed.[25]

A method was developed to produce large synthetic diamond crystals from a diamond seed. The method can be used to grow diamond in a batch or a continuous process at comparatively low temperature and pressure.[26]

A device has been designed to finish and to polish semiprecious gem stones quickly by applying a high-frequency vibration to a plastic-lined container, mixing and tumbling the charge of gem stone and abrasive completely.[27]

A method to synthesize diamond particles by using an electric discharge across a spark gap has been developed. One or both of the electrodes contain elemental carbon and are immersed in a dielectric liquid. Repeated discharges provide an elevated pressure and temperature that converts particles of carbon to diamond.[28]

An apparatus has been built to inspect a mounted or unmounted gem stone. A magnified image is projected which makes any flaw easily visible.[29]

A method was developed to join two brilliant-cut natural diamonds to form a large composite doublet stone in a marquise form.[30]

[19] Hickman, Bill. Synthetic Emerald Process May Aid Laser, Maser R&D. Electronic News, v. 10, No. 484, Apr. 12, 1965, p. 44.

[20] White, E. A. D., and J. W. Brightwell. The Growth of Ruby Crystals From Solution in Molten Lead Fluoride. (Paper pres. at the Symp. on Inorganic Single Crystals in London, Apr. 12–13, 1965). Chem. and Ind. (London), No. 39, Sept. 25, 1965, pp. 1662–1668.

[21] Seal, Michael. Structure in Diamonds as Revealed by Etching. Am. Mineralog., v. 50, No. 1 and No. 2, January–February 1965, pp. 105–123.

[22] Patel, A. R., and M. K. Agarwal. Microstructures on Panna Diamond Surfaces. Am. Mineralog., v. 50, No. 1 and No. 2, January–February 1965, pp. 124–131.

[23] Roos, S. (assigned to Nederlandse Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek ten behoewe van Nijerheid Handel en Verkeer, The Hague, Netherlands). Method for Making Girdles. U.S. Pat. 3,202,147, Aug. 24, 1965.

[24] Redmond, Gordon. At Your Disposal. Gems and Minerals, September 1965, pp. 16–18.

[25] Drown, C. R. Method of Gem Cutting. U.S. Pat. 3,211,141, Oct. 12, 1965.

[26] Brinkman, J. A., C. J. Meecham, and H. M. Dieckamp (assigned to North American Aviation, Inc.). U.S. Pat. 3,175,885, Mar. 30, 1965.

[27] Smith, E. E. Apparatus for Agitating and Polishing Materials. U.S. Pat. 3,197,922, Aug. 3, 1965.

[28] Inoue, Kiyoshi. Method of Synthesizing Diamond Particles by Utilizing Electric Discharge. U.S. Pat. 3,207,582, Sept. 21, 1965.

[29] Robinson, D. A., L. M. Robinson, and J. Dods. Apparatus for Viewing Gems and Similar Objects. U.S. Pat. 3,225,647, Dec. 28, 1965. Australian Pat. 249,602, Feb. 13, 1964.

[30] Sirakian, C., and Fils. British Pat. 1,005,-060, Sept. 22, 1965.

Gem Stones

Table 1.—U.S. imports for consumption of precious and semiprecious stones, exclusive of industrial diamond

Stones	1965 Quantity (thousands)	1965 Value (thousands)	1956 Quantity (thousands)	1956 Value (thousands)
Diamond:				
Rough or uncut, suitable for cutting into gem stones ---carats--	1,901	$175,457	2,032	$208,039
Cut but unset, suitable for jewelry ----do -----	1,259	131,828	1,452	165,737
Emerald: Cut but unset ----do -----	190	5,397	220	6,025
Rubies and sapphires: cut but unset suitable for jewelry ----------	NA	4,769	NA	7,163
Marcasites: Real and imitation, dutiable ----------	NA	3	NA	5
Pearls and parts, not strung or set:				
Natural ----------	NA	592	NA	733
Cultured or cultivated ----------	NA	21,674	NA	21,236
Imitation ----------	NA	415	NA	506
Other precious or semiprecious stones:				
Rough or uncut ----------	NA	2,728	NA	2,483
Cut but unset ----------	NA	r 3,630	NA	4,972
Other n.s.p.f. ----------	NA	218	NA	326
Imitation:				
Cut but unset, synthetic ----number--	2,526	1,007	2,699	1,175
Other ----------	NA	r 6,131	NA	8,341
Total ----------	NA	r 353,849	NA	425,735

r Revised. NA Not available.

Table 2.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by countries

(Thousand carats and thousand dollars)

Country	1965				1966			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Belgium-Luxembourg								
Brazil	75	$7,697	680	$73,923	72	$9,620	787	$94,353
British West Africa	4	293	1	97	4	425	----	------
Canada	----	------	----	------	2	325	----	------
Central African Republic	7	1,138	(1)	44	10	1,663	(1)	16
France	144	8,365	----	------	187	9,835	----	------
Germany, West	2	70	16	1,665	3	211	18	1,902
Ghana	----	------	19	1,370	(1)	1	17	1,441
Guinea	3	146	(1)	16	20	464	----	------
Guyana	2	205	----	------	1	66	----	------
India	19	742	----	5	25	995	(1)	8
Ireland	----	------	2	342	----	------	8	720
Israel	4	71	(1)	3	56	2,248	2	101
Japan	57	3,310	473	42,134	36	3,096	525	51,446
Liberia	(1)	8	1	142	(1)	6	1	78
Netherlands	7	674	----	------	16	1,831	----	------
Sierra Leone	34	4,094	21	2,835	49	8,825	21	3,013
South Africa, Republic of	44	2,818	----	------	161	7,705	(1)	53
Switzerland	159	15,330	27	6,166	121	13,023	28	7,001
U.S.S.R.	104	9,879	1	633	69	8,504	1	422
United Kingdom	----	------	11	1,410	----	------	29	3,391
Venezuela	1,142	113,481	6	857	1,106	131,809	10	1,354
Western Africa, n.e.c.[2]	54	1,960	----	------	66	2,525	----	------
Western Portuguese	35	4,903	----	------	21	3,446	----	------
Africa, n.e.c.	2	124	----	------	7	1,445	----	------
Other countries	3	259	1	186	(1)	71	5	438
Total	1,901	175,457	1,259	131,828	2,032	208,039	1,452	165,737

[1] Less than ½ unit.
[2] Not elsewhere classified.

Table 3.—World production of gem diamond, by countries

(Thousand carats)

Country	1965	1966
Africa:		
Angola	878	964
Central African Republic	268	270
Congo (Brazzaville) [1 2 e]	318	318
Congo (Kinshasa)	14	15
Ghana	225	282
Guinea [e]	21	21
Ivory Coast	[r] 119	110
Liberia [e]	277	343
Sierra Leone	658	629
Republic of South Africa:		
Pipe mines:		
Premier	[r] 610	625
De Beers group [3]	[r] 985	1,429
Other	[r] 123	131
Alluvial	[r] 230	300
South-West Africa	[r] 1,491	1,583
Tanzania	414	473
Total Africa	[r] 6,631	7,493
Other countries:		
Brazil [e]	175	150
Guyana	45	37
India	4	2
U.S.S.R.[e]	300	300
Venezuela	46	42
World total [4]	7,201	8,024

[e] Estimated. [r] Revised.
[1] Exports.
[2] Probable origin, Congo (Kinshasa).
[3] Includes some alluvial from De Beers Properties.
[4] Does not include minor world production.

Gem Stones

By Benjamin Petkof [1]

Domestic gem stone production was estimated during 1967 at $2.4 million, unchanged from 1966. Gem stone collection continued to be essentially a recreational activity of individual collectors and hobbyists.

DOMESTIC PRODUCTION

Production estimates indicated that 38 States produced gem material in 1967. The leading producing States were Oregon, California, Idaho, Arizona, Texas, Wyoming, Colorado, Montana, and Nevada with each State producing material valued over $100,000. These States provided 77 percent of total production.

CONSUMPTION

Consumption of gem diamond, both rough and cut, reached $387 million, only a small increase from $374 million in 1966. Value of imported synthetic and imitation gem stones including imitation pearl reached $11.5 million, compared with $10.0 million in 1966; natural and cultured pearls declined 19 percent from 1966.

Apparent consumption of gem stones (domestic production plus imports minus exports and reexports) was $304 million, compared with $289 million in 1966.

PRICES

During the year, price ranges for cut and polished, unmounted gem diamond were 0.25 carat, $80 to $375; 0.50 carat, $200 to $800; 1 carat, $500 to $2,500; 2 carat, $1,800 to $7,000.

FOREIGN TRADE

Exports of precious and semiprecious gem stone were valued at $6.5 million, compared with $64.1 million in 1966. Diamond, over one-half carat in weight, cut but unset, made up the bulk of the exports.

Reexports of all varieties of gem stone reached $72.0 million, a decline of $3.2 million from those of 1966. The major portion of reexports consisted of rough or uncut gem quality diamond.

Ruby and sapphires valued at $5.7 million were imported from 27 countries. Thailand, India, and Ceylon supplied about 70 percent of the total.

Imports of emerald rose in quantity but declined in value. India supplied 38 percent of all imports.

India and Japan were the major sources of imported natural pearl. However, Japan remained the largest supplier of cultured pearls.

[1] Commodity specialist, Division of Mineral Studies.

Table 1.—U.S. imports for consumption of precious and semiprecious stones, exclusive of industrial diamond

(Thousand carats and thousand dollars)

Stones	1966		1967	
	Quantity	Value	Quantity	Value
Diamond:				
Rough or uncut, suitable for cutting into gem stones carats	2,032	$208,039	2,506	$212,902
Cut but unset, suitable for jewelry do	1,452	165,737	1,455	174,570
Emeralds: Cut but unset do	r 218	r 5,994	242	5,518
Rubies and sapphires: Cut but unset, suitable for jewelry	NA	7,163	NA	5,685
Marcasites: Real and imitation, dutiable	NA	5	NA	3
Pearls and parts, not strung or set:				
Natural	NA	733	NA	576
Cultured or cultivated	NA	21,236	NA	17,140
Imitation	NA	506	NA	374
Other precious or semiprecious stones:				
Rough or uncut	NA	2,483	NA	4,900
Cut but unset	NA	4,972	NA	6,539
Other n.s.p.f.	NA	320	NA	270
Imitation:				
Cut but unset, synthetic number	2,699	1,178	3,042	1,382
Other	NA	8,341	NA	9,786
Total	NA	r 426,707	NA	439,645

r Revised. NA Not available.

Table 2.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by countries

(Thousand carats and thousand dollars)

	1965				1966				1967			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	-	-	-	-	-	-	-	-	4	$241	-	-
Belgium-Luxembourg	76	$7,597	680	$78,923	72	$9,620	787	$94,353	47	6,111	775	$96,676
Brazil	4	293	1	97	4	425	-	-	21	1,009	2	169
British West Africa	-	-	-	-	2	825	-	-	2	380	-	-
Canada	7	1,138	([1])	44	10	1,663	([1])	16	5	847	([1])	64
Central African Republic	144	8,865	-	-	187	9,895	-	-	188	9,002	-	-
Cyprus	-	-	-	-	-	-	-	-	2	281	([1])	33
France	2	70	16	1,665	3	211	18	1,902	1	101	17	2,085
Germany, West	-	-	19	1,370	([1])	1	17	1,441	2	227	11	1,039
Ghana	3	146	([1])	16	20	464	-	-	5	68	-	-
Guinea	2	205	-	-	1	66	-	-	-	-	-	-
Guyana	19	742	-	5	25	995	([1])	8	31	1,370	-	-
India	-	-	2	342	-	-	8	720	-	-	14	1,239
Ireland	4	71	([1])	3	56	2,248	2	101	132	571	8	240
Israel	57	3,310	478	42,134	36	3,096	525	51,446	46	4,079	533	55,033
Japan	([1])	8	1	142	([1])	6	1	78	([1])	14	2	150
Liberia	7	674	-	-	16	1,831	-	-	26	3,946	-	-
Netherlands	34	4,094	21	2,835	49	8,825	21	3,013	39	8,566	14	2,065
Sierra Leone	44	2,818	-	-	161	7,705	([1])	53	180	5,921	3	307
South Africa, Republic of	159	16,330	27	6,166	121	13,023	28	7,001	333	39,852	32	7,766
Southern Africa, n.e.c	-	-	-	-	-	-	-	-	2	101	([1])	31
Switzerland	104	9,879	1	633	69	8,504	1	422	7	1,524	([1])	174
U.S.S.R	-	-	11	1,410	-	-	29	3,391	([1])	17	39	5,918
United Kingdom	1,142	113,481	6	857	1,106	131,809	10	1,354	1,339	122,000	10	1,395
Venezuela	54	1,950	-	-	66	2,525	-	-	64	2,347	-	-
Western Africa, n.e.c	35	4,903	-	-	21	3,446	-	-	35	4,260	([1])	6
Western Portuguese Africa, n.e.c	2	124	-	-	7	1,445	-	-	-	-	-	-
Other countries	3	259	1	186	([1])	71	5	438	([1])	67	([1])	180
Total	1,901	175,457	1,259	131,828	2,032	208,039	1,452	165,737	2,506	212,902	1,455	174,570

[1] Less than ½ unit.

WORLD REVIEW

Brazil.—The diamond mining industry has been undergoing a change from hand mining method to the application of large hydraulic dredges for large-scale recovery. A dredge has been placed in operation on the Jequitinhonha River by Meneraçao Tijucana S.A., Dragagem de Ouro S.A., and Pacific Tin Corporation which moves material at the rate of 400 cubic yards per hour in 12-cubic-foot buckets. Test drilling has shown that the diamond recovery rate averaged 0.01 carat per cubic yard of diamondiferous gravel. Eighty percent of the material recovered is of gem grade.

The Mining Department of the Federal Government began prospecting and evaluating the Tocantins River area for available diamond by the interpretation of aerial photographs and coring operations. This area has previously been worked by crude hand methods.[2]

Table 3.—World production of gem diamond, by countries [1]

(Thousand carats)

Country	1963	1964	1965	1966	1967 [p]
Africa:					
Angola	759	804	878	964	[e] 1,000
Central African Republic	121	221	268	270	260
Congo (Kinshasa)	296	295	14	15	263
Congo (Brazzaville) [e 2 3]	341	316	318	[r] 300	300
Ghana	[r] 4	[r] 378	[r] 25	282	254
Guinea [e]	[r] 22	21	21	21	20
Ivory Coast	63	120	119	110	105
Liberia [2]	240	298	277	343	353
Sierra Leone	555	585	658	629	[e] 600
South-West Africa, Territory of	1,076	1,387	1,491	1,583	[e] 1,700
Tanzania	276	338	414	[r] 474	494
South Africa, Republic of:					
Premier	522	556	610	625	NA
De Beers group [4]	921	928	985	1,429	NA
Other pipe mines	16	18	123	131	NA
Alluvial	338	288	230	300	NA
Total South Africa	[r] 1,797	1,790	1,948	2,485	[e] 2,100
Total Africa	[r] 5,550	[r] 6,553	[r] 6,431	[r] 7,476	7,449
Other areas:					
Brazil [e]	175	175	175	150	160
Guyana	60	60	45	37	38
India	1	2	[r] 3	2	6
Indonesia	NA	NA	1	2	2
U.S.S.R. [e]	[r] 600	[r] 800	[r] 1,000	[r] 1,200	1,400
Venezuela	[r] 38	[r] 57	[r] 52	42	38
World total [5]	[r] 6,424	[r] 7,647	[r] 7,707	[r] 8,909	9,093

[e] Estimate. [r] Revised. [p] Preliminary. NA Not available.
[1] Compiled mostly from data available April 1968.
[2] Exports.
[3] Probable origin, Republic of the Congo.
[4] Includes some alluvial from De Beers properties.
[5] Totals are of listed figures only; no undisclosed data included.

Canada.—A recent paper postulates that the source of the diamond previously found in the glacial deposits of Ohio and Wisconsin was kimberlite deposits in the James Bay area.[3]

Lesotho.—The Government and The Rio Tinto-Zinc Corp. Ltd. announced an agreement for diamond prospecting and eventually mining at the Lesotho State Diamond deposit at Letseng-la-Terai in northeastern Lesotho. The agreement provided for a 2- to 3-year prospecting period to determine if large-scale mining operations are justified.[4] A large pale-brown stone weighing 601 carats was recovered.

[2] Linder, P. H. Modern Dredges Successful in Recovering Brazilian Diamond. Lapidary J.; v. 21, No. 2, May 1967, pp. 298–305.
[3] Northern Miner (Toronto, Canada). Diamond-Type Rocks in James Bay Area No. 1, Mar. 30, 1967, p. 15.
[4] U.S. Embassy, Maseru, Lesotho. Department of State, Airgram A-83, Oct. 27, 1967, pp. 1–2.

Sierra Leone.—In terms of value diamond was the major mineral product of Sierra Leone.

Sierra Leone Selection Trust Ltd. (SLST) and the Government renegotiated the SLST leases, providing for an increase in the income and diamond profits tax paid by the company. SLST also agreed to release certain locations in Kono and Tongo for licensed alluvial mining, to allow licensed diggers to recover diamond from its mine tailings, to begin a program of rehabilitating mined-out areas, and to study prospecting potential for more diamond.[5]

South Africa, Republic of.—The Finsch diamond mine was formally opened on February 24, 1967. The ore reserves were estimated at 110 million tons down to the open pit mining limit of 900 feet; at a planned production rate of 17,000 loads (16 cubic feet per load) per day, minimum life would be 25 years. The recovery rate was 38 carats per 100 loads.[6] About 75 percent of the diamond recovered was industrial grade. The average overall recovery ratio is 1 to six million. The Finsch is the first new pipe mine since the Premier mine was opened in 1903.[7]

Tanzania.—Williamson Diamonds, Ltd. and two subsidiary companies, New Alamasi and Kahama Mines, Ltd., supplied most of the diamond production and exports. The Government has 50 percent interest in this group. The company mined 3,285,038 tons of ore which yielded 923,423 carats at the Mwadui mine. Ore production at the New Alamasi totaled 411,512 tons of ore which contained 23,176 carats. The ore body was mined out at the Kahama Mines Ltd., and treatment of the stockpile began. Completion is expected in 4 years. Williamson Diamond continued to look for diamond north of Kahama during 1967, but nothing of value was found.[8]

[5] Bureau of Mines. Mineral Trade Notes. v. 64, No. 6, June 1967, p. 5.
[6] U.S. Embassy, Johannesburg, Republic of South Africa. Department of State, Airgram A-351, Mar. 28, 1967, p. 1.
[7] World Mining. What's Going On in World Mining. v. 3, No. 4, April 1967, p. 41.
[8] Bureau of Mines. Mineral Trade Notes. v. 65, No. 1, January 1968, p. 7.

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Gem Stones

By Benjamin Petkof [1]

Estimates of domestic gem stone production indicate that output has increased slightly from $2.4 million in 1967 to $2.5 million in 1968. The United States has no formal gem stone mining industry and the collection of gem materials rests firmly in the hands of individual collectors and rock hobbyists as a recreational activity.

DOMESTIC PRODUCTION

Thirty-eight States produced gem material during 1968. The following States were the major producers and supplied material valued in excess of $100,000: Oregon, California, Idaho, Texas, Arizona, Wyoming, Colorado, and Montana. These States supplied 72 percent of total production.

CONSUMPTION

Consumption of both rough and cut gem diamond exceeded 4.3 million carats valued at $475 million, an increase of 10 percent in quantity and 23 percent in value over that of 1967. The value of imported synthetic and imitation gem stones including imitation pearl reached $12.4 million, an increase of 20 percent over that of the previous year; natural and cultured pearls declined 24 percent from 1967.

Apparent consumption of gem stones (domestic production plus imports minus exports and reexports) increased 45 percent from $304 million in 1967 to $441 million in 1968.

PRICES

During the year, price ranges for cut and polished, unmounted gem diamond were 0.25 carat, $75 to $400; 0.50 carat, $200 to $800; 1 carat, $650 to $2,500; 2 carats, $1,500 to $9,000; 3 carats, $3,000 to $18,000.

FOREIGN TRADE

Exports of precious and semiprecious gem stone increased over 50 percent to a value of $99.2 million. Diamond, over one-half carat in weight, cut but unset made up the bulk of the exports.

Imports of gem material increased 22 percent in value over those of 1967 with gem diamond accounting for 88 percent of the total.

Emerald imports almost doubled, with India and Colombia supplying almost 60 percent of the receipts.

Ruby and sapphire imports increased 61 percent and were received from 27 countries with Ceylon, Burma, and India furnishing 68 percent of the total.

Imports of natural and cultured pearl declined with India and Japan supplying the major portions of natural and cultured material, respectively.

[1] Physical scientist, Division of Mineral Studies.

Table 1.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1967		1968	
	Quantity	Value	Quantity	Value
Diamonds:				
Rough or uncut ... carats	2,506	$212,902	2,514	$252,653
Cut but unset ... do	1,455	174,570	1,834	222,478
Emeralds: Cut but unset ... do	242	5,518	365	10,644
Rubies and sapphires: Cut but unset	NA	5,685	NA	9,175
Marcasites	NA	3	NA	1
Pearls:				
Natural	NA	576	NA	525
Cultured	NA	17,140	NA	12,865
Imitation	NA	374	NA	403
Other precious and semiprecious stones:				
Rough and uncut	NA	4,900	NA	5,062
Cut but unset	NA	r 7,745	NA	11,038
Other, n.s.p.f.	NA	270	NA	374
Synthetic:				
Cut but unset ... number	3,042	1,382	5,085	2,404
Other	NA	104	NA	166
Imitation gem stones	NA	r 8,476	NA	9,405
Total	NA	439,645	NA	537,193

r Revised. NA Not available.

Table 2.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by countries

(Thousand carats and thousand dollars)

Country	1966				1967				1968			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Belgium-Luxembourg	72	$9,620	787	$94,853	47	$6,111	775	$96,676	46	$7,455	954	$119,396
Brazil	4	425	--------	--------	21	1,009	2	169	10	694	(1)	8
Canada	10	1,663	(1)	16	5	847	(1)	64	9	1,256	5	205
Central African Republic	187	9,835	--------	--------	183	9,002	--------	--------	218	11,818	1	61
France	3	211	18	1,902	1	101	17	2,085	22	1,004	22	2,514
Germany, West	(1)	1	17	1,441	2	227	11	1,039	(1)	2	5	556
Ghana	20	464	--------	--------	5	68	--------	--------	--------	--------	(1)	46
Guyana	25	995	(1)	8	31	1,370	--------	--------	14	880	(1)	5
India	--------	--------	8	720	--------	--------	14	1,239	--------	--------	30	2,714
Ireland	56	2,248	2	101	132	571	3	240	--------	--------	3	305
Israel	36	3,096	525	51,446	46	4,079	583	55,038	50	5,245	666	70,217
Japan	(1)	6	1	78	(1)	14	2	150	(1)	52	1	100
Liberia	16	1,331	--------	--------	26	8,946	--------	--------	7	1,398	--------	--------
Netherlands	49	8,825	21	3,013	39	8,566	14	2,065	46	9,953	19	3,073
Sierra Leone	161	7,705	(1)	53	180	5,921	3	307	61	1,892	9	1,310
South Africa, Republic of	121	13,028	28	7,001	383	39,852	82	7,766	434	46,380	85	9,076
Switzerland	69	8,504	1	422	7	1,524	(1)	174	20	2,089	4	785
U.S.S.R.	--------	--------	29	8,391	(1)	17	39	5,918	--------	--------	68	9,588
United Kingdom	1,106	131,809	10	1,854	1,339	122,000	10	1,895	1,439	152,881	17	2,239
Venezuela	66	2,525	--------	--------	64	2,347	--------	--------	95	3,468	--------	--------
Western Africa, n.e.c.	21	3,446	--------	--------	85	4,260	(1)	6	36	5,614	(1)	5
Other countries	10	1,907	5	438	10	1,070	(1)	244	7	272	(1)	275
Total	2,082	208,089	1,462	165,737	2,506	212,902	1,465	174,570	2,514	252,653	1,834	222,478

[1] Less than ½ unit.

WORLD REVIEW

Canada.—Kimberlite dikes were discovered underground at the Upper Canada Mines, Limited, by the Geological Survey of Canada. Upper Canada and neighboring Queenston Gold Mines Limited, entered into an exploration agreement with Canadian Rock Company Limited, a wholly owned subsidiary of De Beers Consolidated Mines Ltd. of South Africa. During the latter part of the year an announcement was made that work progress had not been encouraging.

The Kimberlite Mining Corporation Limited began a drilling and geophysical program in the Coral Rapids area of northern Ontario. Reportedly a 250-foot width of kimberlite material was found during drilling.[2]

Ceylon.—Export duties on precious and semiprecious stones were abolished effective November 16, 1968. The abolition of duties was expected to provide incentive for gem exporters to accept foreign exchange controls.[3]

Colombia.—The Government has established a group called the Empresa Colombiana de Esmeraldas to develop and administer deposits of emeralds and other precious stones in the national reserve region of Colombia. The directorate of this organization will consist of the Minister of Mines and four other members appointed by the Government. The issuance of permits to others for the purposes of exploration and development of emerald deposits has been suspended.[4]

[2] Canadian Mining Journal. Diamonds. V. 90, No. 2, February 1969, p. 124.
[3] U.S. Embassy, Ceylon. State Department Airgram A-544, Nov. 27, 1968, p. 1.
[4] Mining Journal (London). Columbia Emerald Exploitation. V. 271, No. 6942, Sept. 6, 1968, p. 168.

Table 3.—World production of gem diamond, by countries

(Thousand carats)

Country	1964	1965	1966	1967	1968 [p]
Africa:					
Angola	[r] 874	[r] 887	[r] 968	983	1,316
Central African Republic	221	268	270	[e] 260	[e] 305
Congo (Kinshasa)	295	14	[r] 12	1	551
Congo (Brazzaville) [e 1 2]	316	318	300	NA	NA
Ghana	378	25	282	254	[e] 245
Guinea [e]	21	21	21	NA	NA
Ivory Coast	120	119	110	[e] 105	[e] 110
Liberia [1]	298	277	343	362	537
Sierra Leone	585	658	629	560	[e] 560
South-West Africa	1,387	1,491	1,583	[r 3] 1,531	[3] 1,552
Tanzania	338	[e] 414	[e] 474	864	356
South Africa, Republic of: [e]					
Premier	556	610	625	594	608
De Beers Group [4]	928	985	1,429	2,128	2,307
Other pipe mines	18	123	131	334	484
Alluvial	288	230	300		
Total, South Africa, Republic of	1,790	1,948	2,485	[r] 3,056	3,399
Total Africa	[r] 6,623	[r] 6,440	[r] 7,477	[r] 7,976	8,931
Other Areas:					
Brazil [e]	175	175	150	160	160
Guyana	60	45	37	41	23
India	2	[r] 4	2	5	7
Indonesia	14	[r] 14	[r] 14	14	14
U.S.S.R. [e]	800	1,000	1,200	1,400	1,400
Venezuela	57	52	42	38	60
Total [5]	[r] 7,731	[r] 7,730	[r] 8,922	[r] 9,634	10,600

[e] Estimate. [p] Preliminary. [r] Revised. NA Not available.
[1] Exports, fiscal year ending August 31.
[2] Probable origin Congo (Kinshasa).
[3] Output of Consolidated Diamond Mines of South-West Africa Ltd.
[4] Includes some alluvial from De Beers properties.
[5] Totals are of listed figures only.

Guyana.—The diamond production potential was discussed and reviewed in a recent paper. Production was primarily industrial with a small quantity of gem grade and was from alleuvial deposits.[5]

India.—The Geological Survey of India has begun work to determine the feasibility of commercially extracting diamond from the pipe rock, conglomerates, and river gravels in Andhra Pradesh.[6]

Sierra Leone.—In November 1968, a mining agreement was reached between the Diamond Corporation West Africa Ltd. and the Sierra Leone Government wherein the corporation would be the sole marketer and exporter of diamond produced under the Alleuvial Diamond Mining Scheme. The terms of the agreement require that the corporation pay an annual fee to the Government for these rights and forego the service fee paid for its operation of the Government Diamond Office. The agreement became effective at the beginning of 1969.[7]

Thailand.—Imports and exports of precious and semiprecious stones for 1967 were published.[8]

TECHNOLOGY

Several papers were published concerning the development of kimberlite deposits. These papers presented theories and supporting data on the occurrence of diamond and other materials in kimberlite.[9]

The refractive index of type I diamond has been shown to vary indirectly with pressure. A direct measurement technique, with the application of hydrostatic pressure, was used to make direct measurements to a pressure of 7 kilobars.[10]

[5] Norwood, V. G. C. Guyana—an Expanding Source of Industrial Diamonds. Min. Mag., v. 118, No. 3, March 1968, pp. 169–171.

[6] Journal of Mines, Metals & Fuels. Exploration for Diamonds in Andhra Pradesh. V. 14, No. 8, August 1968, p. 286.

[7] Bureau of Mines. Mineral Trade Notes. Diamond (Sierra Leone). V. 66, No. 3, March 1969, p. 7.

[8] Bureau of Mines. Mineral Trade Notes. Gem stones. V. 65, No. 12, December 1968, pp. 18–19.

[9] Crockett, Richard N., and Robert Mason. Foci of Mantle Disturbance in Southern Africa and Their Economic Significance. Econ. Geol., v. 63, No. 5, August 1968, p. 532–540.

Dawson, J. B. Recent Researches on Kimberlite and Diamond Geology. Econ. Geol., v. 63, No. 5, August 1968, p. 504–511.

Kennedy, George C., and Bert E. Nordlie. The Genesis of Diamond Deposits (Abstract). Econ. Geol., v. 63, No. 5, August 1968, p. 495–503.

[10] Schmidt, E. D. D., J. L. Kirk, and K. Vedam. Variation of the Refractive Index of Diamond With Hydrostatic Pressure to 7 Kilobars. Am. Miner., v. 53, Nos. 7–8, July–August 1968, pp. 1,404–1,406.

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Gem Stones

By Jerry J. Gray [1]

Estimated gem stone production of $2.4 million was 4 percent less than the previous year because output dropped at the Star garnet deposit, Clarkia, Idaho. The decrease would have been larger except for initiation of production from a new commercial jade mine in Washington and increased visitor days at a precious opal fee site in Idaho. Domestic gem stone production continued to be principally the result of recreational mining by private individuals at free or fee sites. Only a few deposits were operated to produce rough material for direct sale to wholesale or retail outlets. The semiprecious gem industry of Oregon was reviewed with reasons given why it developed into a significant activity for the State. [2]

DOMESTIC PRODUCTION

Gem stone production was reported from 38 States. The following States supplied 78 percent of the total: Oregon, $750,000; California, $200,000; Arizona, $153,000; Texas, $150,000; Washington, $150,000; Wyoming, $129,000; Colorado, $122,000; Montana, $109,000; and Nevada, $100,000.

Activities involving all of the precious gem stones (except ruby) were reported. The Murfreesboro, Ark., diamond pipe, 60 years after its discovery, was consolidated under one owner, General Earth Minerals. The Dallas, Tex., firm opened the whole pipe to fee digging; formerly, only a small portion was available to the public. [3] Both the largest emerald crystal (3-1/16 inches by 2½ inches, 1,438 carats) and the longest (6 inches by ½ inch) ever found in North America were collected at the newly opened Rist mine. This fee site and the older Ellis mine fee site are located near Hiddenite, N.C., and were operated by American Gem, Inc. [4] Two Montana sapphire deposits were described. One, a placer deposit, was open to the public for a straight fee,[5] and the other, a dike, 5 miles long with an average width of 8 feet, was to be worked partially commercial and partially by individuals who gained digging rights by buying a lot in a vacation real estate development situated near the dike. [6] The precious opal deposit near Spencer, Idaho, had its first full season as a fee site. The mine had been operated as a commercial mine until late in the 1968 season. [7]

Concerning semiprecious gem stones, jade was in danger of being in oversupply. Two new jade provinces were supplying the market, one in Washington [8] and the other in Alaska, [9] along with continued production from two mines in

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[1] Geologist, Albany Mineral Supply Field Office, Bureau of Mines, Albany, Oreg.

[2] Shaffer, Leslie L. D., and Steve T. Hashimoto. The Semiprecious Gem Industry of Oregon. Oreg. Bus. Rev., v. 28, No. 7, July 1969, pp. 1–4.

[3] Leiper, Hugh. Crater of Diamonds is Reopened to the Public. Lapidary J. v. 23, No. 7, October 1969 pp. 970–974.

[4] Trapp, Francis W. Green Bolts are Found Again Near Hiddenite, N.C. Lapidary J. v. 24, No. 1, April 1970, pp. 116–126.

[5] Williams, Marjorie. Sapphires on the Eldorado Bar. Gems and Minerals, No. 383, August 1969, pp. 28–31.

[6] Leiper, Hugh. "Five Miles of Sapphires" Famous Yogo Montana Sapphire Mine to be Reopened. Lapidary J., v. 22, No. 10, January 1969, pp. 1278–1286.

[7] Cuthbert, Donna L. Precious Opal, Queen of Gems, in Idaho. Lapidary J. v. 23, No. 7, October 1969, pp. 928–930.

[8] McLeod, D. L. Nephrite Jade Has Been Discovered in Washington. Lapidary J. v. 22, No. 8, November 1968, pp. 1034–1037.

[9] Munz, William. Hundreds of Tons of Nephrite Jade. Lapidary J. v. 24, No. 1, April 1970, pp. 18–26.

California[10] and a small output from Wyoming.[11] Jade imported from a new mine in British Columbia added to the oversupply.[12] Demand for jade probably did not keep pace with supply because demand had been a function of population growth and affluence, which did not exhibit a sudden growth surge.

Output of star garnet, from Clarkia, Idaho, dropped sharply after the U.S. Forest Service stopped the free collecting on several square miles of its acquired lands. Collecting was restricted to a 40-acre fee site concession.[13]

CONSUMPTION

The domestic gem stone output generally went to rock, mineral, and gem stone collections, objects of art, and jewelry. Apparent consumption of gem stones (domestic production plus imports minus exports and reexports) declined to $343 million, compared with $355 million revised in 1968, because of greater exports.

Total consumption was measured primarily by reported import-export data. The reported values contain mainly high-value-per-unit-weight rough and cut stones. The cut stones inflate the total consumption value figure by that amount added by foreign cutting and polishing. Gem diamond consumption, both rough and cut, continuing an upward trend, reached $505 million, a 6-percent increase over that of 1968 and 163 percent over the $192 million of 1962. Value of synthetic and imitation gem stones including imitation pearl was $12.7 million, an increase of 2 percent over that of 1968; value of natural and cultured pearls declined to $12.7 million, a 5-percent decline from that of 1968 and a 43-percent decline from that of 1965.

If gem stone consumption were viewed from the standpoint of quantity instead of value, it would change from 1 ton of imported diamonds to hundreds of tons of domestically produced semiprecious materials. Consumption, in terms of quantity, equates to domestic production of semiprecious materials; however, there is no good estimate available for domestic quantitative output.

PRICES

During the year, price ranges for cut and polished, unmounted gem diamond were 0.25 carat, $100 to $400; 0.50 carat, $250 to $800; 1 carat, $650 to $2,750; 2 carats, $1,500 to $9,000; and 3 carats, $3,900 to $17,000. The medium price for each range was 0.25 carat, $200; 0.5 carat, $500; 1 carat, $1,600; 2 carats, $4,250; and 3 carats, $8,000.

FOREIGN TRADE

Precious and semiprecious gem stone exports were valued at $128.0 million, compared with $99.2 million in 1968. Diamond, over one-half carat in weight, cut but unset, made up the bulk of the exports. Reexport of all varieties of gem stones was valued at $97.6 million, compared with $85.6 million the previous year. Rough or uncut gem-quality diamond formed the major portion of reexports.

Imports of gem material increased 5 percent in value over those of 1968; gem diamond supplied from 26 countries accounted for 89 percent of the total.

The total value of emeralds imported was 14 percent less than the previous year. Although originating from 33 countries, Brazil, Colombia, and India supplied 86 percent of the total carats and 68 percent

[10] Davis, Fenelon F. Some Highlights of 1969, California Mining Review. Mineral Information Service, v. 23, No. 4, April 1970, p. 75.

Draper, James W. Botryoidal Jade of the California Coast. Lapidary J. v. 23, No. 5, August 1969, pp. 684–686.

Hemrich, Gerald I. Botryoidal Jade in California. Lapidary J. No. 386, November 1969, pp. 42–47.

[11] Gregory, Gardiner E. Jade Hunting at Jeffrey City, Wyoming. Lapidary J. v. 22, No. 11, February 1969, pp. 1476–1481.

[12] Cavenaile, Rene. Surrey, B.C., Housewife-Prospector Finds British Columbia "Mountain of Jade." Lapidary J. v. 22, No. 12, March 1969, p. 1562.

[13] Gems and Minerals. National Forest Service Announces New Arrangements for Garnet Collecting at Emerald Creek, Idaho. No. 382, July 1969, pp. 11–12.

of the total value. Imports of rubies and sapphires remained at about the same level with Thailand, India, and Ceylon supplying 69 percent of the total value. The value of imported pearls decreased 5 percent from that of 1968 and 40 percent from that of 1965. India was the major source of natural pearl, 69 percent; Japan the major source of cultured pearls, 92 percent.

Table 1.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1968		1969	
	Quantity	Value	Quantity	Value
Diamonds:				
Rough or uncut......carats..	2,514	$252,653	2,932	$287,566
Cut but unset......do....	1,834	222,478	1,758	217,081
Emeralds: Cut but unset......do....	365	10,644	309	9,175
Rubies and sapphires: Cut but unset......	NA	9,175	NA	9,201
Marcasites......	NA	1	NA	6
Pearls:				
Natural......	NA	525	NA	475
Cultured......	NA	12,865	NA	12,238
Imitation......	NA	403	NA	672
Other precious and semiprecious stones:				
Rough and uncut......	NA	5,062	NA	4,847
Cut but unset......	NA	11,038	NA	12,799
Other, n.s.p.f......	NA	374	NA	559
Synthetic:				
Cut but unset......number..	5,085	2,404	4,886	2,793
Other......	NA	166	NA	282
Imitation gem stones......	NA	9,405	NA	8,999
Total......	NA	537,193	NA	566,693

NA Not available.

Table 2.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by countries

(Thousand carats and thousand dollars)

Country	1967				1968				1969			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Belgium-Luxembourg	47	$6,111	775	$96,676	46	$7,455	964	$119,396	59	$6,729	916	$113,114
Brazil	21	1,009	2	169	10	594	(1)	8	29	1,033	1	58
Canada	5	847	(1)	64	9	1,256	5	205	8	1,307	(1)	54
Central African Republic	183	9,002	---	---	218	11,818	1	61	232	9,806	---	---
France	1	101	17	2,085	22	1,004	22	2,514	10	379	20	2,484
Germany, West	2	227	11	1,039	(1)	2	5	666	1	13	5	507
Ghana	5	68	---	---	---	---	(1)	46	(1)	9	---	---
Guyana	31	1,370	---	---	14	830	(1)	5	20	1,020	---	---
India	---	---	14	1,239	---	---	30	2,714	---	---	30	2,663
Ireland	132	571	3	240	---	---	3	305	---	---	2	220
Israel	46	4,079	533	55,033	50	5,245	666	70,217	36	4,155	658	73,777
Japan	(1)	14	2	150	(1)	52	1	100	(1)	6	1	71
Liberia	26	3,946	---	---	7	1,898	---	---	13	2,976	---	---
Netherlands	39	8,566	14	2,065	46	9,953	19	3,073	48	12,810	27	3,561
Sierra Leone	180	5,921	3	307	61	1,892	9	1,310	224	8,331	10	1,447
South Africa, Republic of	333	39,852	32	7,766	434	46,380	35	9,076	361	41,585	28	8,713
Switzerland	7	1,524	(1)	174	20	2,039	4	785	6	1,043	3	919
U.S.S.R.	(1)	17	39	5,918	---	---	63	9,588	---	---	43	6,629
United Kingdom	1,339	122,000	10	1,395	1,439	152,881	17	2,239	1,697	185,278	9	1,496
Venezuela	64	2,347	---	---	95	3,468	---	---	167	5,439	---	---
Western Africa, n.e.c.	35	4,260	(1)	6	36	5,614	(1)	5	27	5,210	---	---
Other countries	10	1,070	(1)	244	7	272	(1)	276	4	438	5	1,368
Total	2,506	212,902	1,455	174,570	2,514	252,653	1,834	222,478	2,982	287,566	1,758	217,081

[1] Less than ½ unit.

WORLD REVIEW

Table 3.—World production of gem diamond, by countries

(Thousand carats)

Country	1967	1968	1969 [p]
Africa: [1]			
Angola	983	1,316	[e] 1,536
Central African Republic	[e] 260	[e] 305	[e] 330
Congo, (Kinshasa)	[r] 263	551	491
Ghana	254	[e] 245	[e] 238
Ivory Coast	[e] 105	[e] 110	[e] 121
Liberia [2]	[r] 262	537	[e] 550
Sierra Leone [e]	560	560	600
South-West Africa [e] [3]	1,531	1,636	1,700
Tanzania	[r] 433	356	[e] 380
South Africa, Republic of: [e]			
Premier	594	580	NA
De Beers Group [4]	2,128	2,170	NA
Other	334	446	NA
Total, South Africa, Republic of	3,056	3,196	3,380
Total Africa	[r] 7,707	8,812	9,326
Other areas:			
Brazil [e]	160	160	160
Guyana [e]	41	28	31
India	5	7	[r] 7
Indonesia [e]	14	14	14
U.S.S.R. [e]	1,400	1,400	1,500
Venezuela	38	60	118
Total [5]	[r] 9,365	10,481	11,156

[e] Estimate. [p] Preliminary. [r] Revised. NA Not available.
[1] Gem diamond is also produced in Guinea but data are not available.
[2] Exports, fiscal year ending August 31.
[3] Output of Consolidated Diamond Mines of South-West Africa Ltd.
[4] Includes some alluvial from De Beers properties.
[5] Totals are of listed figures only.

Angola.—Exports of gem and industrial diamonds, totaling 2 million carats valued at $70 million, continued to provide a major portion of the country's total export value. Only one company, Companhia de Diamantes Angola (DIAMANG), mined for diamond; however, two new companies were granted concessions for the exploration and exploitation of diamond and other precious stones.[14]

Australia.—A 220-ounce opal found at Andamooka sold for a world record price of $188,000.[15]

Botswana.—De Beers Consolidated Mines Ltd. established that one of the diamondiferous kimberlite pipes discovered during 1968 at Orapa, in the central part of the country, could become a major source of diamonds. Initial ore production of 8,000 tons per day is scheduled for 1971 with a doubling of production by 1974–75. Output to date indicated a ratio of 70 percent industrial stones to 30 percent gem-quality stones. The National Assembly of Botswana passed the "Precious Stone Industry (Protection) Act, 1969" to regulate and control the new industry. A mineral resource and mining activities review of the Republic was published.[16]

Burma.—The Burmese Government held its fifth annual Gem, Jade, and Pearl Emporium March 5–13, 1969, and sold $2.4 million worth of material. Cultured pearls accounted for 44 percent of total sales. All gem stone prospecting, mining, and marketing was nationalized March 12, and all private gem-mining operations and equipment were appropriated without promise of compensation. The justification for the action was that it would provide greater benefits to the gem workers and to the people of Burma generally, and that it

[14] Bureau of Mines. Mineral Trade Notes. Diamond. V. 66, No. 8, August 1969, pp. 8–10.
———. Gem Stones. V. 66, No. 12, December 1969, pp. 13–14.
[15] The Mining Journal. The Industry in Action: World Record-Priced Opal. V. 273, No. 7008, Dec. 12, 1969, p. 541.
[16] Boocock, C. Review of Mineral Resources and Mining Activities in the Republic of Botswana. Geological Survey—Botswana, Jan. 15, 1969, 12 pp.

would curb smuggling. The claim was made that the gem trade had enriched only a few individuals, largely persons of foreign origin, and had brought only poor revenue to the Government.[17]

Canada.—A new type opal gem stone with prismatic reflective colors was discovered in the Province of Alberta. The stone, suitable for doublets, was the opalized conchiolin of the fossil ammonite.[18] Two lode deposits of jade were reported to have been discovered in British Columbia.[19]

Colombia.—An emerald weighing 7,025 carats (almost 3 pounds) was reported to have been found at the Las Cruces mine in Cundinamarca. It was the largest ever found in Colombia.[20]

Southern Rhodesia.—A portion of an emerald crystal weighing 1,160 carats was found at the Chikwanda mine near Fort Victoria. The area may have possibilities as a new emerald source.[21]

Tanzania.—Tanzania exported 780,210 carats of diamond (gem and industrial combined) valued at $24.9 million and 514 kilograms of other gem stones valued at $200,000. Gem-corundum, ruby, and sapphire exports totaled 296 kilograms valued at $140,000. A new source of ruby and sapphire was reported to have been located and was being mined.[22]

Exports of gem zoisite totaled 20 kilograms valued at $30,000. During 1967, a deposit of gem-quality violet-blue zoisite crystals (given the varietal name tanzanite) was discovered. The crystals, because of a striking red, blue, yellow-green pleochroism, quickly gained popularity in the gem market. A 122.7 carat faceted tanzanite was placed on display by the Smithsonian Institute,[23] and several reports were published describing the gem mineral and its location.[24]

TECHNOLOGY

A colorless synthetic yttrium-aluminum garnet developed for use in microwave, laser, and ultrasonic devices was marketed as a diamond substitute. Faceted stones were sold for $50 per carat under the trade name "Diamonair".[25] A general review of diamond mining and recovery was published.[26] A study of diamonds recovered from the Witwatersrand gold mines suggested that the stones were subject to charged-particle radiation and subsequent annealing.[27] Single crystal sapphire filaments were grown to lengths of 100 feet with tensile strength of 300,000 pounds per square inch and a modulus of elasticity 65 to 75 million pounds per square inch.[28] A molten salt solution method of growing gem-grade rubies was discussed. Controlled defects can be introduced similar to those found in natural stones.[29]

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[17] Bureau of Mines. Mineral Trade Notes. Gem Stones. V. 66, No. 6. August 1969, pp. 13–14.
[18] Leiper, Hugh. A New Fossil Gem is Found in Alberta, Canada. Lapidary J. v. 23, No. 7, October 1969, pp. 932–937.
[19] The Northern Miner. B.C. Companies Join in Consortium To Exploit Mountainside Jade Find. Sept. 25, 1969, p. 20.
Western Mining News. Second Jade Discovery. Mar. 6, 1970, p. 4.
[20] Bureau of Mines. Mineral Trade Notes. Gem Stones. V. 66, No. 7, July 1969, p. 15.
[21] Bureau of Mines. Mineral Trade Notes. Gem Stones. V. 67, No. 4, April 1970, p. 12.
[22] Lapidary Journal. New Ruby, Sapphire Sources in Africa. V. 23, No. 9, December 1969, p. 1296.
[23] Trapp, Francis W. "The Midnight Blue." A New Tanzanite is Added to the Smithsonian's Collection. Lapidary J. v. 23, No. 5, August 1969, p. 680.
[24] Brayman, Harold H. "Really Beautiful Stuff" Tanzanite. Science Digest, May 1969, pp. 70–72.
Hurlbut, C. S., Jr. Gem Zoisite From Tanzania. Miner., v. 54, No. 5–6, June 1969, pp. 702–709.
Thompson, Thomas. Tanzania to Tiffany's. Life, v. 66, No. 18, May 9, 1969, pp. 70–76.
[25] Business Week. Marketing—Why the Fake Diamoind Market Glitters. No. 2111, Feb. 14, 1970, p. 116.
Chabria, John R. How To Grow King Size Single Crystal Y I Gs. Ceram. Ind. Mag., v. 89, No. 5, November 1967, pp. 52–54.
Crowingshield, Robert. Diamonair—A New Diamond Substitute. Lapidary J. v. 23, No. 12, March 1970, pp. 1614–1619.
[26] Linholm, A. A. L. Diamond Recovery is Big Business. Eng. & Min. J. v. 170, No. 11, November 1969, pp. 67–80.
[27] Raal, F. A. A Study of Some Gold Mine Diamonds. The Am. Miner., v. 54, No. 1–2, January–February, 1969, pp. 292–301.
[28] Chemistry. Hundred-Foot-Long Sapphires. V. 42, No. 1, January 1969, p. 23.
[29] Chemical Engineering. Growing Gem-Grade Rubies. V. 76, No. 5, Mar. 10, 1969, p. 64.

Gem Stones

By Robert G. Clarke[1]

Domestic gem stone production was estimated at $2.4 million in 1970, unchanged from that of 1969. Gem stone collection continued to be principally a recreational activity of individual collectors and hobbyists at free or fee sites. Only a few deposits were operated to produce rough material for direct sale to wholesale or retail outlets or for raw material to manufacture finished jewelry by the deposit operators.

DOMESTIC PRODUCTION

Gem stone production was reported from 38 States. The following States led in production and accounted for 78 percent of the total: Oregon, $750,000; California, $200,000; Arizona, $155,000; Texas, $150,000; Washington, $150,000; Wyoming, $130,000; Colorado, $120,000; Montana, $109,000; and Nevada, $100,000.

Many States publish brochures describing their major occurrences of gem stones and minerals, including maps and instructions on how to reach the deposits. The brochures are free and usually may be obtained from the individual State Department of Economic Development, or from the State Geologist.

Reports of activities in gem collecting included all varieties of precious and semiprecious stones. In Louisiana, an 18.20 carat diamond was found in Princeton, in a yard, by a little girl at play.[2] It was named the LaMounce diamond for Louisiana (La), and Mr. Mounce, the jeweler who purchased it. It has since been cut into three fine gems by Lazare Kaplan and Sons of New York City; an oval, a marquise, and a heart shape.

In South Dakota, the Cheyenne River Agency of the South Dakota Sioux operated a quarry near Rapid City for alabaster which was handcrafted at the Sioux Stone Craft Co.[3] Third year sales exceeded the total of the first 2 years combined. Many accounts of interesting field trips resulting in mineral and gem stone finds were related in journals for enthusiasts.[4] [5] Many clubs and societies reported on the activities of their members.

CONSUMPTION

The output of domestic gem stones generally went to rock, mineral, and gem stone collections, objects of art, and jewelry. Apparent consumption of gem stones (domestic production plus imports minus exports and reexports) declined to $292 million, compared with $343 million in 1969 because of greater exports and reexports of diamonds.

PRICES

During the year, price ranges for cut and polished, unmounted gem diamond were as follows: 0.25 carat, $100 to $425; 0.50 carat, $275 to $900; 1 carat, $700 to $2,800; 2 carats, $2,000 to $9,500; and 3 carats, $4,000 to $20,000. The median price for each range was 0.25 carat, $200; 0.5 carat, $500; 1 carat, $1,550; 2 carats, $4,100; and 3 carats, $8,500.

[1] Physical scientist, Division of Nonmetallic Minerals.
[2] Lapidary Journal. Diamond Found in Louisiana. V. 24, No. 8, November 1970, p. 1122.
[3] Lapidary Journal. Stone Age Provides New Business for Sioux. V. 24, No. 7, October 1970, p. 925.
[4] Gems and Minerals. News Notes of Collecting Areas. No. 388, January 1970–No. 399, December 1970.
[5] Rocks and Minerals. Mineral Localities Information Department. V. 45, No. 1, January 1970–V. 45, No. 12, December 1970.

FOREIGN TRADE

United States exports of diamond in 1970, on which some work was done prior to reexport, amounted to 391,599 carats valued at $116.6 million. Of this total, diamonds, cut but unset, suitable for gem stones, not classified by weight, were 93,937 carats valued at $5.3 million; cut but unset, suitable for gem stones, not over ½ carat, were 49,297 carats valued at $5.4 million; and, cut but unset, suitable for gem stones, over ½ carat, were 248,365 carats valued at $105.9 million.

Reexports of diamond in 1970, on which no work was done, amounted to 1,258,146 carats valued at $67.8 million in the following categories: Cut but unset, suitable for gem stones, not classified by weight, 1,213,958 carats valued at $58.5 million; cut but unset, suitable for gem stones, not over ½ carat, 28,704 carats valued at $4.4 million; cut but unset, suitable for gem stones, over ½ carat, 15,484 carats valued at $4,920,588.

Exports and reexports of all other gem materials amounted to $12.4 million. Of this total, natural precious and semiprecious stones, worked or unworked, not set or strung, were valued at $11.1 million. Exports and reexports of pearls, natural and cultured, not set or strung, were valued at $0.9 million. Synthetic or reconstructed precious or semiprecious stones, not set or strung, exports and reexports, were valued at $0.4 million.

Imports of gem material decreased 14 percent in value compared with that of 1969. Gem diamonds accounted for 87 percent of the total value of imports.

Imports of emeralds decreased 16 percent in value, but increased 6 percent in quantity. Of 24 countries supplying emeralds to the United States, India furnished 215,664 carats valued at $2.8 million; Brazil, 33,565 carats valued at $0.6 million; and Colombia, 17,419 carats valued at $1.5 million. These three countries furnished 82 percent of the quantity (in carats) and 64 percent of the value of emeralds. Imports of emeralds from Switzerland amounted to 14,224 carats valued at $1.2 million, but the actual country of origin is unknown.

Imports of rubies and sapphires decreased 37 percent in value from 29 countries. Four countries accounted for 76 percent of the value of rubies and sapphires as follows: Thailand, $2.3 million; India, $0.9 million; Ceylon, $0.7 million; and Hong Kong, $0.5 million. The value of imported natural and cultured pearls decreased 22 and 17 percent, respectively; the value of imported imitation pearls increased 122 percent.

Table 1.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1969		1970	
	Quantity	Value	Quantity	Value
Diamonds:				
Rough or uncut ____ carats	2,932	$287,566	2,633	$234,164
Cut but unset ____ do	1,758	217,081	1,642	190,733
Emeralds: Cut but unset ____ do	309	9,175	326	7,715
Rubies and sapphires: Cut but unset	NA	9,201	NA	5,769
Marcasites	NA	6	NA	4
Pearls:				
Natural	NA	475	NA	371
Cultured	NA	12,238	NA	10,184
Imitation	NA	672	NA	1,493
Other precious and semiprecious stones:				
Rough and uncut	NA	4,847	NA	10,001
Cut but unset	NA	12,799	NA	12,034
Other, n.s.p.f.	NA	559	NA	590
Synthetic:				
Cut but unset ____ number	4,886	2,793	7,333	4,363
Other	NA	282	NA	526
Imitation gem stones	NA	8,999	NA	8,096
Total	NA	566,693	NA	486,043

NA Not available.

Table 2.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by countries

(Thousand carats and thousand dollars)

Country	1968				1969				1970			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Belgium-Luxembourg	46	$7,455	954	$119,396	59	$6,729	916	$113,114	64	$6,572	863	$103,705
Brazil	10	594	(1)	8	29	1,033	1	58	81	1,184	1	80
Canada	9	1,256	5	205	8	1,307	(1)	54	2	462	1	60
Central African Republic	218	11,818	1	61	232	9,806	--------	--------	165	5,826	--------	--------
France	22	1,004	22	2,514	10	379	20	2,484	4	195	27	2,550
Germany, West	(1)	2	5	556	1	13	5	507	2	117	4	516
Guyana	14	830	(1)	5	20	1,020	--------	--------	26	1,074	(1)	19
India	--------	--------	30	2,714	--------	--------	30	2,663	--------	--------	40	3,475
Israel	50	5,245	666	70,217	36	4,155	658	73,777	62	6,723	604	61,758
Japan	(1)	52	1	100	(1)	5	1	71	(1)	20	(1)	18
Liberia	7	1,898	--------	--------	13	2,976	--------	--------	6	1,898	--------	--------
Netherlands	46	9,953	19	3,073	48	12,810	27	3,561	23	7,886	13	1,899
Sierra Leone	61	1,892	9	1,810	224	8,331	10	1,447	--------	--------	6	814
South Africa, Republic of	434	46,380	35	9,076	361	41,585	28	8,713	593	54,571	26	6,868
Switzerland	20	2,039	4	785	6	1,043	3	919	4	354	1	262
U.S.S.R	--------	--------	63	9,588	--------	--------	43	6,629	--------	--------	44	6,826
United Kingdom	1,439	152,881	17	2,239	1,697	185,278	9	1,496	1,432	140,243	6	970
Venezuela	95	3,468	--------	--------	157	5,439	--------	--------	223	6,383	--------	--------
Western Africa, n.e.c	36	5,614	(1)	5	27	5,210	--------	--------	1	366	--------	--------
Other countries	7	272	3	626	4	447	7	1,588	5	845	6	918
Total	2,514	252,653	1,834	222,478	2,932	287,566	1,758	217,081	2,633	234,164	1,642	190,733

[1] Less than ½ unit.

WORLD REVIEW

Angola.—Diamond exports amounted to 2,239,912 carats, compared with 1,980,394 carats in 1969. The number of exploration projects increased tremendously because most of the area previously held exclusively for Companhia de Diamantes de Angola (DIAMANG) has been released, particularly at sites near Luanda and Gabela.

Australia.—A large kimberlite intrusion was located by a team working for Stellar Mining Co. in the Kimberley district of Western Australia, where gems have been discovered in prior years.[6]

Botswana.—Work at the Orapa pipe, covering 276 acres, claimed to be the world's second largest, proceeded on schedule.[7] The indicated recovery ratio of industrial diamond to gem diamond was 90 to 10. First stage development was forecast for July 1971 at 7,250 metric tons per day to yield 2 million carats per year.

Brazil.—Dredging activity for diamond in the Rio Jequitinhonha was increased 50 percent by the transfer of a dredge formerly used for gold recovery in the Rio das Belhas by Mineração Tejucana S.A., of Minas Gerais. Geologists reportedly found diamond pipe or kimberley-like deposits of diamonds in Piauí State.[8] Opals in large quantities were also reported from Piauí State. Exact weight and value of gem production were unavailable, but the Federal Government of Brazil has set up a Gem Bank in Minas Gerais State to control the gem industry.

Central African Republic.—Diamond production fell 18 percent in value and 10 percent in volume from 1969. Most of the decrease was due to disagreements between mining companies and the Government. Also, in 1970 the Government passed a law forbidding anyone but native-born citizens from prospecting for diamonds or other precious stones.

Congo, Kinshasa.—In 1970 the total output of diamonds, both gem and industrial, was almost equal to that of 1969. However, the amount of gem diamonds (in carats) increased 256 percent. The increase in gem diamonds reflected a decrease in industrial diamonds, which alleviated slightly the Government's distress in light of the planned sales of U.S. surplus industrial diamond holdings. The Congo retained its world rank of number one for total natural diamonds produced.

India.—The National Mineral Development Corp. operated the nationalized diamond industry in the Panna district more vigorously, and also conducted prospecting operations at Angore, in the Chhatarpur district, and at Andhra Pradesh, in the Anantpur district.[9] India aimed to satisfy domestic diamond demand through domestic production. India imported rough diamonds purchased through the Central Selling Organization (CSO) and reexported finished gems.

Israel.—The decrease in general business activity in the United States in 1970 affected the two countries that import the greatest amount of rough diamonds and export the greatest amount of polished diamonds. Belgium ranked first and Israel ranked second, and both countries procured most of their rough diamonds through the CSO. At Tel Aviv, in the world's largest diamond exchange, daily transactions in 1970 were estimated at $60 million.[10]

Ivory Coast.—Diamond production in 1970 increased 5 percent over that of 1969. A new plant at Tortiya (south of Korogho) was started to treat low-grade ore. Improvements were also made at older plants at Seguela. The increase in production from all plants was estimated at 30 percent, and will be reflected in future reports. Output of diamonds from Ivory Coast is estimated to be 40 percent gem stones.

Kenya.—Gem stone production included amethyst, sapphire, ruby, garnet, tourmaline, aquamarine, and zircon. Indicated quantities and value were greater than in 1969.

Liberia.—Exports of rough diamonds were reported as 775,500 carats valued at $5.5 million. No distinction was made between gem diamonds and industrial diamonds, but according to a report by the Director of the Bureau of Natural Resources and Surveys of Liberia, most of the diamond output was not high quality.

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[6] Mining & Mineral Engineering (London). V. 6, No. 12, December 1970, p. 53.
[7] Mining Magazine. Botswana Diamonds. V. 123, No. 6, December 1970, p. 473.
[8] Rolff, Almeida. Gem News From Brazil. Lapidary J., v. 24, No. 3, June 1970, pp. 514–516.
[9] Singh, D. V. A Review on Diamond and Its Beneficiation. J. Mines, Metals and Fuels, v. 18, No. 11, November 1970, pp. 399–406.
[10] Time. Israel, the Kindest Cut of All. V. 96, No. 7, Aug. 17, 1970, p. 62.

Table 3.—Diamond: World production, by countries [1]

(Thousand carats)

Country [2]	1968 Gem	1968 Industrial	1968 Total	1969 Gem	1969 Industrial	1969 Total	1970 [p] Gem	1970 [p] Industrial	1970 [p] Total
Africa:									
Angola	1,316	351	1,667	1,617	404	2,021	1,917	479	2,396
Central African Republic	305	304	609	268	267	535	241	241	482
Congo (Kinshasa)	551	11,353	11,904	491	13,625	14,116	1,750	12,336	14,086
Ghana	245	2,202	2,447	239	2,152	2,391	252	2,271	2,523
Guinea [3]	21	49	70	22	50	72	22	52	[3] 74
Ivory Coast	77	110	187	81	121	202	85	128	213
Lesotho	2	10	12	5	24	29	4	13	17
Liberia [4]	537	212	749	562	184	746	[5] 620	[5] 206	[5] 826
Sierra Leone	560	962	1,522	736	1,258	1,989	[5] 723	[5] 1,232	[5] 1,955
South Africa, Republic of:									
Premier mine	[r] 608	1,824	2,432	631	1,891	2,522	669	2,008	[6] 2,677
Other De Beers Company [7]	[r] 2,313	1,892	4,205	2,457	2,010	4,467	[e] 2,511	[e] 2,054	[e] 4,565
Other	[r] 478	318	796	524	350	874	[e] 522	[e] 348	[e] 870
Total, South Africa, Republic of	[r] 3,399	4,034	7,433	3,612	4,251	7,863	3,702	4,410	8,112
South-West Africa, Territory of	1,636	86	1,722	1,923	101	2,024	[e] 2,100	[e] 100	[e] 2,200
Tanzania	356	346	702	394	383	777	359	349	708
Other areas:									
Brazil [e]	160	160	320	160	160	320	160	160	320
Guyana	28	38	66	21	31	52	24	37	61
India	7	2	9	10	2	12	[e] 10	[e] 2	[e] 12
Indonesia [e]	14	6	20	14	6	20	14	6	20
U.S.S.R. [e]	1,400	5,600	7,000	1,500	6,000	7,500	1,600	6,250	7,850
Venezuela	60	54	114	118	76	194	129	371	500
World total	[r] 10,674	25,879	36,553	11,773	29,090	40,863	13,712	28,643	42,355

[e] Estimate. [p] Preliminary. [r] Revised.

[1] Total (gem plus industrial) diamond output of each country is actually reported except where indicated to be an estimate by footnote. In contrast, the detailed separate reporting of gem diamond and industrial diamond represents Bureau of Mines estimates in the case of all countries except Angola, Congo (Kinshasa), Lesotho (1969 only), Liberia, and Venezuela, where sources list both total output and the detail. The estimated distribution of the total in the case of several countries is conjectural, based on unofficial sources of varying reliability.

[2] In addition to the countries listed, Botswana also produces diamond, but output statistics are regarded as confidential by the producer, and there is insufficient general information to prepare reliable estimates.

[3] Government of Guinea estimate.

[4] Exports for year ending August 31 of that stated.

[5] Exports.

[6] Officially reported production of nonalluvial stones from Transvaal; the Premier mine is the only major source of such stones in the Transvaal.

[7] All company output from the Republic of South Africa except for that from the Premier mine; excludes company output from the Territory of South-West Africa.

Sierra Leone.—Diamonds are the country's most important mineral resource. To derive maximum benefit from its diamond resources, the Government acquired majority control (51 percent) of Sierra Leone Selection Trust Ltd. (SLST), which had the concession to about 450 square miles of the best diamond area. A new company, the National Diamond Mining Co., Ltd. (DIMINCO) was formed. Diamond exports dropped owing to the depressed world diamond market.[11]

South Africa, Republica of.—From the best information available, South Africa ranked second in total diamond production and first in gem diamonds in 1970. The Department of Mines also reported production of 7,500,000 carats of emerald, of which 4,975,000 carats was exported; and 1,150 short tons of Tiger's-Eye, of which 139 short tons was exported. In the annual report of De Beers Consolidated Mines Ltd., sales by the CSO were 23 percent less than sales in 1969, and the book value of diamonds-on-hand increased 92 percent.[12]

Southern Rhodesia.—A large emerald crystal, 2 inches high by 3 inches across, weighing 1,160 carats, was found at the Chikwanda mine of Rhodesia Star mines, Fort Victoria, Rhodesia, in late December 1969. If a cut gem stone was produced from it, one appraiser estimated the gem could be worth $2 million. The collector, who has acquired it, intends to keep it uncut.[13]

Tanzania.—Diamonds were the principal mineral mined and almost the entire output came from Williamson Diamonds Ltd., which is 50 percent Government owned. Prospecting for colored gem stones attracted numerous small miners in the northern sections for minerals such as tanzanite.[14]

U.S.S.R.—Diamond production increased in 1970 and was claimed by the U.S.S.R. to rank second in the world. However, most of the output was industrial diamond, and was from the pipes in Yakutia near Mirny. Gem deposits were reported to have been discovered in the Turkestan mountain range in Uzbekistan and included turquoise, amethyst, chalcedony, jasper, and selenite.[15]

TECHNOLOGY

The practical aspects of the diamond cutter's art, from cleaving and sawing to the final facetting operations were described; and the assistance of science was explained as an aid to the cutter in understanding the structure and properties of the diamond crystal.[16]

Pigmented synthetic quartz crystals of large size (up to 2 pounds) in citrine, peridine, and cobalt blue colors, developed by Soviet scientists, and believed to be intended for less expensive jewelry items, were displayed at gem shows as crystals and in cut form in jewelry.[17]

On May 28, 1970, General Electric Corp. made public its progress in developing man-made, gem-quality diamonds up to 1 carat in size, but the cost of their production exceeded that of natural stones.[18]

The defects of the crystalline structure of a natural emerald from Muzo, Colombia, and of an artificial emerald synthesized by Gilson, were studied by X-ray. The study revealed zoning of strong misorientations in the natural crystals and a high number of irregularities of curved grains in the synthetic.[19]

Polarized absorption spectra of natural yellow, green, and blue sapphires, and of synthetic blue sapphires grown by the Verneuil process were studied and interpreted for the roles of titanium and iron in the resulting colors.[20]

[11] Bureau of Mines. Mineral Trade Notes. Diamonds. V. 68, No. 2, pp. 8, 9.
[12] Mining Journal. De Beers Consolidated Mines Ltd. Annual Report. V. 276, No. 7082, May 14, 1971, pp. 389–395.
[13] Lapidary Journal. Giant Emerald Crystal Found at Ft. Victoria, Rhodesia. V. 24, No. 4, July 1970, p. 646.
[14] Skilling's Mining Review. Diamonds and Gold Are Leading Exports of Tanzania. V. 59, No. 48, Nov. 28, 1970, pp. 14, 15.
[15] Mining Journal. V. 276, No. 7082, May 14, 1971, p. 391.
[16] Rainier, D. M. How Gem Diamonds are Fashioned. Ind. Diamond Rev., v. 30, No. 358, September 1970, pp. 350–357.
[17] Pough, F. H. Colored Synthetic Quartz From Russia. Lapidary J., v. 24, No. 3, June 1970, pp. 444–446.
[18] Lapidary Journal. G. E. Announces First Man-Made Gem-Quality Diamonds. V. 24, No. 4, July 1970, pp. 540–548.
[19] Schubnel, H. J., and A. Zarka. Topographie Aux Rayons X D'une Émeraude Naturelle et D'une Émeraude Artificielle. Association Francoise de Gemmologie. Bull. No. 25, December 1970, pp. 7–10.
[20] Lehmann, G. and H. Harder. Optical Spectra of Di- and Trivalent Iron in Corundum. The Am. Miner., v. 55, Nos. 1 and 2, January–February 1970, pp. 98–105.

Gem Stones

By Robert G. Clarke [1]

Gem stone production was estimated to be $2.6 million dollars in 1971, an increase of 8 percent over 1970 figures. Individual collectors reported more finds of gem materials in both quantity and value. Since the United States has no formal gem stone mining industry, activity was principally the result of recreational mining by hobbyists. A few deposits were operated to produce rough material for direct sale to wholesale or retail outlets, or for raw material to manufacture finished jewelry.

DOMESTIC PRODUCTION

Collectors in 38 States produced gem materials estimated at $1,000 or more for each State. Of these, the following States supplied 78 percent of the total, in thousand dollars, as follows: Oregon, $755; California, $205; Arizona, $160; Texas $155; Washington, $155; Wyoming, $135; Colorado, $125; Montana, $114; Nevada, $105; and Idaho, $100.

Emeralds from Hiddenite, N.C. made news in that the largest emerald crystal, 59 carats, ever found in North America was discovered there August 1970. The stone was fashioned, cut to 13.14 carats as a gem, named the Carolina Emerald and displayed by Tiffany's of New York.[2] Reports of emerald recoveries from Hiddenite were published in newspapers and journals.[3] A jade boulder, 8 feet long and weighing over 5 tons, was taken from the Pacific Ocean near Jade Cove, just south of the town of Big Sur, Calif.[4] Similar nephrite boulders, weighing up to 1 ton, were reported to have been found at a site on the Rib River in Marathon County in Wisconsin.[5]

Black opal from Virgin Valley, Nev., has an unfortunate tendency to craze. A process has now been developed which stabilizes the opal and allows it to become one of the most treasured gems of the world.[6]

Descriptions of field trips, events, and reports of mineral and gem stone finds were reported in periodicals.[7]

CONSUMPTION

Domestic gem stone output generally went to rock, mineral, and gem stone collections, objects of art, and jewelry. Apparent consumption of gem stones (domestic production plus imports minus exports and reexports) increased to $311 million, compared with $292 million in 1970, because of greater imports of diamond.

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1 Physical scientist, Division of Nonmetallic Minerals.

2 Crowningshield, R. America's Largest Faceted Emerald. Lapidary J., v. 25, No. 1, April 1971, p. 40.

3 Knoxville (Tenn.) News-Sentinel. Rockhound Finds Gems in N. C. Hole. Aug. 18, 1971, p. 40. The State, Columbia, S. C. Raw Emeralds. Aug. 1, 1971, p. 26A.

4 The Evening Star, Washington, D.C. $180,000 Jade Slab. V. 110, No. 215, Aug. 3, 1971, p. A3.

5 Kraege, H. Another Prospectors Mecca. Rocks and Minerals, v. 46, No. 12, December 1971, p. 737.

6 Zeitner, June C. Precious Opal from Nevada. Lapidary J. v. 24, No. 12, March 1971, pp. 1534–1542.

7 Gems and Minerals. Field Trips, News Notes of Collecting Areas. No. 400, January 1971–No. 411, December 1971.

Rocks and Minerals. Mineral Localities Information, Visiting Rockhounds Welcome. V. 46, No. 1, January 1971–V. 46, No. 12, December 1971.

Lapidary Journal. Calendar of Events, Show News. V. 24, No. 10, January 1971–V. 25, No. 9, December 1971.

The Mineralogical Record. Friends of Mineralogy. V. 2, No. 1, January–February 1971–V. 2, No. 6, November–December 1971.

PRICES

During the year, representative price ranges for first quality, cut and polished, unmounted gem diamond were 0.25 carat, $100 to $450; 0.5 carat, $250 to $950; 1 carat $650 to $3,000; 2 carats, $2,000 to $10,000; and 3 carats, $3,000 to $18,000. The median price for each range was 0.25 carat, $210; 0.5 carat, $525; 1 carat, $1,600; 2 carats, $4,500; and 3 carats, $8,700.

FOREIGN TRADE

Exports of all gem materials amounted to $132.9 million, and reexports, to $85.1 million. Diamond was 94 percent of the value of each, exports and reexports. United States exports of diamond in 1971, on which work was done prior to reexport amounted to 349,136 carats valued at $125.3 million. Of this, diamonds, cut but unset, suitable for gem stones, not classified by weight, were 62,904 carats valued at $4.9 million; cut but unset, not over 0.5 carat, were 109,932 carats valued at $8.6 million; and cut but unset, over 0.5 carat, were 176,300 carats valued at $111.8 million.

Reexports of diamond, on which no work was done, amounted to 1,226,755 carats valued at $79.8 million in the following categories: Cut, but unset, suitable for gem stones, not classified by weight, 1,173,727 carats valued at $65.2 million; cut but unset, not over 0.5 carat, 20,851 carats valued at $4.4 million; cut but unset, over 0.5 carat, 32,177 carats valued at $10.2 million.

The seven leading countries for diamond exports and reexports combined, accounting for 95 percent of the carats and 93 percent of the value were as follows: Israel, 577,121 carats valued at $32.2 million; Belgium, 335,274 carats valued at $23.7 million; Switzerland, 282,846 carats valued at $27.5 million; Hong Kong, 119,124 carats valued at $59.0 million; The Netherlands, 117,363 carats valued at $23.8 million; Japan, 39,969 carats valued at $21.1 million; and the United Kingdom 23,809 carats valued at $3.1 million.

Exports of all other gem materials amounted to $7.6 million. Of this total, pearls, natural and cultured, not set or strung, were valued at $0.4 million. Natural precious and semiprecious stones, unset, were valued at $5.7 million; and synthetic stones, unset, were valued at $1.6 million. Reexports of all other gem materials amounted to $5.3 million. Reexports of pearls amounted to $0.3 million; of natural precious and semiprecious stones, unset, to $4.9 million; and of synthetic precious and semiprecious stones, to $0.1 million.

Imports of gem material increased 8 percent in value compared with that of 1970. Diamond accounted for 88 percent of the total value of gem stone imports.

The four leading countries from which diamond imports came, in total carats and in total value were as follows: Belgium-Luxembourg, 1,123,193 carats valued at $122.7 million; the United Kingdom, 959,516 carats valued at $120.3 million; the Republic of South Africa, 928,896 carats valued at $89.8 million; and, Israel, 717,470 carats valued at $73.0 million.

Imports of emeralds increased 8 percent in quantity and less than 1 percent in value. Of 33 countries supplying natural emeralds to the United States, India furnished 190,358 carats valued at $3.6 million; Brazil, 67,519 carats valued at $0.7 million; Hong Kong, 34,818 carats valued at $0.4 million; and Colombia, 18,622 carats valued at $1.3 million. These four countries furnished 89 percent of the quantity (in carats) and 78 percent of the value of total emerald imports. The United Kingdom, Switzerland, France, West Germany, Israel, and Italy accounted for most of the remainder, but the country of origin was unknown.

Imports of rubies and sapphires increased 42 percent and came from 27 countries. Seven countries accounted for 92 percent of the value of rubies and sapphires, as follows: Thailand, $4.4 million; India, $0.8 million; Ceylon, $0.7 million; Hong Kong $0.5 million; France, $0.4 million; Switzerland, $0.4 million; and the United Kingdom, $0.3 million.

Synthetic materials, gem stone quality, cut but not set, amounted to $9.6 million in imports. From West Germany, the value of synthetics was $3.5 million; from Japan, $1.4 million; from Switzerland, $1.3 million; from Israel, $1.1 million; and from France, $0.9 million.

Table 1.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1970 Quantity	1970 Value	1971 Quantity	1971 Value
Diamonds:				
Rough or uncut	2,633	$234,164	2,742	$254,575
Cut but unset	1,642	190,733	1,925	208,667
Emeralds: Cut but unset	326	7,715	351	7,731
Rubies and sapphires: Cut but unset	NA	5,769	NA	8,206
Marcasites	NA	4	NA	1
Pearls:				
Natural	NA	371	NA	364
Cultured	NA	10,184	NA	6,895
Imitation	NA	1,493	NA	5,013
Other precious and semiprecious stones:				
Rough and uncut	NA	10,001	NA	8,532
Cut but unset	NA	12,034	NA	13,456
Other, n.s.p.f.	NA	590	NA	734
Synthetic:				
Cut but unset number	7,333	4,363	11,040	9,492
Other	NA	526	NA	137
Imitation gem stones	NA	8,096	NA	7,180
Total	NA	486,043	NA	525,983

NA Not available.

Table 2.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by country

(Thousand carats and thousand dollars)

Country	1969				1970				1971			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Belgium-Luxembourg	59	$6,729	916	$113,114	64	$6,572	863	$103,705	88	$9,092	1,036	$113,626
Brazil	29	1,033	1	58	31	1,184	1	80	8	129	2	232
Canada	8	1,307	(1)	54	2	462	1	60	--	--	1	69
Central Africa Republic	232	9,806	--	--	165	5,826	--	--	208	6,785	--	--
France	10	379	20	2,484	4	196	27	2,550	21	634	31	2,514
Germany, West	1	13	5	507	2	117	4	516	1	121	2	210
Guyana	20	1,020	--	--	26	1,074	(1)	19	1	49	(1)	19
India	--	--	30	2,663	--	--	40	3,475	--	--	80	6,429
Israel	36	4,165	658	73,777	52	6,723	604	61,753	47	3,425	671	69,569
Japan	(1)	5	1	71	(1)	20	(1)	18	(1)	38	2	203
Liberia	13	2,976	--	--	6	1,893	--	--	17	3,797	(1)	66
Netherlands	48	12,810	27	3,561	23	7,886	13	1,899	31	6,190	20	2,440
Sierra Leone	224	8,331	10	1,447	--	--	6	814	281	14,331	4	527
South Africa, Republic of	361	41,585	28	8,713	593	54,571	26	6,868	904	83,389	25	6,388
Switzerland	6	1,043	3	919	4	354	1	262	16	3,149	11	1,156
U.S.S.R.	--	--	43	6,629	--	--	44	6,826	--	--	24	3,324
United Kingdom	1,697	185,278	9	1,496	1,432	140,243	6	970	947	118,913	12	1,366
Venezuela	157	5,439	--	--	223	6,333	--	--	177	4,283	--	--
Western Africa, n.e.c.	27	5,210	--	--	1	366	--	--	--	--	--	--
Other countries	4	447	7	1,588	5	345	6	918	--	255	4	529
Total	2,932	287,566	1,758	217,081	2,633	234,164	1,642	190,733	2,742	254,575	1,925	208,667

[1] Less than ½ unit.

WORLD REVIEW

Angola.—A new firm, Consorcio Mineiro de Diamantes (CONDIAMA), formed by Companhia de Diamantes de Angola (DIAMANG) of Lisbon, and De Beers Consolidated Mines Ltd. of Kimberley, Republic of South Africa, was granted exclusive rights to concession areas relinquished by DIAMANG whose rights originally granted in 1921 expired May 14, 1971.[8] The Angolan Government will gain financially from the new contracts.

Australia.—A major emerald deposit was opened near Poona, 430 miles northeast of Perth. One emerald from the deposit weighed 138 carats and measured 1.8 inches by 0.8 inch.[9] At Glengarry, an oval shaped black opal, valued at $168,000, measuring 2.25 inches by 1.5 inches was found and named the Orient Queen.[10]

Botswana.—The Orapa diamond mine began operations in July 1971 on a scheduled treating of 8,000 tons of diamond-bearing ore per day.[11] Gem diamond recovery was indicated to be only 10 percent of the estimated annual yield of 2 million carats.[12]

Burma.—The Mineral Development Corp., the Burmese state-owned mining concern, sent an exploration team to the Shan State following reported diamond finds in Mongmit township.[13] Jade was predominant in sales at Burma's Seventh Annual Gem, Jade, and Pearl Emporium accounting for $1.96 million of the total of $2.60 million. Pearl sales amounted to $480,000. All other gem sales amounted to $154,000. Jade sales, accounting for 76 percent of the total sales, set a new record owing to strong demand from Hong Kong. No single large stones were sold.[14]

Brazil.—A new diamond rush started in Minas Gerais State when diamond stones were found weighing 75, 44, and 24 carats.[15]

Ceylon.—The Government set up the State Gem Corporation which sponsored a gem auction. To protect consumers, the State Gem Corporation initiated a procedure to issue a certificate of authenticity for each gem stone giving its specific gravity, refractive index, hardness, weight, volume, color, and luster, together with a true-to-scale contact print.[16]

India.—The National Mineral Development Corporation (NMDC) started operations in the Majhgawan diamond pipe of 21 surface acres at Panna.[17] Ore reserves down to 1,000 feet was estimated to be 55 million tons. Although the grade is low, 10 carats per 100 tons, the venture is profitable because of the high ratio of gem diamond to industrial diamond, about 4 to 1. Other areas investigated by NMDC were at Golconda and Kurnool in Andhra Pradesh. NMDC imports gem diamond from Ghana for cutting and reexport.[18]

Ivory Coast.—Société Anonyme de Recherches et d'Exploitation Minières en Côte d'Ivoire (SAREMCI) at Tortiya south of Korogho, accounted for 91 percent and Société Diamantifere de Côte d'Ivoire (SODIAMCI) accounted for 8 percent of diamond production reported in 1970. New equipment installed by each was expected to maintain the ratio in 1971.[19]

Malagasy Republic.—Garnets were the most important gem stones produced and were marketed for jewelry, bearings, and abrasives.[20] De Beers Consolidated Mines Ltd. of South Africa concluded an agreement with the Government for prospecting for diamond. Under the agreement De Beers would analyze 20,000 samples of ore concentrate from the Malagasy Republic. The contract included Government sharing in any subsequent corporation.[21]

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[8] Bureau of Mines. Mineral Trade Notes. Diamond, Angola. V. 68, No. 12, December 1971, pp. 11–12.
[9] Journal of Mines, Metals & Fuels (India). Notes and News, Emerald Mine in Western Australia. V. 19, No. 12, December 1971, p. 372.
[10] The Evening Star, Washington, D.C. $168,000 Opal Found. V. 119, No. 190, July 9, 1971, p. D6.
[11] Holz P. Other African Countries. Botswana. Canadian Mining J., v. 93, No. 3, March 1972, p. 71.
[12] World Mining. De Beers Orapa Diamond Mine Starts Production in June 1971. V. 6, No. 13, December 1970, p. 50.
[13] Industrial Minerals (London). No. 46, July 1971, p. 45.
[14] Bureau of Mines. Mineral Trade Notes. Gem Stones, Burma. V. 68, No. 6, June 1971, p. 5.
[15] Jewelers' Circular-Keystone. Briefly. V. 142, No. 3, December 1971, p. 74.
[16] Staff, Modern Asia: Hong Kong. Gem Country. V. 5, No. 8, October 1971, pp. 24–27. Ceylon Government Gazette, No. 14, 989/8, Dec. 23, 1971, pp. 11A–16A.
[17] Staff, World Mining. Diamond Mining in India Today. V. 24, No. 6, June 1971, pp. 34–35.
[18] Journal of Mines, Metals & Fuels (India). Import of African Diamonds. V. 19, No. 1, January 1971, p. 25.
[19] Bureau of Mines. Mineral Trade Notes. Ivory Coast. V. 68, No. 8, August 1971, p. 11.
[20] Mining Annual Review. Malagasy. June 1971, p. 352.
[21] Bureau of Mines. Mineral Trade Notes. Malagasy Republic. V. 68, No. 7, July 1971, p. 17.

Table 3.—Diamond (natural): World production by country [1]

(Thousand carats)

Country	1969			1970			1971 p		
	Gem	Industrial	Total	Gem	Industrial	Total	Gem	Industrial	Total
Africa:									
Angola	r 1,516	r 506	2,022	1,797	599	2,396	e 1,625	e 542	e 2,167
Botswana	NA	NA	NA	54	490	544	87	785	2 872
Central African Republic	r 348	r 187	535	r 313	r 169	482	304	163	467
Ghana	239	2,152	2,391	255	2,295	2,550	256	2,306	2,562
Guinea	22	50	72	22	52	3 74	e 22	e 52	e 74
Ivory Coast	81	121	202	85	128	213	e 88	e 132	e 220
Lesotho 4	5	25	30	4	13	17	1	6	7
Liberia	5 562	5 184	5 746	5 577	5 235	5 812	525	214	739
Sierra Leone	736	1,253	1,989	723	1,232	1,955	715	1,220	1,935
South Africa:									
Premier	631	1,891	2,522	623	1,867	2,490	6 652	6 1,955	6 2,607
Other DeBeers Company 7	2,457	2,010	4,467	2,615	2,140	4,755	2,267	1,855	e 4,122
Other	524	350	874	520	347	867	181	121	e 302
Total	3,612	4,251	7,863	3,758	4,354	8,112	3,100	3,931	7,031
South-West Africa, Territory of	1,923	101	2,024	1,772	93	1,865	e 1,800	e 100	e 1,900
Tanzania	394	383	777	359	349	708	404	404	2 808
Zaire (formerly Congo-Kinshasa)	r 1,802	r 11,621	r 13,423	1,649	12,438	14,087	e 1,700	e 12,000	e 13,700
Other Areas:									
Brazil e	160	160	320	160	160	320	160	160	320
Guyana	21	31	52	24	37	61	19	29	48
India	10	2	12	17	3	20	16	3	19
Indonesia e	14	6	20	14	6	20	14	6	20
U.S.S.R. e	1,500	6,000	7,500	1,600	6,250	7,850	1,800	7,000	8,800
Venezuela	118	76	194	129	371	500	e 130	e 370	e 500
World total	13,063	27,109	40,172	13,312	29,274	42,586	12,766	29,423	42,189

e Estimate. p Preliminary. r Revised. NA Not available.

1 Total (gem plus industrial) diamond output of each country is actually reported except where indicated to be an estimate by footnote. In contrast, the detailed separate reporting of gem diamond and industrial diamond represents Bureau of Mines estimates in all cases except Angola (1969 only), Lesotho (all years), Liberia (1969 and 1970), Zaire (1969 only), and Venezuela (1969 and 1970), where sources give both total output and detail. The estimated distribution of the total in the case of a number of countries is conjectural, based on unofficial information of varying reliability.

2 Exports.

3 Official estimate by Government of Guinea.

4 Exports of diamond originating in Lesotho; excludes stones imported for cutting and subsequently reexported.

5 Exports for year ended August 31 of that stated.

6 Total non-alluvial output of Transvaal, presumably includes a small share of total originating from non-De Beers-owned properties other than the Premier mine.

7 All company output from the Republic of South Africa except for that from the Premier mine; excludes company output from the Territory of South-West Africa and from Botswana.

Nigeria.—The Government published Decree No. 55, Diamond Trading Decree 1971, in the Official Gazette No. 64, V. 58, Dec. 31, 1971.[22] The Federal Military Government issued the decree which contained 15 sections. Mining, selling, buying, importing, exporting, and cutting of diamond was to be licensed or authorized, and violators subject to arrest, forfeitures, and penalties.

Scotland.—A short paper described areas for collectors of minerals, precious stones, and semiprecious stones in Scotland.[23] A location map of the country was included.

Sierra Leone.—The third largest diamond ever found, 969.8 carats and valued at $11.7 million, was reported.[24] Sierra Leone diamond production has a high ratio of gem diamond. The Government and the economy are tied to diamond production to a remarkable degree as trade data for the last three years showed. Diamond exports were about two-thirds of the country's exports in value and were the source of 15 to 20 percent of the Government's revenue.

South Africa, Republic of.—Production of diamond decreased but value of sales increased. De Beers announced a 5 percent general increase in prices in terms of U.S. dollars on November 1, 1971; also, the South African exchange rate varied between August and December 1971.[25]

South West Africa.—Consolidated Diamond Mines of South-West Africa, Ltd. (CDM), a subsidiary of De Beers, closed the sea and foreshore operations in the areas leased to the Marine Diamond Corporation Ltd., a subsidiary of CDM.[26]

Tanzania.—Diamond was the most important mineral mined and exported. Diamond exports in 1971 were 808,000 carats. Gem zoisite (tanzanite) exports amounted to 79,000 carats and were 36 percent of the total value of exports of gem stones excluding the value of diamond. Ruby, sapphire, garnet, amethyst, and tourmaline were other gem stone types exported.

Venezuela.—A significant diamond discovery of gem quality on a 15,000 acre concession in the State of Bolivar was reported.[27] Diamond production increased 6 times in quantity and 4 times in value from 1965 to 1970 according to Government data in an article which also described mining methods and laws.[28]

TECHNOLOGY

A detailed description of synthetic gem stones and other synthetic materials was published.[29] Diamond imitations, their pretensions, and some trade names were also described.[30]

Personnel of the Hawaii Institute of Marine Biology tested a miniature submarine at Makapuu Point, Oahu, in a series of dives to harvest precious coral of which the varieties included gold, pink, bamboo, gold bamboo, and black. The submersible was equipped with an arm and claw and a large basket.[31] Union Carbide Corp.'s Crystal Products Department reported production of a giant synthetic white sapphire, 28,000 carats, 3.5 inches in diameter and 8 inches long, the largest manufactured sapphire crystal on record, using the Czochralski process.[32]

The damage caused by mechanically polishing sapphire and spinel wafers was minimized by chemical polishing.[33] Topaz was described in terms of geometrical and electrostatic interactions.[34] Tiny laser beams were used to burn out unsightly dark inclusions in diamond, a development for jewelers to be aware of.[35]

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[22] Bureau of Mines. Mineral Trade Notes. Diamond, Nigeria. V. 69, No. 4, April 1972, pp. 5–12.

[23] Adamson, G. F. S. The Gemstones of Scotland. Mining and Minerals Engineering, v. 7, No. 6, June 1971, pp. 21–24.

[24] The Sunday Star, Washington, D.C. Third Largest Diamond Found on Conveyor in Mine Plant. V. 120, No. 107, Apr. 16, 1972, p. D7.

[25] Staff, Mining Journal, (London). Diamond Sales Improve. V. 278, No. 7117, Jan. 14, 1972, p. 33.

[26] Mining and Minerals Engineering (London). Marine Diamonds. V. 7, No. 6, June 1971, p. 25.

[27] The Wall Street Journal. Fairway Explorations Ltd. Reports Making Significant Diamond Find. V. 178, No. 8, July 13, 1971, p. 33.

[28] Fairbairn, W.C. Diamonds in Venezuela. Mining Magazine, v. 125, No. 4, October 1971, pp. 349–353.

[29] Webster, R. A. Comprehensive Compendium on Modern Synthetic Gem Stones, Part I. Lapidary J., v. 25, No. 1, April 1971, pp. 275–280; Part II, Lapidary J., v. 25, No. 2, May 1971, pp. 304–317.

[30] Sarett, M. R. The Facts About Diamond Imitations. Lapidary J. v. 25, No. 5, August 1971, pp. 714–715.

[31] Reported by Bureau of Mines State Liaison Officer for Hawaii.

[32] Iron Age. Gem of a Giant and Giant of a Gem. Techfront. V. 208, No. 15, Oct. 7, 1971, p. 31.

[33] Reisman, A., M. Berkenblit, J. Cuomo, and S. A. Chan. The Chemical Polishing of Sapphire and MgAl Spinel. J. Electrochemical Soc., v. 118, No. 10, October 1971, pp. 1653–1657.

[34] Ribbe, P. H., and G. V. Gibbs. The Crystal Structure of Topaz and Its Relation to Physical Properties. The American Mineralogist, v. 56, January–February 1971, pp. 24–30.

[35] Jewelers' Circular-Keystone. Something New to Look For in a Diamond. V. 61, No. 6, p. 114.

Gem Stones

By Robert G. Clarke [1]

Although no formal gem stone mining industry exists in the United States, production in 1972 was estimated to be $2.7 million, an increase of 4% over the value of production in 1971. Individual collectors accounted for most of the quantity and value. Members of clubs in all States collected mineral specimens and rock samples. A few deposits were operated for the production of rough material that was sold directly to wholesale or retail outlets and sometimes to jewelry manufacturers.

DOMESTIC PRODUCTION

Gem stone production was estimated to be $1,000 or more for each of 38 States. The following States accounted for 77% of the total production, in thousands: Oregon, $793; California, $215; Arizona, $168; Texas, $163; Washington, $163; Wyoming, $142; Colorado, $131; Montana, $120; Nevada, $110; and Idaho, $105.

The State of Arkansas purchased the only diamond mine area in North America for development as a State park.[2] The property amounted to 867 acres, including the 78-acre diamond-producing crater. The cost was $750,000.

A find of semiprecious tourmaline was reported at the Vevel Pit on Plumbago Mountain, near Newry, Maine.[3] High value estimates were made for the find because of the large quantity of watermelon tourmalines, 3 inches in diameter, 4 to 5 inches long, green on the outside and pink inside.

The Ruggles mine, near Grafton, N.H., the oldest mica mine in the United States, was reopened to tourists and rock collectors on a fee basis.[4] The mine was originally opened in 1803 and was operated for the production of feldspar from 1932 to 1959. About 150 minerals have been found at the Ruggles mine. The list, in addition to mica and feldspar, includes amethyst, beryl, rose and smoky quartz, aquamarine, garnet, gummite, autunite, and zircon.

Tourists to the Mt. Washington Valley area of the White Mountain National Forest obtained collector's permits free of charge from the U.S. Forest Service Headquarters at Laconia, N.H.[5] The permit allowed hobby collecting only and required restoring work areas. Minerals mentioned as collected included smoky quartz, amethyst, topaz, feldspar, mica, and other pegmatite minerals.

Mines and minerals of the State of Virginia were described in a four-part series.[6]

A 10,000-pound boulder of jade was cut at the Majestic Jade Co., Riverton, Wyo.[7] The boulder was one of several removed by the company from its Verla-Irene operations near Jeffrey City, Wyo. After cutting, the jade sold for an average of $10 per pound.

Descriptions of field trips, events, and mineral and gem stone finds were reported throughout the year by Gems and Minerals, Lapidary Journal, Mineralogical Record, and Rocks and Minerals.

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1 Physical scientist, Division of Nonmetallic Minerals.

2 Arkansas Gazette (Little Rock, Ark.). Crater of Diamonds Land is Purchased by State. Mar. 15, 1972, p. 17.

3 Shevis, A. $1 Million Value Newry Tourmaline Trove Is Found. Daily Kennebec Journal, Augusta, Maine, Nov. 18, 1972, pp. 1–2.

4 Bohlin, V. Gems To Fall From the Sky. Herald Traveler and Boston Record American (Boston, Mass.), Sept. 6, 1972, p. 22.

5 Morrisey, C. There's Quartz in Them Thar Hills. New Hampshire Sunday News (Manchester, N.H.), Sept. 3, 1972, pp. 31, 37.

6 Morrill P. Virginia Mines and Minerals. Rocks and Minerals. Part I; No. 393, v. 47, No. 6, June 1972, pp. 363–371. Part II; Nos. 394–395, v. 47, Nos. 7–8, July–August 1972, pp. 435–444. Part III; No. 396, v. 47, No. 9, September 1972, pp. 515–523. Part IV; No. 397, v. 47, No. 10, October 1972, pp. 587–596.

7 Star-Tribune (Casper, Wyo.). More To Come. Jan. 6, 1973.

CONSUMPTION

Domestic gem stone output generally went to rock, mineral, and gem stone collections, objects of art, and jewelry. Apparent consumption of gem stones (domestic production plus imports minus exports and reexports) increased to $423 million, compared with $311 million in 1971, because of greater imports of diamond.

PRICES

During 1972, representative price ranges for first-quality, cut and polished, unmounted gem diamond were 0.25 carat, $100 to $400; 0.5 carat, $300 to $1,000; 1 carat, $700 to $3,500; 2 carats, $2,000 to $11,500; and 3 carats, $3,500 to $25,000. The median price for each range was 0.25 carat, $200; 0.5 carat, $550; 1 carat, $1,675; 2 carats, $4,500; and 3 carats, $9,000.

FOREIGN TRADE

Exports of all gem materials amounted to $184.9 million, and reexports, to $110.9 million. Diamond was 93% of the value of exports and 92% of the value of reexports. U.S. exports of diamond in 1972, on which work was done prior to reexport, amounted to 371,381 carats valued at $172.3 million. Of this, diamond, rough or uncut, suitable for gem stones, not classified by weight, was 345 carats valued at $18,975; cut but unset, not over 0.5 carat, was 63,780 carats valued at $11.5 million; and cut but unset, over 0.5 carat, was 307,256 carats valued at $160.8 million.

Reexports of diamond, on which no work was done, amounted to 1,430,244 carats valued at $101.9 million in categories as follows: Rough or uncut, suitable for gem stones, not classified by weight, 1,335,606 carats valued at $79.0 million; cut but unset, not over 0.5 carat, 40,384 carats valued at $7.7 million; cut but unset, over 0.5 carat, 54,254 carats valued at $15.2 million.

The six leading recipients of diamond exports and reexports accounted for 94% of the carats and 86% of the value and were as follows: Israel, 609,121 carats valued at $41.0 million; Belgium, 435,075 carats valued at $28.5 million; Switzerland, 203,209 carats valued at $37.7 million; Netherlands, 177,003 carats valued at $40.0 million; Japan, 154,497 carats valued at $34.7 million; and Hong Kong, 112,124 carats valued at $71.1 million.

Exports of all other gem materials amounted to $12.6 million. Of this total, pearls, natural and cultured, not set or strung, were valued at $0.2 million. Natural precious and semiprecious stones, unset, were valued at $9.7 million; synthetic or reconstructed stones, unset, were valued at $2.7 million. Reexports of all other gem materials amounted to $9.0 million. Reexports of pearls amounted to $0.3 million; of natural precious and semiprecious stones, unset, to $8.5 million; and of synthetic or reconstructed stones, unset, to $0.2 million.

Imports of gem material increased 36% in value compared with that of 1971. Diamond accounted for 88% of the total value of gem stone imports.

The four leading suppliers of diamond imports were as follows: United Kingdom, 1,334,000 carats valued at $182.2 million; Belgium-Luxembourg, 1,275,000 carats valued at $158.1 million; Republic of South Africa, 980,000 carats valued at $108.3 million; and Israel, 890,000 carats valued at $103.4 million.

Imports of emeralds increased 63% in quantity and 187% in value. Of 30 countries supplying natural emeralds to the United States, India furnished 276,198 carats valued at $6.2 million; Brazil, 90,483 carats valued at $1.5 million; and Colombia, 26,635 carats valued at $7.2 million. Also furnishing emeralds to the United States, but for which the country of origin was unknown, were Switzerland, 31,266 carats valued at $2.3 million; Hong Kong, 52,905 carats valued at $1.4 million; United Kingdom, 31,634 carats valued at $1.2 million; and France, 4,979 carats valued at $1.0 million. These seven countries furnished 90% of the quantity (in carats) and 94% of the value of total emerald imports.

Imports of rubies and sapphires increased 61% and came from 31 countries. Seven countries accounted for 95% of the value of rubies and sapphires, as follows: Thailand, $7.3 million; Sri Lanka (Ceylon), $1.5 million; Switzerland, $1.0 million; India, $1.0 million; Hong Kong, $0.7 million; France, $0.5 million; and United Kingdom, $0.5 million.

Synthetic materials, gem stone quality,

Table 1.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1971 Quantity	1971 Value	1972 Quantity	1972 Value
Diamonds:				
Rough or uncut	2,742	254,575	3,096	338,624
Cut but unset	1,925	208,667	2,410	288,055
Emeralds: Cut but unset	351	7,731	573	22,176
Rubies and sapphires: Cut but unset	NA	8,206	NA	13,172
Marcasites	NA	1	NA	96
Pearls:				
Natural	NA	364	NA	571
Cultured	NA	6,895	NA	7,615
Imitation	NA	5,013	NA	3,707
Other precious and semiprecious stones:				
Rough and uncut	NA	3,532	NA	6,210
Cut but unset	NA	13,456	NA	17,238
Other, n.s.p.f.	NA	734	NA	1,107
Synthetic:				
Cut but unset ... number	11,040	9,492	16,957	10,671
Other	NA	137	NA	165
Imitation gem stones	NA	7,180	NA	6,829
Total	NA	525,983	NA	716,136

NA Not available.

Table 2.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by country

(Thousand carats and thousand dollars)

Country	1970 Rough or uncut Quantity	1970 Rough or uncut Value	1970 Cut but unset Quantity	1970 Cut but unset Value	1971 Rough or uncut Quantity	1971 Rough or uncut Value	1971 Cut but unset Quantity	1971 Cut but unset Value	1972 Rough or uncut Quantity	1972 Rough or uncut Value	1972 Cut but unset Quantity	1972 Cut but unset Value
Belgium-Luxembourg	64	6,572	863	103,705	88	9,092	1,086	113,626	64	10,706	1,211	147,392
Brazil	31	1,184	1	80	3	129	2	232	(1)	26	3	321
Canada	2	462	1	60	--	--	1	69	--	--	1	82
Central African Republic	165	5,826	--	--	208	6,785	--	--	207	6,587	--	--
France	4	195	27	2,550	21	634	31	2,514	33	1,564	23	1,895
Germany, West	2	117	4	516	1	121	2	210	(1)	31	8	324
Guyana	26	1,074	(1)	19	1	49	(1)	19	2	96	(1)	6
India	--	--	40	3,475	--	--	80	6,429	--	--	186	16,507
Israel	52	6,723	604	61,753	47	3,425	671	69,569	38	5,120	852	98,316
Japan	(1)	20	(1)	18	(1)	33	2	203	--	--	1	129
Liberia	6	1,893	--	--	17	3,797	(1)	66	3	1,611	(1)	67
Netherlands	23	7,886	13	1,899	31	6,190	20	2,440	37	10,948	15	2,266
Sierra Leone	--	--	6	814	281	14,331	4	527	164	15,593	3	324
South Africa, Republic of	598	54,571	26	6,868	904	83,889	25	6,988	953	100,059	27	8,286
Switzerland	4	354	1	262	16	3,149	11	1,156	47	2,269	8	1,188
U.S.S.R.	--	--	44	6,826	--	--	24	3,324	--	--	35	5,802
United Kingdom	1,432	140,243	6	970	947	118,913	12	1,366	1,302	178,659	32	3,586
Venezuela	228	6,333	--	--	177	4,283	--	--	244	6,118	--	--
Other	6	711	6	918	(1)	256	4	529	2	237	10	1,564
Total	2,633	234,164	1,642	190,733	2,742	254,575	1,925	208,667	3,096	338,624	2,410	288,055

[1] Less than ½ unit.

cut but not set, and including others, amounted to $10.7 million in imports. From West Germany, the value of synthetics was $3.8 million; from Switzerland, $1.5 million; from France, $1.0 million; from Japan, $0.9 million; and from Austria, $0.8 million.

Marcasites, cut, not set, and suitable for jewelry were imported from two countries. From France, the value of marcasites was $77,000, and from Israel, $19,000.

Precious and semiprecious stones, rough and uncut, amounted to $6.2 million in imports. Three countries accounted for 75% of the value as follows: Colombia, $2.7 million; Brazil, $1.0 million; and Australia, $0.9 million.

Precious and semiprecious stones, cut but not set, amounted to $17.2 million in imports. Six countries accounted for 86% of the value as follows: Hong Kong, $7.8 million; Brazil, $2.2 million; Australia, $2.2 million; West Germany, $1.3 million; Japan, $0.9 million; and Taiwan, $0.5 million.

Natural pearls and parts imported from India were valued at $0.4 million. Other leading suppliers of natural pearls and the value of imports were as follows: France, $57,500; Hong Kong, $35,500; and Japan, $29,000. Imports of cultured pearls from Japan were valued at $7.3 million. Cultured pearls were also imported from Hong Kong valued at $112,600; from Burma, $89,000; and from Switzerland, $67,600.

Four countries accounted for nearly 100% of the value of imports of imitation pearls, as follows: Japan, $3.0 million; Hong Kong, $0.5 million; Taiwan, $0.2 million; and Spain, $0.04 million.

Of 18 countries supplying imitation gem stones to the United States, five countries accounted for 97% by value, as follows: Austria, $3.2 million; West Germany, $1.9 million; Czechoslovakia, $0.8 million; Japan, $0.4 million; and Hong Kong, $0.3 million.

WORLD REVIEW

Angola.—The consortium composed of Companhia de Diamantes de Angola (45%), De Beers Consolidated Mines, Ltd. (45%), and the Angolan Government (10%) reported the finding of two promising and extensive kimberlite deposits in its concession area.[8] No announcement of significant finds during the past year was made by the smaller companies.

Australia.—Australian production of natural sapphire was the world's largest in 1970.[9] Recovery of alluvial sapphires were mainly from Swanbrook Creek near Inverell and from Frazer Creek near Glen Innes, both in New South Wales. Dominion Mining, Ltd. commissioned a new $600,000 sapphire washing plant, claimed to be the world's largest. The sapphires ranged from colorless to dark blue, blue green, green, yellow, and blue yellow. A large portion of the marketable gems weighed more than 1 carat each, and some weighed as much as 40 carats.

Botswana.—The Orapa diamond mine, which became fully operational in June 1972, was the only producer of diamonds. It was estimated that 85% of the diamond production by weight was industrial diamond, and that 50% of the value was gem stone. About 8,540 tons per day were mined from the open pit. Little additional cost would be involved to expand processing by 50% should the market demand warrant the increase.[10]

Brazil.—Mineração Tejucana S.A. continued to be the largest diamond mining operation. The company operated two electric bucket dredges (12- and 9-cubic-foot buckets) on the Jequitinhonha River 54 miles north of Diamantina, Minas Gerais. The company also operated a suction dredge to remove barren sand ahead of the bucket dredges. Early in 1972, a large aquamarine weighing 65 kilograms was found near Ihla Grande, Municipio of Itaobim, Minas Gerais, and was the largest found in Minas Gerais since 1947.

Burma.—Burma's Eighth Annual Gem, Jade, and Pearl Emporium closed March 5, 1972, with reported sales of US$2.3 million, a 12% decrease from the previous year's record sales.[11] Jade was the biggest

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8 Bureau of Mines. Diamond: Angola. Mineral Trade Notes, v. 69, No. 10, October 1972, p. 3.

9 World Mining. Mechanization Boosts Australian Sapphire Output. V. 26, No. 1, January 1973, p. 55.

10 Bureau of Mines. Diamond: Botswana. Mineral Trade Notes, v. 69, No. 9, September 1972, p. 3.

11 Bureau of Mines. Gem Stones: Burma. Mineral Trade Notes, v. 69, No. 6, June 1972, p. 10.

seller, accounting for US$1.7 million in sales. Several Burmese press accounts commented unfavorably on the status of the gem industry and suggested that a better system should be found. A ruby deposit was reported 60 miles northwest of Mogong, Kachin State.[12]

Guyana.—M & V Diamond Mines was incorporated in Canada under a Dominion charter with the objective of mining diamonds in Guyana.[13] The company qualified in Guyana on December 31, 1971. The company obtained five diamond locations covering a combined length of 5.5 miles on th Potaro and Kopinang Rivers in the Mazaruni Mining District, the main diamond area of Guyana.

India.—All diamond production in 1972 was from the Panna District, Madhya Pradesh. Diamond mining operations were controlled and supervised by the Government of India-owned National Mineral Development Corporation (NMDC) in collaboration with the State Government of Madhya Pradesh. About 82% of the production was gem quality. NMDC imported mine-run diamond from African sources for cutting, polishing, and reexport, which in 1971 amounted to US$28 million as imports and US$42 million as exports.

Ivory Coast.—Diamond production was the only output of the mining industry in Ivory Coast since the stoppage of manganese ore mining in 1970.[14] Société Anonyme de Recherches et d'Exploitation Minières en Côte d'Ivoire (SAREMCI) produced 250,367 carats in 1971 and aimed for a similar production in 1972. Société Diamantifere de Côte d'Ivoire (SODIAMCI) stopped activities at Sassandra and at Seguela. On the other hand, the Waston Co. put into operation in January 1971 a processing plant that produced 65,382 carats in 1971 and for which the objective in 1972 was 72,000 carats.

Lesotho.—London and Rhodesian Mining and Land Co. (Lonrho) ceased prospecting operations at Kao in Butha Buthe district that it had begun in 1969 in a search for diamond.[15] Rio Tinto-Zinc Corp. (RTZ) pulled out of Letseng-la-Terai in the Mokhotlong district after more than 3 years of prospecting and sampling. Lonrho spent approximately $1.25 million and RTZ about $3.75 million on their respective operations. Newmont Mining Corp., which began prospecting at Kao in 1971, has spent $1.9 million on its operation.

Sierra Leone.—The "Star of Sierra Leone," a 969-carat diamond, third largest ever found in the world, was sold to Harry Winston, Inc., of New York for more than 900,000 pounds sterling or over $2 million. The sale of "The Star of Sierra Leone" contributed greatly to the profits of the National Diamond Mining Co. (DIMINCO). DIMINCO is 51% owned by the Government.[16] Diamond sales represented more than 60% of all Sierra Leone official exports in 1971. The importance of the diamond mining industry to the economy resulted in further prospecting for kimberlite sources by DIMINCO to offset projected decreases in production from alluvial areas.

South Africa, Republic of.—The Republic of South Africa and the Territory of South-West Africa combined are credited with over 40% of the gem-quality diamond output of the world in the period 1966 to 1971.[17] The De Beers group of mines, open pit, underground, and coastal, accounted for over 90% of the combined output of the two countries. De Beers developed a long-term mining plan for its mines under which part of the operations will be on standby to stretch out the lives of all the mines. Also, preference can be given to the sizes of diamond stones in demand by opening mines that satisfy the demand and by closing those that do not meet the demand.

United Kingdom.—A comprehensive list of sites in England was published for collectors of gem stones and ornamental rocks.[18] General locations for 18 mineral and rock types were shown on an accompanying map.

U.S.S.R.—V-O Almazjuvelirexport, the

[12] World Mining. Burma. Jadeite and Precious Stones. V. 26, No. 1, January 1973, p. 38.
[13] Northern Miner (Toronto). Form New Company To Mine Diamonds In South America. V. 57, No. 51, Mar. 9, 1972, p. 15.
[14] Ivory Coast Bureau of Mines and Geology. Translations on Africa, No. 1242. Joint Publications Research Service, No. 57754, Dec. 12, 1972, pp. 16–20.
[15] Bureau of Mines. Diamond: Lesotho. Mineral Trade Notes, v. 70, No. 3, March 1973, pp. 3–4.
[16] Meisler, S. Diamond Digging in Sierra Leone is Dirty Business. The Denver Post, Sept. 28, 1972, p. 47.
[17] Engineering and Mining Journal. Diamonds: One of South Africa's Best Friends. V. 173, No. 11, November 1972, pp. 184–185.
[18] Adamson, G. L. S. Gems and Decorative Stones in England. Mine & Quarry (London), v. 2, No. 1, January 1973, pp. 35–37.

U.S.S.R. foreign trade organization specializing in diamond and jewelry exporting, exhibited amber products and diamonds at Unimart 1972, the Annual International Trade Fair, at Seattle, Wash.[19] Representatives of U.S.S.R. claimed that the production of diamond from Siberia equals that of the Republic of South Africa in quantity and quality. It was also claimed that the Kaliningrad amber fields are the largest in the world and constitute more than two-thirds of the world's amber reserve.

Table 3.—Diamond (natural): World production by country [1]

(Thousand carats)

Country	1970			1971			1972 [p]		
	Gem	Industrial	Total	Gem	Industrial	Total	Gem	Industrial	Total
Africa:									
Angola	1,797	599	2,396	1,810	603	2,413	1,171	391	1,562
Botswana	[r] 47	[r] 417	[r] 464	82	740	822	360	2,043	2,403
Central African Republic	313	169	482	288	149	437	346	178	524
Ghana	255	2,295	2,550	256	2,306	2,562	266	2,393	2,659
Guinea [e]	22	52	[2] 74	22	52	74	25	55	80
Ivory Coast	85	128	213	130	196	326	131	199	[e] 330
Lesotho [3]	4	13	17	1	6	7	1	8	9
Liberia	[4] 577	[4] 235	[4] 812	[4] 532	[4] 277	[4] 809	532	278	[e] 810
Sierra Leone [5]	723	1,232	1,955	715	1,220	1,935	609	1,038	1,647
South Africa, Republic of:									
Premier mine	623	1,867	2,490	609	1,828	2,437	613	1,841	2,454
Other De Beers Company [6]	2,615	2,140	4,755	2,162	1,769	3,931	2,291	1,874	4,165
Other	520	347	867	398	265	663	466	310	776
Total	3,758	4,354	8,112	3,169	3,862	7,031	3,370	4,025	7,395
South-West Africa, Territory of	1,772	93	1,865	1,566	82	1,648	1,516	80	1,596
Tanzania	359	349	708	419	418	837	365	365	[5] 730
Zaire	1,649	12,438	14,087	1,250	11,270	12,520	980	12,380	13,360
Other areas:									
Brazil [e]	[r] 150	[r] 150	[r] 300	[r] 150	[r] 150	[r] 300	155	155	310
Guyana	24	37	61	19	29	48	20	29	49
India	17	3	20	16	3	19	17	3	20
Indonesia [e]	14	6	20	12	3	15	12	3	15
U.S.S.R.[e]	1,600	6,250	7,850	1,800	7,000	8,800	1,850	7,350	9,200
Venezuela	[r] 131	[r] 378	[r] 509	114	385	499	141	315	456
World total	13,297	29,198	42,495	12,351	28,751	41,102	11,867	31,288	43,155

[e] Estimate. [p] Preliminary. [r] Revised.

[1] Total (gem plus industrial) diamond output of each country is actually reported except where indicated to be an estimate by footnote. In contrast, the detailed separate reporting of gem diamond and industrial diamond represents Bureau of Mines estimates in the case of all countries except Lesotho (all years), Liberia (1970 and 1971) and Venezuela (all years), where sources give both total output and detail. The estimated distribution of total output between gem and industrial diamond is conjectural in the case of a number of countries, based on unofficial information of varying reliability.

[2] Official estimate by Government of Guinea.

[3] Exports of diamond originating in Lesotho; excludes stones imported for cutting and subsequently reexported.

[4] Exports for year ended August 31 of that stated.

[5] Exports.

[6] All company output from the Republic of South Africa except for that from the Premier mines; also excludes company output from the Territory of South-West Africa and from Botswana.

TECHNOLOGY

A description of a technique to pan for diamond was published.[20] By a modification of the method used to pan for placer gold, it is possible to find diamond specimens in the United States. The specific gravity of gold is 19.3 in the pure state and may decrease to 15.0 with impurities. The specific gravity of diamond is 3.52. Hence, the difference between diamond and quartz or common sand, specific gravity of 2.7, indicates the care to be exercised in the panning operation for diamond. The technique was used by the

[19] Barnett, C. Soviet Diamonds Mined in Siberia Dazzle Onlookers at Trade Fair. J. of Commerce, v. 313, No. 22, 762, Aug. 15, 1972, p. 3.

[20] Joque, M. S. Prospecting for Diamonds. Lapidary J., v. 26, No. 10, January 1973, pp. 1501–1507.

author at localities in California. In addition, to these finds, Frank Fischer, an entrepreneur now of Lake Hamilton, Ark., applied his knowledge of diamond identification that he gained from 10 years experience in the diamond fields of Minas Gerais, Brazil, to sites south of Murfreesboro, Ark. Mr. Fischer reported diamond finds at several locations. He believed that the lack of familiarity with diamond by most collectors explains the dearth of diamond finds in the United States.

The quality of synthetic crystals was improved by application of computer controls to the growth process.[21] The system was developed for producing the rare-earth garnet (gadolinium gallium garnet or GGG) and can be adapted to growing other kinds of crystals.

At least 15 lasers were in use by diamond cutters around the world in New York, Antwerp, Israel, and India to increase the value of diamond gem stones by 100% or more.[22]

A yearlong scientific study of the patented 144-facet diamond cut showed that the new cut had an average brilliance 32.2% higher than that of the conventional 58-facet cut.[23]

The most valuable gem stone of the feldspars is moonstone. A complete description of the chemical and physical requirements for forming moonstone was presented in an article that also described means for proper identification.[24]

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21 American Metal Market. Crystals of Gadolinium Produced at Bell Labs. V. 79, No. 176, Sept. 26, 1972, p. 11.

22 Ward, A. Pique Diamonds, Treated By Lasers On The Increase In World Markets. Jewelers' Circular-Keystone, v. 142, No. 6, March 1972, pp. 98–100.

23 Jewelers' Circular-Keystone. 144-facet diamonds more brilliant: Zeiss. V. 143, No. 3, December 1972, p. 109.

24 Rieman, H. M. Moonstone. Lapidary J., v. 25, No. 11, February 1972, pp. 1560–1564.

Gem Stones

By Robert G. Clarke [1]

The production value of gem stones and mineral specimens in the United States during 1973 was estimated to be \$2.7 million, essentially equal to the value of production in 1972. Amateur collectors provided most of the material. A few small companies operated deposits for turquoise, opal, jade, emerald, and sapphire. These small companies sold mostly to wholesale or retail outlets and sometimes to jewelry manufacturers.

DOMESTIC PRODUCTION

Gem stone production was estimated to be \$1,000 or more for each of 38 States. The following States accounted for 76% of the total production, in thousands: Oregon, \$700; California, \$220; Arizona, \$170; Texas, \$163; Washington, \$160; Montana, \$150; Wyoming, \$142; Nevada, \$140; Colorado, \$131; and Idaho, \$110.

The Yogo mine near Utica, Mont. was reopened by a new firm controlled by Sapphire International Corp.[2] The operation was described as employing 40 miners on two shifts, and daily ore production was 100 to 150 tons yielding 3,000 to 5,000 carats per day of a mix of good gem stones, imperfect stones, and chips. The aboveground washing plant operated about 6 months of the year, depending on the weather. Underground operations continued year-round. The sapphires from Yogo Gulch are a consistent corn-flower blue and are brilliant under artificial light.

Pala Properties, International, continued to work the Stewart Lithia mine and the Tourmaline Queen mine in the Pala district, San Diego County, Calif.[3] Good pockets of tourmaline matrix exhibiting deep rose coloring with green caps were uncovered in the Tourmaline Queen. Large tourmaline crystals, 2 inches in diameter and 4¾ inches long, were accompanied by quartz crystals 4 inches in diameter and 6½ inches long. The company also worked the White Queen mine where morganite was produced on an intermittent schedule and also planned to reopen the Pala Chief, Esmeralda, and the Himalaya mines.

Benitoite, one of the rarest gem stones, was produced from an open-cut mine in San Benito County, Calif.[4] The locality is near the headwaters of the San Benito River, about 25 miles north of Coalinga. Benitoite has a fire and dispersion very close to that of diamond; however, it has a hardness of 6.5 or less on the Mohs' scale.

Seashell and rock collectors at Miami Beach, Fla., found a large new source of material for their hobby.[5] A dredging project to deepen the shipping channel at the Port of Miami yielded about 400,000 tons of mixed material that contained a high percentage of coral and clam shells. The dredgings were put in numerous piles at the southern end of Miami Beach. An abundance of the coral and of the clam shells were infilled with yellow calcite crystals caused by fossilization. A mollusk paleontologist at the Rosenstiel School of Marine and Atmospheric Science, University of Miami, estimated the fossils to have a range in age from 100,000 to 1 million years.

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[1] Physical Scientist, Division of Nonmetallic Minerals—Mineral Supply.
[2] The Mining Record of Denver, Colorado. Yogo Mine in Montana is Reopened. V. 84, No. 34, Aug. 22, 1973, p. 2.
[3] California Geology. Mining Activity in California, July 1972–July 1973. V. 26, No. 12, December 1973, p. 294.
[4] Schiffman, W. Mine Produces Rarest of Gems. San Jose Mercury-News, July 22, 1973, p. 12.
[5] Gems and Minerals. Good News for Florida Rockhounds. No. 430, July 1973, pp. 40–41.

Touchstones were collected from gravel beds of the Coosa River system near Wetumpka, Ala., in Elmore County.[6] Touchstone, which has been used since ancient times by jewelers and goldsmiths, can give a precision of about 1 part in 100 in estimating the gold content of a gold-silver or gold-copper alloy. The stones from the Coosa River are also called tarbaby agates. The touchstone from the Coosa River is a deep velvet black variety of jasper and can be polished to a strikingly beautiful gem stone.

Two gem-quality diamonds, 2 to 2½ carats in weight, were reportedly found at the Crater of Diamonds State Park at Murfreesboro, Ark. Mr. J. Cannon, Superintendent of the Park, commented that the stones were of beautiful gem quality. Finders are keepers at the Park, and hence the value of the stones was unknown until the finders report appraisals.

Descriptions of field trips, events, and mineral and gem stone finds were reported regularly in the following publications: Gems and Minerals, Lapidary Journal, Mineralogical Record, and Rocks and Minerals.

Domestic Gem Stone Producers.—The Department of the Interior has received many inquiries regarding producers of gem stones. In response to these inquiries, the Bureau of Mines started an annual canvass in 1973. Quantity and value data were withheld to maintain confidentiality of the producers who responded to the canvass. The following lists producers by principal gem stone reported:

Emerald.—Big Crabtree mine, Mitchell County, N.C., operated by PBH Emerald Co., P.O. Box 163, Little Switzerland, N.C. 28749.

Jade.—Stewart mine, Kobuk Village, Alaska, operated by Stewart Jewel Jade Co., 531 4th Ave., Anchorage, Alaska 99501.

Opal.—Royal Peacock mine, Humboldt County, Nev., operated by Harry W. Wilson, Denio, Nev. 89404.

Spencer Opal mine, Clark County, Idaho, operated by Mark L. Stetler, 1862 Ranier Street, Idaho Falls, Idaho 83401. Mostly operated on a daily fee digging basis for amateurs.

Sapphire.—Chaussee Sapphire mine, Granite County, Mont., operated by Chaussee Sapphire Corp., P.O. Box 706, Philipsburg, Mont. 59858.

Sapphire Village mine (Yogo Gulch), Judith Basin County, Mont., operated by Sapphire International Corp., Utica, Mont. 59452.

Turquoise.—Blue Eye mine, Lander County, Nev. operated by Elmer F. Schroeder, Roderick Corp., Box 6, Crescent Valley, Nev. 89821.

Blue Jay mine, Esmeralda County, Nev., operated by M. C. Winfield, P.O. Box 813, Tonopah, Nev. 89049.

June #1 mine, Lander County, Nev., operated by W. H. Coplen, Box 301, Sells, Ariz. 85634.

Pinto Valley Turquoise Operation, Gila County, Ariz., operated by L. W. Hardy Co., Inc., 3809 E. Hwy. 66, Kingman, Ariz. 86401.

Tina Gem mine, Lander County, Nev., operated by R. G. Bonner, Box 948, Fallon, Nev. 89406.

Variscite.—Brown Claims, Esmeralda County, Nev., operated by C. R. Barbe, Box 187, Mina, Nev. 89422.

CONSUMPTION

Domestic gem stone output generally went to rock, mineral, and gem stone collections, objects of art, and jewelry. Apparent consumption of gem stones (domestic production plus imports, minus exports and reexports) was $423 million, equal to that of 1972.

PRICES

Prices of all gem stones increased during 1973. Price ranges in February 1973 for first-quality, cut and polished, unmounted gem diamond were as follows: 0.25 carat, $100 to $425; 0.5 carat, $300 to $1,000; 1 carat, $700 to $3,800; 2 carats, $2,300 to $12,000; and 3 carats, $4,100 to $25,000. The median price for each range in Feb-

[6] Mayo, R. Tarbaby Agate. Rocks and Minerals, v. 48, No. 1, January 1973, pp. 63–64.

ruary was 0.25 carat, $225; 0.5 carat, $550; 1 carat, $1,750; 2 carats, $4,750; and 3 carats, $9,500. A similar determination of price ranges in June 1973 was 0.25 carat, $100 to $450; 0.5 carat, $300 to $1,195; 1 carat, $800 to $5,000; 2 carats, $2,200 to $20,000; and 3 carats, $4,500 to $35,000. The median price for each range in June was 0.25 carat, $250; 0.5 carat, $595; 1 carat, $2,000; 2 carats, $4,950; 3 carats $11,950. Price data were not ascertained in the latter part of 1973 because of instability and conflict in international political affairs.

FOREIGN TRADE

Exports of all gem materials amounted to $333.1 million, and reexports to $186.8 million. Diamond comprised 94% of the value of exports and 93% of the value of reexports. U.S. exports of diamond in 1973, on which work was done prior to shipment, amounted to 259,119 carats valued at $314.2 million. Of this, diamond cut but unset, suitable for gem stones, not over 0.5 carat, was 44,714 carats valued at $16.7 million; and cut but unset, over 0.5 carat, was 214,405 carats valued at $297.5 million.

Reexports of diamond, on which no work was done, amounted to 1,467,234 carats valued at $173.9 million in categories as follows: Rough or uncut, suitable for gem stones, not classified by weight, 1,389,340 carats valued at $128.3 million; cut but unset, not over 0.5 carat, 35,579 carats valued at $9.0 million; cut but unset, over 0.5 carat, 42,315 carats valued at $36.6 million.

The six leading recipients of diamond exports accounted for 92% of the carats and 93% of the value and were as follows: Hong Kong, 69,071 carats valued at $97.2 million; Switzerland, 59,126 carats valued at $52.3 million; Japan, 53,592 carats valued at $51.7 million; the Netherlands, 30,037 carats valued at $53.9 million; Belgium, 19,878 carats valued at $30.8 million; and Israel, 7,395 carats valued at $6.3 million. The six leading recipients of diamond reexports accounted for 94% of the carats and 92% of the value and were as follows: Israel, 636,497 carats valued at $70.2 million; Belgium, 403,108 carats valued at $30.7 million; the Netherlands, 194,101 carats valued at $30.4 million; Switzerland, 124,715 carats valued at $19.3 million; Japan, 15,874 carats valued at $5.8 million; and Hong Kong, 9,075 carats valued at $2.8 million.

Exports of all other gem materials amounted to $19.0 million. Of this total, pearls, natural and cultured, not set or strung, were valued at $0.5 million. Natural precious and semiprecious stones, unset, were valued at $16.2 million; and synthetic or reconstructed stones, unset, were valued at $2.3 million. Reexports of all other gem materials amounted to $12.9 million. Reexports of pearls amounted to $0.8 million; of natural precious and semiprecious stones, unset, to $11.6 million; and of synthetic or reconstructed stones, unset, to $0.5 million.

Imports of gem material from 85 countries and territories increased 31% in value compared with that of 1972. Diamond accounted for 86% of the total value of gem material imports.

Most of the rough and uncut diamond imports were from seven countries, which accounted for 98% of this category as follows: the United Kingdom, 978,553 carats, $225.8 million; Sierra Leone, 747,000 carats, $78.9 million; Republic of South Africa, 426,881 carats, $83.7 million; Venezuela, 296,271 carats, $9.8 million; Central African Republic, 190,833 carats, $7.7 million; Belgium-Luxembourg, 68,056 carats, $16.8 million; and the Netherlands, 55,255 carats, $22.2 million. Of the imports of diamond, cut and unset, not over 0.5 carat, 89% was supplied by the following eight countries: Belgium-Luxembourg, 1,016,871 carats, $131.4 million; Israel, 774,090 carats, $106.6 million; India, 211,061 carats, $22.8 million; the U.S.S.R., 27,435 carats, $5.2 million; France, 23,485 carats, $2.4 million; the United Kingdom, 18,511 carats, $1.9 million; the Netherlands 15,158 carats, $1.7 million; the Republic of South Africa, 13,656 carats, $3.9 million. For diamond, cut and unset, over 0.5 carat, 99% came from the following seven countries: Belgium-Luxembourg, 142,001 carats, $45.8 million; Israel, 77,944 carats, $21.6 million; the Republic of South Africa, 10,070 carats, $8.9 million; the Netherlands, 2,832 carats, $2.4 million; India, 2,148 carats, $0.3 million; the U.S.S.R., 1,882 carats, $0.7

million; and the United Kingdom, 1,683 carats, $0.5 million.

Imports of emeralds increased 31% in quantity and 47% in value. Of 28 countries supplying natural emeralds to the United States, 10 countries accounted for 97% of the quantity as follows: India, 412,179 carats, $6.7 million; Brazil, 148,399 carats, $1.2 million; Colombia, 47,524 carats, $15.2 million; Hong Kong, 34,196 carats, $1.0 million; Switzerland, 27,840 carats, $2.9 million; the United Kingdom, 22,651 carats, $2.3 million; Israel, 13,771 carats, $0.6 million; the Netherlands, 9,652 carats, $0.1 million; West Germany, 9,419 carats, $0.2 million; and Belgium-Luxembourg, 3,478 carats, $0.2 million.

Imports of rubies and sapphires increased 47% and came from 30 countries. Eight countries accounted for 90% of the value of rubies and sapphires as follows: Thailand, $11.7 million; Hong Kong, $2.5 million; India, $1.4 million; Switzerland, $0.7 million; the United Kingdom, $0.6 million; France, $0.3 million, and Israel, $0.2 million.

Natural pearls and parts imported from India were valued at $260,000. Other leading suppliers of natural pearls and the value of imports were as follows: Italy, $33,100; Japan, $28,600; Hong Kong, $18,500; Switzerland, $10,500; Burma, $8,300; and Taiwan, $5,300. Imports of cultured pearls from Japan were valued at $8.4 million. Cultured pearls, also imported from Hong Kong were valued at $231,000; from Burma, $348,000; from Switzerland, $101,000; from France, $38,000; from Thailand, $22,000; from Italy, $19,000; from West Germany, $8,000; and from India, $8,000.

The imports of imitation pearls decreased two-thirds. Imports from Japan valued at $1.1 million comprised 85% of the total. Other countries from which imitation pearls were imported included: Spain, $78,000; Taiwan, $27,000; Australia, $7,000; Hong Kong, $5,000; the Republic of Korea, $4,000; and West Germany, $1,000. Smaller values also came from France, Switzerland, and Portugal.

Of 17 countries supplying imitation gem stones to the United States, 6 countries accounted for 78% by value, as follows: Austria, $4.0 million; West Germany, $2.8 million; Czechoslovakia, $0.8 million; Switzerland, $0.5 million; Japan, $0.3 million; and Denmark, $0.1 million.

Synthetic materials, gem-stone quality, cut but not set, and others, decreased about 3% in value. From West Germany, the value of synthetics was $4.8 million; from Switzerland, $1.2 million; from Japan, $1.0 million; from France, $0.8 million; from Taiwan, $0.7 million; from Israel, $0.5 million; from Hong Kong, $0.4 million; from Belgium-Luxembourg, $0.3 million; and from Austria, $0.2 million. These nine countries accounted for 98% of synthetic gem imports.

Table 1.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1972		1973	
	Quantity	Value	Quantity	Value
Diamonds:				
Rough or uncut	3,096	338,624	[1] 2,821	[1] 460,198
Cut but unset	2,410	288,055	2,360	360,892
Emeralds: Cut but unset	573	22,176	749	32,600
Rubies and sapphires: Cut but unset	NA	13,172	NA	19,336
Marcasites	NA	96	NA	28
Pearls:				
Natural	NA	571	NA	368
Cultured	NA	7,615	NA	9,232
Imitation	NA	3,707	NA	1,257
Other precious and semiprecious stones:				
Rough and uncut	NA	6,210	NA	5,859
Cut but unset	NA	17,238	NA	25,043
Other n.s.p.f.	NA	1,107	NA	1,532
Synthetic:				
Cut but unset number	16,957	10,571	16,365	10,066
Other	NA	165	NA	341
Imitation gem stones	NA	6,829	NA	10,906
Total	NA	716,136	NA	937,658

NA Not available.
[1] Adjusted by the Bureau of Mines.

Table 2.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by country

(Thousand carats and thousand dollars)

Country	1971				1972				1973			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Belgium-Luxembourg	88	9,092	1,036	113,626	64	10,706	1,211	147,392	68	16,836	1,159	177,222
Brazil	3	129	2	232	(1)	26	3	821	(1)	6	2	409
Canada	--	--	1	69	--	--	1	82	1	276	1	91
Central African Republic	208	6,785	--	--	207	6,587	--	--	191	7,668	--	--
France	21	634	31	2,514	33	1,564	28	1,895	6	169	24	2,441
Germany, West	1	121	2	210	(1)	31	3	324	1	301	1	94
Guyana	1	49	(1)	19	2	96	(1)	6	(1)	37	(1)	3
India	--	--	80	6,429	--	--	186	16,507	(1)	21	213	23,099
Israel	47	3,425	671	69,569	38	5,120	852	98,316	34	7,838	852	128,204
Japan	(1)	33	2	203	--	--	1	129	1	36	2	286
Liberia	17	3,797	(1)	66	3	1,611	(1)	67	7	5,192	(1)	406
Netherlands	31	6,190	20	2,440	37	10,948	15	2,266	55	22,209	18	4,143
Sierra Leone	281	14,331	4	527	164	15,598	3	324	[2] 747	[2] 78,919	(1)	40
South Africa, Republic of	904	83,389	25	6,388	953	100,059	27	8,286	427	83,707	24	12,833
Switzerland	16	3,149	11	1,156	47	2,269	8	1,188	1	181	5	1,429
U.S.S.R	--	--	24	3,324	--	--	35	5,802	--	--	80	5,931
United Kingdom	947	118,913	12	1,366	1,302	178,659	32	3,586	979	225,802	20	2,415
Venezuela	177	4,283	--	--	244	5,118	--	--	296	9,839	(1)	12
Other	(1)	255	4	629	2	287	10	1,564	7	1,161	9	1,834
Total	2,742	254,575	1,925	208,667	3,096	388,624	2,410	288,055	[2] 2,821	[2] 460,198	2,360	360,892

[1] Less than ½ unit.
[2] Adjusted by the Bureau of Mines.

Marcasites, cut but not set, and suitable for jewelry were imported from four countries: Israel, $23,125; Switzerland, $3,644; Hong Kong, $850; and the United Kingdom, $450.

Precious and semiprecious stones, rough and uncut, amounted to $5.9 million in value of imports. Seven countries accounted for 92% of the value as follows: Colombia, $2.4 million; Brazil, $1.3 million; Australia, $0.8 million; the United Kingdom, $0.3 million; the Republic of South Africa, $0.3 million; Mozambique, $0.2 million; and Hong Kong, $0.1 million.

Precious and semiprecious stones, cut but not set, amounted to $25.0 million. Eleven countries accounted for 94% of the value as follows: Hong Kong, $9.4 million; Australia, $3.4 million; Brazil, $3.1 million; West Germany, $1.9 million; Iran, $1.4 million; Taiwan, $1.4 million; Japan, $1.0 million; Sri Lanka, $0.5 million; Mexico, $0.5 million; India, $0.5 million; and Switzerland, $0.5 million.

Coral and cameos, cut but not set, were imported from Italy, $1.2 million; from Japan, $0.5 million; and from Taiwan, $0.3 million. Minor quantities of coral and cameos were also imported from the United Kingdom, France, West Germany, Switzerland, Israel, Singapore, the Philippine Republic, Hong Kong, the People's Republic of China, Australia, and Egypt.

WORLD REVIEW

Angola.—Companhia de Diamantes de Angola (DIAMANG), the only diamond producer, reported an increase in export value in 1972 of 4% to $63.4 million owing to an increase in the percentage of gem stones produced.[7] The quantity of diamond exported in 1972 decreased 6% to 2.2 million carats. All diamond exports go to metropolitan Portugal. The Consorcio de Diamantes de Angloa, the consortium of DIAMANG and De Beers interests that inherited all but 50,000 square kilometers of DIAMANG's former concession area, continued active exploration. A number of promising kimberlite deposits were found, but no plans were made for immediate exploitation.

Australia.—Large deposits of high-quality nephrite jade were discovered near Cowell, a town in the east coast of Eyre Peninsula, about 125 miles northwest of Adelaide, South Australia.[8] A newly formed company, Jade Australia Proprietary Ltd., Adelaide, was reported to have extensive proven reserves.

According to Australian sources, its 300 sapphire mines produce sapphires valued at $15 million and account for 80% of the world volume of sapphire and 50% of the world sapphire value.[9]

Botswana.—Development of a second large diamond mine is expected.[10] The Government of Botswana and De Beers Botswana Mining Co., discussed development of the DK 1 kimberlite pipe 25 miles southeast of the existing Orapa mine, which currently produces 2.4 million carats worth about $30 million per year. The mine at DK 1 could be operating within 18 months after agreements are reached.

Burma.—Burma's Ninth Annual Gem, Jade, and Pearl Emporium was held February 19–24, 1973. Jade sold amounted to $4,307,000; gems, to $281,000; and pearls, to $1,247,000. The total amounted to $5,835,000, a record high. The increase was due primarily to rising world prices of jade rather than an increase in the quantity of jade, or gems, or pearls. Attendance was by 12 countries, 151 firms, and 219 persons. Hong Kong buyers took 119 lots of jade out of the 156 lots sold. The People's Republic of China delegation bought 27 lots of jade, and Japanese buyers bought 9 lots. One bidder from the United States bought one lot of jade. Neither gems nor pearls were bought by U.S. bidders. Motivated by the success of the Ninth Emporium, the Government held a special emporium in August 1973 for jade and pearls, omitting gem stones. At the special emporium, jade sales amounted to $5.3 million. Hong Kong dealers monopolized the buying of jade, accounting for 72 lots of the 81 sold. Burmese authorities assert that reserves of jadeite are adequate

[7] U.S. Bureau of Mines. Angola. Mineral Trade Notes, v. 70, No. 8, August 1973, pp. 8–9.
[8] Stone, J. Massive Jade Discovery in South Australia. Calif. Min. J., v. 42, No. 11, July 1973, p. 24.
[9] Jewelers' Circular-Keystone. Briefly, Australia Becomes a Major Source of Sapphires. V. 64, No. 3, December 1973, p. 97.
[10] Engineering and Mining Journal. In Africa. Botswana. V. 174, No. 12, December 1973, p. 127.

and that prospects are good for locating additional deposits.

Canada.—Pacific Jade Industries, operators of all nephrite jade mines near Ogden Mountain, British Columbia, reported 1972 jade sales of nearly $200,000, over half of which was sold to the People's Republic of China.[11] Exports to other countries included West Germany, Hong Kong, Singapore, and Japan. The most precious jade is generally apple-green in color, translucent, free of flaws, and free of color variations. Variations in color can be almost white or black and all shades of green in between. The value of jade sold ranged from $1 to $30 per pound, averaging about $3.30 per pound. In addition to selling crude jade, Pacific Industries also marketed finished pieces ranging from inkstands and paper weights to works of art.

Central African Republic.—Cominco, Ltd., a Canadian company and Diamond Distributors, Inc., of New York formed a new company, Société Centraficaine d' Exploitation Diamantifere, to conduct diamond mining and exploration in the Central African Republic.[12] Cominco, which has the majority interest, will manage the new company and provide technical direction; Diamond Distributors, Inc., will be responsible for marketing. In the Central African Republic, 60% of the amount of diamond recovered is from the Upper Sangha (Carnot, Berberati, and Nola regions); the remainder is from the northern (Bamingui-Bangoran) and eastern (Haute-Kotte) areas.[13] About 45,000 workers were employed in 1973 to gather diamond from alluvial deposits.

Colombia.—The Government-owned emerald mines at Muzo, Coscuez, and Peña Blanca were closed in July 1973 and the operations landfilled to conserve the unmined emeralds. The emerald mine areas were placed under Colombian Army control. Negotiations were underway between the Ministry of Mines and private operators to arrange the reopening of the mines. The amount of security to be exercised by the Army to protect the operations was an important item. The export of emeralds accounted for more than half of the value of mineral exports from Colombia up to the time of the mine closures.

Israel.—The growth in the imports and exports of gem stones, particularly diamond, has been explosive. The main reasons have been the continual turmoil in exchange rates, and worldwide inflation. People are actively seeking a reliable item of value and a hedge against inflation. Gem stones, most of all diamond, fill the need. The following tabulation indicates the growth pattern: [14]

Year	Net imports of rough gem diamond		Net exports of polished diamond	
	Carats	Value	Carats	Value
1970	3,624,027	$154,861,873	1,501,265	$202,040,738
1971	5,292,715	224,065,256	1,874,685	265,269,576
1972	6,176,605	316,059,884	2,296,829	385,691,783
1973	6,587,698	448,020,973	2,445,092	556,754,004

The value of diamond exports to the United States increased 78% from $74 million in 1971 to $132 million in 1973; however, the share of the exports to the United States decreased from 28% in 1971 to 24% in 1973. After the United States, Japan, Hong Kong, the Netherlands, Switzerland, Belgium, and West Germany, in that order, were the major recipients of diamond exports for 1971 through 1973. In September 1973, diamond enterprises numbered 649 and the employees numbered 9,857.

Lesotho.—As part of a continuing effort by the Lesotho National Development Corp. (LNDC) to revive commercial interest in diamond mining, De Beers Consolidated Mines, Ltd., was granted permission to conduct a 6-month evaluation of the Letseng-la-Terai diamond pipe in the Mokhotlong District.[15] This site was abandoned by Rio Tinto Zinc Corp. in 1972,

[11] Fish, R. H. East and West Meet at B. C. Jade Mine. Northern Miner, v. 59, No. 37, Nov. 29, 1973, p. 44.

[12] Northern Miner (Toronto). Cominco to Mine Diamonds in Central African Republic. V. 59, No. 37, Nov. 29, 1973, p. 32.

[13] Translations on Africa. Central African Republic. 1972 Mining Statistics Show Diamond Production Recovering. JPRS July 23, 1973. No. 1340, p. 1.

[14] Israel, State of. Annual Report for the Year 1973. Ministry of Commerce & Industry, Diamond Department, February 1974, 27 pp.

[15] U.S. Bureau of Mines. Diamond: Lesotho. Mineral Trade Notes, v. 70, No. 9, September 1973, p. 5.

and Newmont Mining Corp. cancelled a similar effort earlier this year at Kao in the Butha Buthe District. However, subsequent evaluations made of the stones in those areas have shown the diamond to be of higher value than originally appraised.

Sierra Leone.—Diamond exports continued to be the main source of revenue for Sierra Leone for 1972 and 1973. World prices which began rising in 1972 were still rising in 1973. The National Diamond Mining Corp. (DIMINCO) increased its work force to recover as much diamond as possible from its alluvial deposits. Diamond production was not tied to long-term price contracts as were other minerals, therefore revenue to the Government of Sierra Leone increased as diamond prices increased.

Sri Lanka.—The State Gem Corp., a Government-owned company, introduced an incentive program to encourage marketing of privately held gem materials. The incentive program was so successful that receipts to the Government increased more than twentyfold for the period January–July 1973 compared with those of the similar period in 1972. Many lovely gem stones are produced in Sri Lanka, but worldwide high prices applied at the source by the State Gem Corp. discouraged buyers from the United States.[16]

South Africa, Republic of.—The Central Selling Organization reported 1973 diamond sales of $1,290 million, an increase

[16] Pough, F. H. Ceylon: Island of Gems. Jewelers' Circular-Keystone, v. 144, No. 5, February 1974, pp. 77–79.

Table 3.—Diamond (natural): World production, by country [1]

(Thousand carats)

Country	1971			1972			1973 [p]		
	Gem	Industrial	Total	Gem	Industrial	Total	Gem	Industrial	Total
Africa:									
Angola	1,810	603	2,413	1,616	539	2,155	1,594	531	2,125
Botswana	82	740	822	360	2,043	2,403	362	2,054	2,416
Central African Republic	[r] 304	[r] 164	[r] 468	346	178	524	251	129	380
Ghana	256	2,306	2,562	266	2,393	2,659	232	2,085	2,317
Guinea [e]	22	52	74	25	55	80	25	55	80
Ivory Coast	130	196	326	134	200	334	120	180	300
Lesotho [2]	1	6	7	1	8	9	1	9	[e] 10
Liberia	[3] 532	[3] 277	[3] 809	[3] 414	[3] 350	[3] 764	450	370	[e] 820
Sierra Leone	[r] 778	[r] 1,168	[r] 1,946	720	1,080	1,800	[4] 670	[4] 1,000	[e 4] 1,670
South Africa, Republic of:									
Premier mine	609	1,828	2,437	613	1,841	2,454	625	1,876	2,501
Other de Beers Co. [5]	2,162	1,769	3,931	2,289	1,872	4,161	2,368	1,938	4,306
Other	398	265	663	468	312	780	455	303	758
Total	3,169	3,862	7,031	3,370	4,025	7,395	3,448	4,117	7,565
South West Africa, Territory of	1,566	82	1,648	1,516	80	1,596	1,520	80	1,600
Tanzania	419	418	837	[4] 326	[4] 325	[4] 651	290	290	[e] 580
Zaire	[r] 1,274	[r] 11,469	[r] 12,743	1,339	12,051	13,390	1,294	11,646	12,940
Other areas:									
Brazil [e]	150	150	300	155	155	310	160	160	320
Guyana	19	29	48	20	29	49	21	31	[e] 52
India	16	3	19	17	3	20	18	3	21
Indonesia [e]	12	3	15	12	3	15	12	3	15
U.S.S.R. [e]	1,800	7,000	8,800	1,850	7,350	9,200	1,900	7,600	9,500
Venezuela	114	385	499	141	315	456	241	537	778
World total	[r] 12,454	[r] 28,913	[r] 41,367	12,628	31,182	43,810	12,609	30,880	43,489

[e] Estimate. [p] Preliminary. [r] Revised.

[1] Total (gem plus industrial) diamond output for each country is actually reported except where indicated to be an estimate by footnote. In contrast, the detailed separate reporting of gem diamond and industrial diamond represents Bureau of Mines estimates in the case of all countries except Lesotho (1971 and 1972), Liberia (1971 and 1972), and Venezuela (1971 and 1972), where sources give both total output and detail. The estimated distribution of total output between gem and industrial diamond is conjectural in the case of a number of countries, based on unofficial information of varying reliability.

[2] Exports of diamond originating in Lesotho; excludes stones imported for cutting and subsequently reexported.

[3] Exports for year ending August 31 of that stated.

[4] Exports.

[5] All company output from the Republic of South Africa except for that from the Premier mine; also excludes company output from the Territory of South West Africa and from Botswana.

of 40% over those of 1972. No breakdown of quantity of gem stones or value of gem stones versus the quantity and value of industrial stones was given. De Beers suspended operations at some mines in favor of operations at other mines to adjust production to meet demand.[17] Consumer demand worldwide in 1973 was mostly for 1.0 carat stones and resulted in a surplus of small stones weighing less than 1/4 carat. A marketing program was developed for use of smaller stones to accentuate other gem stones in jewelry settings.

Zaire.—On November 30, 1973, the Government of Zaire announced that companies formerly operated by a Belgian group, FORMINIERE, would be taken over 100%. Included in this group was the diamond mine of the Société Minière de Bakwanga (MIBA) located at Mbuji Mayi, East Kasai Region. The MIBA mine produces over 12 million carats of diamond annually, nearly all industrial diamond, and is a major foreign exchange earner for Zaire. MIBA employed about 4,000 workers in East Kasai in 1973.

TECHNOLOGY

The Diamond Grading Laboratory, London, England, developed a method for positive identification of individual diamond gems.[18] The method utilizes the range of color in diamond, approximately 1,000 hues, and the characteristics of flaws and inclusions commonly found in all diamond. A full "fingerprint" dossier, including a color photograph, was recommended for all stones 1 carat and over, for an approximate cost of $75 each.

Another utilization of diamond characteristics was developed for identifying the source, or area in the world, from which a diamond came. The De Beers Diamond Research Center, Johannesburg, Republic of South Africa, compiled a set of 150,000 physical observations of diamond from various parts of the world for use in establishing the identifying traits.[19]

Geologists have believed that high pressures and temperatures were necessary for the growth of diamond. Laboratory efforts using high pressure and temperatures were proven successful, first by General Electric Co. research workers and subsequently by many others. However, a review of all available data disclosed that other conditions may foster the growth of diamond.[20] Information gained from patent literature and from laboratory experiments was used to present a new theory on the growth of both natural and synthetic diamond. According to the theory, the essential requirement is a set of conditions that will provide a source of individual carbon atoms that exist in excited states. This theory attempts to explain why diamond is not present in the lower regions of kimberlite pipes, and why some kimberlite pipes have no diamond present. Although high pressure and high temperature used by the earlier experimenters provided a set of conditions that presented carbon atoms in an excited state, the passage of an electric current in the presence of catalytic contaminants was needed to complete the transformation to diamond.

Nephrite jade has a hardness of 6½ on the Mohs' scale and jadeite jade has a hardness of 7. However, the hardness is not an indication of the toughness, or the resistance to breakage. In addition to the two jades, a number of minerals were measured for relative toughness even though no widely accepted scale exists.[21] For comparison, carbonado diamond was found to be the toughest mineral. Of all other natural minerals, nephrite jade measured highest in resistance to breakage, and jadeite was ranked next, a sequence which is the reverse of their accepted relative hardness. In fact, the two jades exceeded most commercially available ceramics. Only ultrahigh strength, hot-pressed oxides and nitrides used for cutting tools and turbine vanes exceeded the two jades in toughness.

The most attractive of current imitation diamonds is a well-made doublet

[17] Forbes. De Beers. V. 112, No. 2, July 15, 1973, pp. 62–64.
[18] Black, S. Diamond: Position Secure As Queen of the Gems. The Financial Times, London. No. 25,968, Feb. 7, 1973, pp. 18–19.
[19] De Beers Consolidated Mines Limited. 1973 Annual Report. P. 23.
[20] Wilson, W. D. On the Growth of Diamond, Part I-A—Modern Theory. Lapidary J., v. 27, No. 6, September 1973, pp. 982–984. On the Growth of Diamond, Part II—Growth of Diamond at Low Pressure. Lapidary J., v. 27, No. 7, October 1973, pp. 1096–1098.
[21] Bradt, R. C., J. V. Biggers, and R. C. Newnham. The Toughness of Jade. Am. Mineralogist, v. 58, Nos. 7-8, July–August 1973, pp. 727–732.

which combines the virtues of two synthetics.[22] A sapphire crown provides durability to the exposed area, and a strontium titanate pavillion provides fire and brilliance. The juncture may be at the girdle or it may be just below the girdle. The plastic cement used to join the crown and pavillion is resistant to almost anything likely to be encountered except steam cleaning.

All phases of faceting require equipment to be properly prepared and also require a skillful artisan. The proper procedure for dopping gems for facet cutting was described for a variety of minerals.[23]

The term "cameo" applies particularly to a stone, shell, glass or other hard substance upon which a design has been carved. A comparison was made of methods used to carve antique cameos and current methods are thoroughly illustrated by examples in color photography.[24]

Pierre Gilson, one of the leading producers of synthetic emeralds, submitted a 3.5–carat synthetic black opal to the Gemological Institute of America for examination.[25] The specimen was described as "absolutely beautiful." The representatives of Gilson claimed that stones as large as 20 carats may be available in the future.

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[22] Pough, F. H. The Simulated Diamond Story. Jewelers' Circular-Keystone, v. 163, No. 10, July 1973, pp. 146, 162–170.

[23] Grieger, J. Faceting Know-How. Grieger J., v. 1, No. 2, May 1973, pp. 1, 11.

[24] Williams, J. D. Cameos. Miner. Digest, v. 2, 2d. Quarter, 1973, pp. 42–51.

[25] Jewelers' Circular-Keystone. Gilson's New Triumph. V. 144, No. 2, November 1973, p. 91.

Gem Stones

Robert G. Clarke [1]

The production value of gem stones and mineral specimens in the United States during 1974 was estimated to be $4.6 million, an increase of 70% over that of 1973. Most of the value was contributed by the few companies which operated deposits for emerald, jade, opal, sapphire, and turquoise. Amateur collectors were important even though their total contribution was surpassed by the commercial operators. The commercial operators sold mainly to wholesale or retail outlets and occasionally to jewelry manufacturers.

DOMESTIC PRODUCTION

Gem stone production was estimated to be $1,000 or more for each of 39 States. The following States accounted for 70% of the total production value in thousands: Arizona, $1,500; Oregon, $500; Montana, $400; Nevada, $400; California, $220; and New Mexico, $200.

Gem stones are considered as one of the reliable items of value sought by people as a hedge against inflation. Added to this demand, the recent tremendous increase in American Indian jewelry has stimulated the turquoise mining industry to new records in value of output.

The Fairburn agate received its name from the town in which it was found first, Fairburn, S. Dak. Fairburns are beautiful agates noted for many fine lines in the pattern and brilliant natural colors. Because of the sharp contrasts of red, white, yellow, and black bands, they are often considered the world's most beautiful agates. Good ones sell for $5 to $100 per pound. Two articles described the collecting areas.[2]

Cape May "diamonds" are little quartz pebbles washed onto New Jersey beaches.[3] These are sold in most Cape May souvenir shops. In addition to beachcombing for the "diamond" quartz pebbles, collectors also gather pebbles of citrine, rose quartz, amethyst, smoky quartz, unakite, jasper, basanite, ilmenite, zircon, and various fossils of shellfish.

Several good quality diamonds, up to 2 carats in weight, were found at the Crater of Diamonds State Park in Arkansas, according to reports from park authorities.

Some of the world's finest sparkling quartz crystals are found in northern and western Arkansas where the collecting localities are numbered by the dozens.[4] Amateurs are permitted to collect at the commercial mine described. The record clear crystal from the operation measured 57 inches in length and 37 inches in width.

Descriptions of field trips, events, and mineral and gem stone finds were reported regularly in the following publications: Gems and Minerals, Lapidary Journal, Mineralogical Record, and Rocks and Minerals.

The quantity and value of emerald, jade, sapphire and tourmaline produced

[1] Physical scientist, Division of Nonmetallic Minerals.

[2] Linde, M. Collecting Fairburn Agates. Gems and Minerals, No. 439, May 1974, pp. 22–23.
Josiassen, S. Rockhound Paradise. Gems and Minerals, No. 439, May 1974, p. 23.

[3] Thomas, C. A. Bonus Trips in the Cape May, New Jersey Area. Gems and Minerals, No. 445, pp. 28–29.

[4] Broughton, P. L. Rock Crystal Clusters From Coleman Crystal Mine Near Hot Springs, Arkansas. Lapidary Journal, v. 28, No. 4, July 1974, pp. 724–728.

domestically were withheld to maintain confidentiality. About 9 tons of rough opal was produced and was valued at $68,000. The production of turquoise of all grades and qualities was nearly 160 tons valued at $2.0 million. Producers of gem stones in the United States, by principal gem stone reported, were as follows:

Emerald.—Big Crabtree mine, Mitchell County, N.C., operated by PBH Emerald Co., P.O. Box 163, Little Switzerland, N.C. 28749.

Jade.—Stewart Jewel Jade mine, Kobuk Village, Alaska, operated by Stewart Jewel Jade Co., 531 4th Ave., Anchorage, Alaska 99501.

Opal.—Jeppesen and Wilson mine, Clark County, Idaho, operated by Jeppesen, Wilson, and others, Rt. 2, Box 162, Idaho Falls, Idaho 83401. Operated on a daily fee-digging basis for amateur collectors.

Lorrie Lee mine, Humboldt County, Nev., operated by Charles L. Eddy, 10799 Sherman Grove, Sunland, Calif. 91040.

Royal Peacock mine, Humboldt County, Nev., operated by Harry W. Wilson, Denio, Nev. 89404.

Spencer Opal mine, Clark County, Idaho, operated by Mark L. Stetler, 1862 Ranier St., Idaho Falls, Idaho 83401. Operated on a daily fee-digging basis for amateur collectors.

Sapphire.—Chaussee Sapphire mine, Granite County, Mont., operated by Chaussee Sapphire Corp., P.O. Box 706, Philipsburg, Mont. 59858. Also sold unscreened material to tourists during the summer months.

Sapphire Village mine (Yogo Gulch), Judith Basin County, Mont., operated by Sapphire International Corp., Box 30, Utica, Mont. 59452.

Tourmaline.—Plumbago Gem mine, Oxford County, Maine, operated by Plumbago Mining Corp., P.O. Box 366, Congress Street, Rumford, Maine 04276.

Turquoise.—Aurora mine, Lander County, Nev., operated by Carico Lake Mining Co., P.O. Box 3426, Albuquerque, New Mexico 87110.

Blue Jim mine, Lander County, Nev., operated by James Elquist, Box 255, Battle Mountain, Nev. 89820.

Cortez Canyon mine, Lander County, Nev., operated by Nevada King Turquoise Co., P.O. Box 21, Searchlight, Nev. 89046.

Duval mine, Mohave County, Ariz., turquoise operations by L. W. Hardy Co., Inc., 3809 E. Highway 66, Kingman, Ariz. 86401.

Pinto Valley mine, Gila County, Ariz., operated by L. W. Hardy Co., Inc., 3809 E. Highway 66, Kingman, Ariz. 86401.

Red Mountain Turquoise mine, Lander County, Nev., operated by Donald B. Potts, Box 629, Tonopah, Nev. 89049.

Shoshone mine, Lander County, Nev., operated by Lombardo Turquoise Milling and Mining Co., Box 148, Austin, Nev. 89310.

Tina Gem mine, Lander County, Nev., operated by Richard G. Bonner, Box 948, Fallon, Nev. 89406.

Villa Grove Turquoise mine, Saguache County, Colo., operated by Clayton C. Musick, Box 101, Villa Grove, Colo. 81155.

CONSUMPTION

Domestic gem stone output went to amateur and commercial rock, mineral, and gem stone collections, objects of art, and jewelry. Apparent consumption of gem stones (domestic production plus imports, minus exports and reexports) was $401 million, about 5% less than that of 1973.

PRICES

Typical costs to a retail jeweler for a 2-week period in December 1974 for representative gem stones, based on a survey of dealers in all parts of the United States, were as follows:[5]

[5] Jewelers' Circular-Keystone. JC-K's Colored Stone Price Index. V. 145, No. 5, February 1975, p. 51.

Gem stone	Carat weight	Median price per carat	Price range per carat
Amethyst	10	$12	$8–$20
Aquamarine	8	95	60–200
Black opal	3	300	200–1,500
Cat's-eye	10	1,000	600–5,000
Citrine	10	6.50	4–20
Emerald	1	1,100	500–7,000
Green garnet	1	275	150–400
Man's sky blue star	10	200	80–1,000
Peridot	15	40	25–60
Ruby	2	800	350–15,000
Sapphire	2	500	250–2,200
Tanzanite	5	220	200–500
Tourmaline	10	35	20–75
White/opal fiery	5	80	35–100

Turquoise prices, wholesale, per pound, Kingman, Ariz., were as follows:

Natural turquoise

	Low-grade	Medium-grade	High-grade
Kingman mine	$80	$100–125	$200–250
Castle Dome mine	80	100–125	150–200

Treated, cutting-grade turquoise

Grade 1—Blue	$60
Grade 1—Blue Green	40
Grade 1—Green	30

Treated, tumbled-polished turquoise

¼-inch = small; ¼-inch-½-inch = medium; ½-inch and up = large. The tumbled-polished turquoise is the same price regardless of size.

Grade 1—Blue	$60-$80
Grade 1—Blue Green	20-40
Grade 1—Green	20-40

Stabilized turquoise

Grade 1	$100
Grade 2	80
Grade 3	60

No survey was made of diamond prices. However, diamond price trends indicated that a 25% increase occurred in the higher range and that the lower range was unchanged.

FOREIGN TRADE

Exports of all gem materials amounted to $320.7 million, and reexports to $165.3 million. Diamond accounted for 95% of the value of exports and 92% of the value of reexports. Exports of diamond in total were 285,136 carats valued at $304.6 million. Of this total, diamond cut but unset, suitable for gem stones, not over 0.5 carat, was 50,340 carats valued at $18.1 million; and cut but unset, over 0.5 carat, was 234,796 carats valued at $286.5 million.

Reexports of diamond amounted to 1,176,132 carats, valued at $151.8 million, in categories as follows: Rough or uncut, suitable for gem stones, not classified by weight, 1,059,089 carats valued at $92.7 million; cut but unset, not over 0.5 carat, 56,686 carats valued at $13.3 million; cut but unset, over 0.5 carat, 60,357 carats, valued at $45.9 million.

The seven leading recipients of diamond exports accounted for 92% of the carats and 95% of the value and were as follows: Hong Kong, 80,627 carats valued at $87.8 million; Switzerland, 75,933 carats, at $63.9 million; the Netherlands, 36,107 carats, at $58.2 million; Japan, 37,247 carats, at $30.6 million; Belgium, 20,170 carats, at $28.6 million; West Germany, 7,822 carats, $10.9 million; and France, 4,968 carats, at $10.2 million. The six leading recipients of diamond reexports accounted for 93% of the carats and 90% of the value and were as follows: Israel, 437,476 carats valued at $41.3 million; Belgium, 383,943 carats, $33.1 million; the Netherlands, 197,919 carats, $31.0 million; Switzerland, 54,924 carats, $20.8 million; Japan, 8,812 carats, $5.3 million; Hong Kong, 12,454 carats, $5.0 million.

Exports of all other gem materials amounted to $16.0 million. Of this total, pearls, natural and cultured, not set or strung, were valued at $0.8 million. Natural precious and semiprecious stones, unset, were valued at $13.3 million; and synthetic or reconstructed stones, unset, were valued at $2.0 million. Reexports of all other gem materials amounted to $13.5 million. Reexports of pearls amounted to $0.9 million; of natural precious and semiprecious stones, unset, to $12.5 million; and of synthetic or reconstructed stones, unset, to $0.1 million.

Imports of gem materials decreased 6% in value from those of 1973. Diamond accounted for 86% of the total value of gem material imports.

Although rough and uncut diamond imports were reported from 28 countries, over 99% in value were from 10 countries as follows: The United Kingdom, 911,165 carats, $211.8 million; the Republic of South Africa, 389,222 carats, $69.0 million; Sierra Leone, 453,084 carats, $57.6 million; the Netherlands, 51,101 carats, $19.2 million; Belgium-Luxembourg, 43,260 carats, $14.8 million; Liberia, 5,724 carats, $8.7 million; Venezuela, 382,738 carats, $8.2 million; Israel, 36,878 carats, $8.1 million; Central African Republic, 131,912 carats, $6.8 million; and France, 30,501 carats, $5.7 million. Cut but unset diamonds, not over ½ carat were imported from 30 countries; however, the imports of this category from 8 countries amounted to 99% of its total value as follows: Belgium-Luxembourg, 838,552 carats, $119.7 million; Israel, 710,386 carats, $109.3 million; India, 219,250 carats, $26.5 million; the Republic of South Africa, 12,956 carats, $3.8 million; the Netherlands, 28,183 carats, $3.6 million; the U.S.S.R., 13,161 carats, $2.6 million; the United Kingdom, 16,967 carats, $2.3 million; and, France, 19,557 carats, $2.1 million.

For diamond cut and unset, over 0.5 carat, 98% in value came from the following six countries: Belgium-Luxembourg, 114,815 carats, $43.2 million; Israel, 63,234 carats, $19.6 million; the Republic of South Africa, 9,837 carats, $6.0 million; the Netherlands, 3,714 carats, $1.4 million; the U.S.S.R., 1,964 carats, $1.0 million; and, the United Kingdom, 1,742 carats, $0.9 million.

Imports of emeralds increased 16% in quantity and 4% in value. Imports of rubies and sapphires increased 8% in value. Natural pearls and parts increased 20% in value but cultured pearls decreased 4% in value. Imitation pearls decreased 19% in value. Other precious and semiprecious stones, rough and uncut, decreased 21% in value. Other precious and semiprecious stones, cut but unset, increased 16% in value and others, not in these categories, increased 21% in value. Synthetic gem stones, cut but unset, decreased 37% in value and imitation gem stones increased 29% in value.

Table 1.—U.S. imports for consumption of precious and semiprecious gem stones
(Thousand carats and thousand dollars)

Stones	1973 Quantity	1973 Value	1974 Quantity	1974 Value
Diamonds:				
Rough or uncut	[1] 2,821	[1] 460,198	2,450	412,678
Cut but unset	2,360	r 360,987	2,083	347,362
Emeralds: Cut but unset	r 750	r 32,865	871	34,046
Coral, cut but not set, and cameos suitable for use in jewelry	NA	2,103	NA	3,082
Rubies and sapphires: Cut but unset	NA	19,336	NA	20,960
Marcasites	NA	28	NA	249
Pearls:				
Natural	NA	368	NA	440
Cultured	NA	9,232	NA	8,874
Imitation	NA	1,257	NA	1,019
Other precious and semiprecious stones:				
Rough and uncut	NA	5,859	NA	4,646
Cut but unset	NA	25,043	NA	29,088
Other n.s.p.f	NA	1,532	NA	1,851
Synthetic:				
Cut but unset .... number	16,365	10,066	9,271	6,316
Other	NA	341	NA	362
Imitation gem stones	NA	r 8,803	NA	11,352
Total	NA	r 938,018	NA	882,320

r Revised. NA Not available.
[1] Adjusted by the Bureau of Mines.

Table 2.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by country

(Thousand carats and thousand dollars)

Country	1972				1973				1974			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Belgium-Luxembourg	64	10,706	1,211	147,392	68	16,836	1,159	[r] 177,317	43	14,804	953	162,926
Brazil	([1])	26	3	321	([1])	6	2	409	1	535	4	642
Canada	--	--	1	82	1	276	1	91	([1])	([1])	([1])	52
Central African Republic	207	6,587	--	--	191	7,668	--	--	132	6,766	--	--
France	33	1,564	23	1,895	6	169	24	2,441	31	5,668	20	2,150
Germany, West	([1])	31	3	324	1	301	1	94	1	72	2	207
Guyana	2	96	([1])	6	([1])	37	([1])	3	--	--	([1])	15
India	--	--	186	16,507	([1])	21	213	23,099	--	--	221	26,709
Israel	38	5,120	852	98,316	34	7,838	652	128,204	37	8,052	774	128,856
Japan	--	--	1	129	1	36	2	286	1	77	4	854
Liberia	3	1,611	([1])	67	7	5,192	([1])	406	6	8,688	([1])	5
Netherlands	37	10,948	15	2,266	55	22,209	18	4,148	51	19,198	32	4,948
Sierra Leone	164	15,593	8	324	[2] 747	[2] 78,919	([1])	40	458	57,577	1	82
South Africa, Republic of	953	100,059	27	8,286	427	83,707	24	12,888	389	68,948	23	9,786
Switzerland	47	2,269	8	1,188	1	181	5	1,429	2	251	8	1,587
U.S.S.R	--	--	35	5,802	--	--	30	5,931	--	--	15	3,609
United Kingdom	1,302	178,659	32	3,586	979	225,802	20	2,415	911	211,799	19	3,209
Venezuela	244	5,118	--	--	296	9,839	([1])	12	383	8,215	([1])	20
Other	2	287	10	1,564	7	1,161	9	1,834	9	2,038	7	1,705
Total	3,096	338,624	2,410	288,055	[2] 2,821	[2] 460,198	2,360	[r] 360,987	2,450	412,678	2,083	347,362

[r] Revised.
[1] Less than ½ unit.
[2] Adjusted by the Bureau of Mines.

WORLD REVIEW

Australia.—Descriptions of the two areas in Australia, where most of the world's sapphires are produced, was provided in a recent issue of the Lapidary Journal.[6] The Swanbrook mine, near Inverel, several hundred miles north of Sydney, New South Wales, is a strip mining operation of Dominion Mining N.L. and is one of the largest of about 50 mines in the area. Each truckload of gravel mined contains about 100 grams (2 ounces) of sapphire of which about 10% is gem quality and sold by the carat. The rest of the sapphires are sold by the kilogram to collectors. Mechanical separation by screens and sieves is done first, followed by handsorting to pick out the materials which cannot be separated mechanically. The mine is in a cultivated area and all land is restored to its original condition. The Queensland sapphire fields are in the vicinity of the settlement of Anakie, about 200 miles west of Rockhampton. Individual miners are allotted mining areas 66 by 66 feet. The sapphire-bearing gravel is generally not more than 3 feet deep and mining is done by hand. If water is available, the gravel is washed over a screen, but dry sorting is also practiced in this arid area of Australia.

Production of opal in Australia probably accounts for 98% of the world's supply. Several well-illustrated articles described the localities in Australia where opals are found and also the methods used to mine them.[7] At Coober Pedy, the largest field in South Australia, heavy equipment such as bulldozers, is used to supplement the pick and shovel common to other areas. Two other major areas are Ankamooka, also in South Australia, and Lightning Ridge in New South Wales. Opal prices varied, depending on quality, from about $1 per ounce for the lowest grade of crude to $1,200 per ounce for excellent quality. Top grade opal in larger pieces up to 1 ounce in size sold for nearly $3,000 per ounce.

Botswana.—The Orapa mine of the De Beers Botswana Mining Co., (Pty.) Ltd., produced an estimated 2,718,000 carats of diamond from 2,954,000 tons of ore treated or 92 carats per ton treated.[8] Gem stones were about 15% of the yield. Sampling of kimberlite pipes, DK 1 and DK 2, by De Beers was completed but negotiations on further development were still in progress. The Government of Botswana has requested a review of terms for the Orapa mine.[9] Drilling was continued in several kimberlite pipes in southern Botswana.

Brazil.—The only large mechanical operation, Mineração Tejucana, S. A., reported production of 65,861 carats of diamond from 8.6 million cubic yards of gravel dredged and treated during 1973. Average sales price was $33.81 per carat. Production was about equally divided between gem and industrial stones.

The Brazil National Department of Mineral Production published its first bulletin on prices of minerals and metallurgical products for the period of January to March 1974. For precious and semiprecious stones the price list gave a range for the various qualities and median price f.o.b. Rio de Janeiro for diamond, aquamarine, emerald, chrysoberyl, citrine, amethyst, topaz, morganite, kunzite, garnet, opal, alexandrite, and tourmaline.

Central African Republic.—The 1974 diamond production attained a level about one-fifth higher than that of 1973. About two-thirds of the output was gem stone diamond by weight; and by value, gem stone diamond was more than 90%. Diamond exports accounted for about 35% of the foreign exchange receipts. Société Centrafricaine d'Exploitation Diamantifére was formed as a joint enterprise in 1973 by Diamond Distributors International, Inc., of New York, Cominco, Ltd., of Canada, and the Government to mechanize mining operations as well as to aid diggers. The joint enterprise was credited with the gains for 1974.

Ghana.—The Ghana Department of Mines reported diamond production of 2.3 million carats in 1973, a decline from

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[6] Curtis, R. Sapphire Treasure Won From Australian Open-Cut Mine. Lapidary Journal, v. 28, No. 8, November 1974, pp. 1280–1282.
Kovac, C. Queensland's Sapphires. Lapidary Journal, v. 28, No. 8, November 1974, pp. 1318–1321.

[7] Wright, D. The Craze for Opal. Lapidary Journal, v. 27, No. 11, February 1974, pp. 1726–1732.
Ross, R. Lightning Ridge Block Opal Knobby. Lapidary Journal, v. 27, No. 12, March 1974, pp. 1796–1802.
Oakley, P. An Opal Prospecting Tour Through Australia. Lapidary Journal, v. 28, No. 5, August 1974, pp. 778–789.

[8] De Beers Consolidated Mines Limited. Annual Report 1974, p. 22.

[9] Page 5 of work cited in footnote 8.

Table 3.—Diamond (natural): World production by country [1]

(Thousand carats)

Country	1972 Gem	1972 Industrial	1972 Total	1973 Gem	1973 Industrial	1973 Total	1974 [p] Gem	1974 [p] Industrial	1974 [p] Total
Africa:									
Angola	1,616	539	2,155	1,594	531	2,125	1,600	500	[e] 2,100
Botswana	360	2,043	2,403	362	2,054	2,416	408	2,310	2,718
Central African Republic	346	178	524	251	129	380	300	150	[e] 450
Ghana	266	2,393	2,659	232	2,085	2,317	257	2,316	[e] 2,573
Guinea [e]	25	55	80	25	55	80	25	55	80
Ivory Coast	134	200	334	120	180	300	130	190	[e] 320
Lesotho [2]	1	8	9	1	[r] 8	9	2	9	11
Liberia [3]	[4] 481	[4] 409	[4] 890	[r] 509	[r] 308	[r] 817	377	259	636
Sierra Leone [3]	720	1,080	1,800	646	758	1,404	670	1,000	[e] 1,670
South Africa, Republic of:									
Premier mine	613	1,841	2,454	625	1,876	2,501	605	1,817	2,422
Other de Beers Co.[5]	2,291	[r] 1,874	[r] 4,165	2,368	1,938	4.306	2,897	1,961	4,858
Other	466	[r] 310	[r] 776	455	303	758	433	289	722
Total	3,370	4,025	7,395	3,448	4,117	7,565	3,435	4,067	7,502
South West Africa, Territory of	1,516	80	1,596	1,520	80	1,600	1,491	79	1,570
Tanzania	326	[r] 326	[r] 652	[r] 251	[r] 250	[r] 501	275	275	[e] 550
Zaire	[r] 1,332	[r] 12,058	13,390	[r] 1,082	[r] 11,858	12,940	1,100	11,900	[e] 13,000
Other areas:									
Brazil [e]	155	155	310	160	160	320	160	160	320
Guyana	20	29	49	[r] 31	[r] 21	52	30	20	50
India	17	3	20	18	3	21	17	3	[e] 20
Indonesia [e]	12	3	15	12	3	15	12	3	15
U.S.S.R.[e]	1,850	7,350	9,200	1,900	7,600	9.500	1,950	7,850	9,800
Venezuela	141	315	456	[r] 315	[r] 463	[r] 778	280	420	700
World total	12,688	31,249	43,937	12,477	30,663	43,140	12,519	31,566	44,085

[e] Estimate. [p] Preliminary. [r] Revised.

[1] Total (gem plus industrial) diamond output for each country is actually reported except where indicated by footnote to be an estimate. In contrast, the detailed separate reporting of gem diamond and industrial diamond represents Bureau of Mines estimates in the case of every country except Central African Republic (1972 and 1973), Lesotho (1972 and 1973), Liberia (all years), Guyana (1972 and 1973), and Venezuela (1972 and 1973), where sources give both total output and detail. The estimated distribution of total output between gem and industrial diamond is conjectural in the case of a number of countries, based on unofficial information of varying reliability.

[2] Exports of diamond originating in Lesotho; excludes stones imported for cutting and subsequently reexported.

[3] Exports.

[4] Revised from data in previous edition, which were for years ending August 31 of year stated, to normal calendar year basis.

[5] All company output from the Republic of South Africa except for that from the Premier mine; also excludes company output from the Territory of South West Africa and Botswana.

the 2.7 carats produced in 1972.[10] Since 1968, the average annual production from Ghana's two diamondiferous areas, the Birim River Basin (Eastern Region) and the Bonsa Region (Western), has averaged 2.47 million carats. Three companies, Ghana Consolidated Diamonds, Ltd., Cayco (Ghana) Ltd., and the Amalgamated Diamond Corp., are actively engaged in mining diamonds in the Birim River Basin. First International Natura Corp. of the United States completed exploration in the Birim and Pra River areas, and it was reported the firm would be issued a license for a project in which the Government will own a 55% share. Since the liquidation in 1969 of Takrowase Diamond Field, the Government has preferred participation rather than outright ownership in diamond mining operations. Effective from October 1, 1972, the Government acquired by decree a 55% interest in Consolidated African Trust's Ghana diamond operations by forming Ghana Consolidated Diamonds Ltd., in which Consolidated African Selection Trust Ltd. has a 45% share. Ghana Consolidated Diamonds Ltd. production in the 5-year period, 1968–73, was 2.39 million carats, or about 96% of the country's production, according to Ghana's Mines Department. The output averages about 10% gem stones of high quality.

Kenya.—A pink corundum deposit was claimed to be possibly the largest ruby mine in the world and was also the subject of dispute between Government administrators and geologists from the United States who made the original discovery.[11] According to the reports, about 300 kilograms of corundum were exported in the first 9 months of 1974 and were worth between $30,000 and $40,000 or over $100 per kilogram. The mine is located in the Tsavo National Game Park in southeastern Kenya.

Lesotho.—On March 1, 1974, an announcement was made that De Beers Diamond Corp. and the Government of Lesotho (GOL) reached an agreement in principle on opening the Letseng-la-terai diamond mine in the Maluti mountains at an estimated cost of over $30 million.[12] The agreement was to be signed early in 1975.[13] GOL will have a 25% equity in the corporation and will receive 62.5% of profits after recovery of invested capital. If the mine were to prove substantially more profitable than anticipated, the GOL percentage of profits could rise on a sliding scale to a maximum of 72%. Production is expected to start in 1977 at a rate of 4,000 tons of ore per day. A diamond sales company registered in Lesotho will be established and, throughout the life of the mine, the production will be marketed through the Central Selling Organization.

South Africa, Republic of.—In April 1974 a miner found a 616-carat gem diamond in the crusher at the Dutoitspan mine in the Kimberley area.[14] The diamond is the ninth largest gem diamond ever found and is the largest found in the Kimberley area. The announcement by De Beers said that the diamond was a yellow octahedron of good shape but not of the best quality.

Diamond sales by the Central Selling Organization decreased from R921 million ($1,289.4 million) in 1973 to R849 million ($1,288.6 million) in 1974, or 7.8%. Production of the larger and more valuable stones from all mines, old and new, declined. Generally, the increased demand for small diamonds was insufficient to offset the drop in value due to lower sales of large diamonds.

Sri Lanka.—The State Gem Corporation established a gem export incentive program under which exporters could reserve 25% of their gem value in unrestricted external accounts. The program created a boom in gem stone mining because all other segments of the business population, in addition to those already in the gem stone industry, joined in the export market to have access to the trade privileges. Gem stones in 1973 ranked fourth after tea, rubber, and coconut products in value of exports and were expected to rank second in 1974, exceeded only by the value of tea. Prior to 1973, gem stones contributed little to the total export value of Sri Lanka, but the 20-fold increase of the value in 1973 compared with that of 1972 raised the value of gem stones into the top rankings. Gem stones of interest to collectors include sapphire, ruby, garnet,

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[10] U.S. Bureau of Mines. Diamond: Ghana. Mineral Trade Notes, v. 71, No. 7, July 1974, pp. 3–4.
[11] Arkansas Gazette. Americans, Kenya Seeking Ruby Mine. Oct. 7, 1974, sec. A, p. 8.
[12] U.S. Bureau of Mines. Diamond: Lesotho. Mineral Trade Notes, v. 71, No. 5, May 1974, p. 3.
[13] Pages 5 and 6 of work cited in footnote 8.
[14] World Mining. Republic of South Africa. Diamonds Sparkle Again for DeBeers. V. 27, No. 6, June 1974, p. 52.

catseye, spinel, moonstone, alexandrite, tourmaline, and varieties of quartz.

Thailand.—Major gem stones mines in Thailand are located in the provinces of Chantaburi, Kanchanburi, Phrae, Si Saket, and Trat.[15] The following types of gem stones are found: Ruby, sapphire, spinel, peridot, garnet, zircon, beryl, tourmaline, jadeite, quartz, and occasionally diamond. A high-volume of jade and rough sapphire stones are imported and reexported as cut stones because of the lower labor costs in Thailand. The majority, about 85%, of Thai gems are sold as cut stones. In Bangkok, the average prices for cut stones late in 1973 were $500 per carat for ruby, $380 per carat for blue sapphire, and $70 per carat for yellow sapphire. In 1957 gem stone exports amounted to about $380,000 but in 1973 the total value was about $31.0 million.

TECHNOLOGY

The world's third largest rough diamond—the 968.9-carat Star of Sierra Leone—was cut into 11 fine white gem stones ranging from 143.2 carats to 1.85 carats.[16] The total weight of the cut stones was 328.14 carats, a recovery of 33.9% comparing favorably with previously cut large stones.

Two color-illustrated articles described in detail the effects of either gamma radiation or heat treatment on the resulting gem stone colors.[17]

Colorless to pale-yellow topaz turned to a sherry color (imperial topaz) or to brown; however, an occasional topaz turned blue when irradiation was followed by heating. When colorless quartz was gamma-irradiated, it had a smoky or amethyst color, depending on the iron and aluminum content as well as the growth direction. Some natural colorless or pale-color beryl turned a deep-blue color after radiation, but the color was unstable on exposure to light. Similar dosages of gamma irradiation induced major color changes in tourmaline, but the stability of these colors was unpredictable on exposure to light or heat. An unstable new color in some Brazilian crystalline quartz was produced by gamma irradiation followed by gentle heating techniques. Pearls, a gem stone material, turned gray, bluish-gray, or blue by gamma irradiation and were stable. Kunzite turned a deep green after gamma irradiation but bleached on exposure to light or after heating. Minor color changes apparently were produced in jade and no changes appeared in opal after irradiation.

Technological progress in the use and application of lasers and grasers (X-ray laser) in gem stone analyses was reported.[18] Items of significant progress were as follows:

1. High-output laser systems have processed a variety of materials including plastic, metal, stone, and minerals.

2. Laser interferometry, holography, and acoustical holography have been used for the nondestructive testing of materials.

3. The X-ray laser or graser has been used in research and may lead to knowledge of the molecular structure of matter but it is extremely dangerous to use.

The first International Kimberlite Conference was held in the Republic of South Africa and Lesotho September 17 through October 8, 1973.[19] The conference of about 200 delegates from 20 countries brought together geologists who have an interest

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[15] Bangkok Bank Monthly Review. Other Aspects of the Economy. Gem Stones—A Promising Industry. V. 16, No. 3, March 1975, pp. 172–176.

[16] Jewelers' Circular-Keystone. The Diamond Scene. Winston Cuts Sierra Leone Star, Largest Gem Is 143.2 Carats. V. 154, No. 4, January 1975, p. 138.

[17] Nassau, K. The Effects of Gamma Rays on the Color of Beryl, Smoky Quartz, Amethyst and Topaz. Lapidary Journal, v. 28, No. 1, April 1974, pp. 20–26, 30, 36–40.

Nassau, K. The Effect of Gamma Rays on Tourmaline, Greenish-Yellow Quartz, Pearls, Kunzite, and Jade. Lapidary Journal, v. 28, No. 7, October 1974, pp. 1064–1074, 1084.

[18] Goldman, L. Progress in Laser Technology and Art. Lapidary Journal, v. 28, No. 4, July 1974, pp. 636–639.

[19] Boyd, F. R. Kimberlite Conference in Africa. Geotimes, v. 19, No. 5, May 1974, pp. 24–25.

in the discovery of kimberlites, which can be the source rock for diamond.

The eruption of kimberlites in various parts of the world has brought an unusual variety of rock to the surface from the upper mantle and crustal basement. Southern Africa is rich in kimberlites, and the kimberlite occurrences in the small country of Lesotho alone amount to 17 pipes, 21 dike enlargements, and more than 200 dikes.[20]

A guide to collecting in working and abandoned mines was published and strongly emphasized attention to safety.[21] The publication was directed towards the experienced mineral collector who occasionally has the opportunity to go underground.

[20] Lesotho National Development Corp. Lesotho Kimberlites, ed. by P. H. Nixon. Printed by Cape & Transvaal Printers, Ltd., Capetown, Republic of South Africa, 1973, 336 pp., 69 plates.

[21] Wilson, W. E. A Guide to Underground Collecting. The Mineralogical Record, v. 5, No. 3, May–June 1974, pp. 128–137.

Gem Stones

By Robert G. Clarke [1]

The value of gem stones and mineral specimens produced in the United States during 1975 was estimated to be $8.7 million, an increase of 90% over that of 1974. The domestic commercial mining industry contributed most of the increase, particularly in the production of turquoise. Amateur collectors accounted for much of the activity in many States. Commercial operators sold mainly to wholesale or retail outlets and also to jewelry manufacturers.

DOMESTIC PRODUCTION

Mines and collectors in 39 States produced gem materials estimated at $1,000 or more in value for each State. Ten States supplied 91% of the total value, as follows: Arizona, $5 million; Nevada, $1 million; Oregon, $500,000; Montana, $400,000; California, $220,000; New Mexico, $200,000; Texas, $160,000; Washington, $160,000; Wyoming, $140,000; and Colorado, $135,000.

Park authorities at the Crater of Diamonds Park in Arkansas reported the finding of the second largest diamond ever found in the area.[2] The diamond, 16.37 carats in weight, was flawless and clear white. The rough value was placed at $15,000; when finished, the stone will be worth $80,000 to $100,000.

Several minute diamond crystals were discovered in a rock sample from a diatreme in Wyoming, according to geologists who have been examining pipelike intrusions of igneous rock in the Rocky Mountain area.[3]

In Nevada, the explosion in demand for turquoise jewelry resulted in an increased value of gem stone production of 150% from an estimated $400,000 in 1974 to $1 million in 1975. To help individuals learn more about collecting localities in Nevada, a "map" was published of the State's rocks and minerals.[4]

The quantity and value of emerald, jade, opal, and sapphire were withheld to maintain confidentiality of reporting producers. Peridot was produced by about 200 individuals of the San Carlos Apache Tribe at Peridot, Ariz.; no estimate of quantity and value of the peridot was available.

The production of turquoise of all grades and quantities was nearly 586 tons, valued at $5.2 million, and was principally from Arizona, Colorado, and Nevada. The great interest in American Indian style jewelry continued throughout 1975. Many articles appeared in various publications describing the qualities of genuine turquoise and Indian jewelry.

The discovery of tourmaline in Maine initially occurred in August 1972. The discovery and subsequent development were described in detail.[5] Tourmaline has appeared in jewelry stores occasionally in the past, but the discovery at Newry assured a regular supply. Retail prices in

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[1] Physical scientist, Division of Nonmetallic Minerals.

[2] Arkansas Gazette. Little Rock, Ark. Record Diamond Found in Park. Aug. 21, 1975, sec A, p. 1.

[3] U.S. Geological Survey. Diamond Discovered in Wyoming. News Release, June 10, 1975.

[4] Nevada Bureau of Mines and Geology. Rockhound's Map of Nevada. Spec. Pub. 1, 1975.

[5] Dunn, P. J. Elbaite From Newry, Maine. Miner. Record, v. 6, No. 1, January-February 1975, pp. 22–25.

MacFall, R. P. Gem Tourmaline . . . Rediscovered at Newry. Miner. Record, v. 6, No. 1, January-February 1975, pp. 14-21.

——. The Story Beyond the Story of the Great Tourmaline Discovery. Lapidary J., v. 29, No. 5, August 1975, pp. 994–1001.

1975 ranged from about $8 per carat for small, slightly flawed stones to $100 per carat for large stones of good color weighing about 50 carats.

In addition to emerald, North Carolina is also the source for rhodolite, a garnet varietal. Western North Carolina is invariably associated with rhodolite garnets and probably the world's only supplier. A description of the area where rhodolite is found was published with complete instructions for gem seekers at the dig-for-fee mine.[6]

Accurate and up-to-date information for collecting areas is difficult to maintain. A listing of fee-basis and free digging areas for agate and other gem materials in central Oregon was provided with the cautionary advice to inquire in advance to verify the information.[7]

Custer, S. Dak., has been called the rose quartz capital of the world. In addition, four totally new minerals were discovered in the area: Jahusite, robertsite, segelerite, and wylheite.[8]

Producers of gem stones in the United States, by principal gem stone reported, follow:

[6] Broughton, P. L. North Carolina's Mason Mountain Rhodolites. Gems and Minerals, No. 453, July 1975, pp. 30–31.
[7] Shipp, M. D. Digging in Central Oregon 1975. Lapidary J., v. 29, No. 4, July 1975, pp. 870–871.
[8] Linde, M. South Dakota Mineral News. Gems and Minerals, No. 452, June 1975, pp. 32–33, 61–64.

Mine	Location	Operator
Emerald: Big Crabtree mine	Mitchell County, N.C	PBH Emerald Co. P.O. Box 163 Little Switzerland, N.C. 28749
Jade: Stewart Jewel Jade mine	Kobuk Village, Alaska	Stewart Jewel Jade Co. 531 4th Ave. Anchorage, Alaska 99501
Opal:		
Royal Peacock mine	Humboldt County, Nev	Harry W. Wilson Denio, Nev. 89404
Spencer Opal mine (dig-for-fee mine).	Clark County, Idaho	Mark L. Stetler 1862 Ranier St. Idaho Falls, Idaho 83401
Sapphire:		
Chaussee Sapphire mine (sold unscreened material to tourists in summer and assisted in screening).	Granite County, Mont	Chaussee Sapphire Corp. P.O. Box 706 Philipsburg, Mont. 59858
Sapphire Village mine (Yogo Gulch).	Judith Basin County, Mont.	Sapphire International Corp. P.O. Box 30 Utica, Mont. 59452
Turquoise:		
Aurora mine	Lander County, Nev	Carico Lake Mining Co. P.O. Box 3426 Albuquerque, N. Mex. 87110
Black Spider mine	do	Grillos Mining Co. 2221 10th St. Lubbock, Tex. 79401
Blue Eagle mine	Mineral County, Nev	E. Loving and D. Lester P.O. Box 155 Mina, Nev. 89422
Blue Jim mine	Lander County, Nev	James Elquist P.O. Box 255 Battle Mountain, Nev. 89820
Blue Spider mine	do	John Lee & Co. 5101 North 40th St., Apt. 119 Phoenix, Ariz. 85018
Boundary mine	Mineral County, Nev	D. Brannon and R. H. Herrington P.O. Box 377 Mina, Nev. 89422
Duval Corp. mine	Mohave County, Ariz	L. W. Hardy Co., Inc. 3809 East Highway 66 Kingman, Ariz. 86401
Morenci mine	Greenlee County, Ariz	W. O. Brown 230 West 66 Avenue Gallup, N. Mex. 87301
Pinto Valley mine	Gila County, Ariz	L. W. Hardy Co., Inc. 3809 East Highway 66 Kingman, Ariz. 86401
Red Mountain mine	Lander County, Nev	J. M. Johnson 102 West 9th Place Mesa, Ariz. 85201 Turquoise Nugget (colessee) P.O. Box 1118 Flagstaff, Ariz. 86001

Mine	Location	Operator
Turquoise—Continued		
Royal Blue mine	Esmeralda County, Nev	R. C. Wilcox P.O. Box 1311 Tonopah, Nev. 89049
Shoshone and Ackerman mines	Churchill County, Nev	Lombardo Turquoise Co., Inc. 1800 East Main St. Austin, Nev. 89310
Turquoise Chief mine	Lake County, Colo	N. F. Reed Albuquerque, N. Mex. 87110
Villa Grove mine	Saguache County, Colo	G. Musick P.O. Box 174 Villa Grove, Colo. 81155

CONSUMPTION

Domestic gem stone output was utilized for amateur and commercial rock, mineral, and gem stone collections, objects of art, and jewelry. Apparent consumption of gem stones (domestic production plus imports minus exports and reexports) was $468 million, about 17% more than in 1974.

PRICES

Typical costs to a retail jeweler in December 1975 for representative better quality gem stones as reported by 15 typical importers follow: [9]

Gem stone	Carat weight	Median price per carat	Price range per carat
Amethyst	10	$12	$8–$20
Aquamarine	8	95	50–250
Black opal	3	450	200–1,500
Cat's eye	5	1,000	700–1,250
Citrine	10	5	4–8
Emerald	1	1,700	750–12,000
Green garnet	1	425	400–500
Man's sky blue star	10	225	85–500
Peridot	10	45	25–70
Ruby	2	2,000	850–15,000
Sapphire	2	650	350–3,500
Tanzanite	5	200	200–260
Tourmaline, green	10	55	30–80
Tourmaline, pink	10	70	25–90
White opal, fiery	5	65	35–120

NOTES.—Ten-carat cat's eyes and 15-carat peridot, both of which were on the 1974 list, became unavailable during 1975, but the median price per carat of the smaller stones held at the levels of the larger stones.

No survey was made of diamond prices; price trends indicated higher prices for cut diamond 1 carat and smaller, but no change in larger cut diamond.

FOREIGN TRADE

Exports of all gem materials amounted to $257.2 million, and reexports to $133.7 million. Diamond accounted for 92% of the value of both exports and reexports. Exports of diamond totaled 264,873 carats valued at $237.0 million. Of this total, diamond cut but unset, suitable for gem stones, not over 0.5 carat, was 50,180 carats valued at $15.2 million; and cut but unset, over 0.5 carat, was 209,427 carats valued at $220.7 million.

Reexports of diamond amounted to 1,178,482 carats, valued at $122.7 million, in categories as follows: Rough or uncut, suitable for gem stones, not classified by weight, 1,049,903 carats valued at $79.4 million; cut but unset, not over 0.5 carat, 44,089 carats valued at $10.1 million; cut but unset, over 0.5 carat, 84,490 carats, valued at $33.1 million.

The eight leading recipients of diamond exports accounted for 84% of the carats

[9] Jewelers' Circular-Keystone. JC-K's Colored Stone Price Index. V. 146, No. 4, January 1976, p. 124.

and 96% of the value and were as follows: Hong Kong, 82,136 carats valued at $94.3 million; Japan, 40,484 carats, $33.5 million; Switzerland, 40,643 carats, $31.8 million; the Netherlands, 21,894 carats, $24.9 million; Belgium, 13,986 carats, $20.5 million; France, 6,598 carats, $9.3 million; West Germany, 3,885 carats, $7.6 million; and the United Kingdom, 12,878 carats, $6.5 million.

The eight leading recipients of diamond reexports accounted for 97% of both carats and value and were as follows: Israel, 506,473 carats valued at $35.0 million; Belgium, 363,304 carats, $33.4 million; the Netherlands, 181,990 carats, $21.7 million; Switzerland, 7,343 carats, $7.1 million; the United Kingdom, 45,784 carats, $6.9 million; Japan, 9,472 carats, $6.2 million; Hong Kong, 8,953 carats, $4.7 million; and France, 18,578 carats, $3.8 million.

Exports of all other gem materials amounted to $20.2 million. Of this total, pearls, natural and cultured, not set or strung, were valued at $0.4 million. Natural precious and semiprecious stones, unset, were valued at $16.7 million; and synthetic or reconstructed stones, unset, were valued at $3.1 million. Reexports of all other gem materials amounted to $19.9 million in categories as follows: Pearls, $10.0 million; natural precious and semiprecious stones, unset, $9.8 million; synthetic or reconstructed stones, unset, $0.1 million.

Imports of gem materials decreased about 4% in value from those of 1974. Diamond accounted for 85% of the total value of gem material imports.

Although rough and uncut diamond imports were reported from 22 countries, over 99% of the value was from 10 areas, as follows: The Republic of South Africa, 926,738 carats, $189.9 million; the United Kingdom, 450,689 carats, $70.0 million; Sierra Leone, 272,331 carats, $32.7 million; the Netherlands, 36,132 carats, $13.6 million; Belgium-Luxembourg, 30,988 carats, $8.3 million; Venezuela, 389,146 carats, $8.2 million; Southwest Africa, 36,206 carats, $6.6 million; Israel, 32,574 carats, $5.5 million; Central African Republic, 134,068 carats, $5.3 million; and Liberia, 3,870 carats, $5.0 million.

Cut but unset diamond, not over 1/2 carat, was imported from 35 countries; however, the imports of this category from 8 countries amounted to 98% of total carats and value as follows: Israel, 834,875 carats, $125.7 million; Belgium, 729,438 carats, $105.4 million; India, 299,214 carats, $36.9 million; the U.S.S.R., 44,634 carats, $9.1 million; the Netherlands, 48,194 carats, $6.4 million; the Republic of South Africa, 14,254 carats, $4.0 million; the United Kingdom, 15,836 carats, $2.1 million; and France, 17,910 carats, $2.0 million. Cut but unset diamond, over 1/2 carat, was imported from 32 countries; the imports from 6 countries amounted to 98% of total carats and value as follows: Belgium, 121,122 carats, $48.6 million; Israel, 72,606 carats, $22.6 million; the Republic of South Africa, 7,636 carats, $4.5 million; the Netherlands, 10,183 carats, $3.9 million; the U.S.S.R., 12,831 carats, $3.8 million; and the United Kingdom, 1,094 carats, $0.5 million.

Imports of emeralds decreased 7% in quantity but increased 19% in value. Emeralds were imported from 33 countries of which the 10 leading countries accounted for 94% of the carats and 92% of the value. In order of value these countries were as follows: Colombia, $13.0 million; India, $6.8 million; Switzerland, $4.6 million; Hong Kong, $3.3 million; Brazil, $2.9 million; France, $2.2 million; the United Kingdom, $1.3 million; Sri Lanka, $1.3 million; Israel, $1.0 million; and West Germany, $0.8 million. Imports of rubies and sapphires decreased 9% in value from those of 1974. Ruby and sapphire imports were reported from 36 countries of which the 7 leading countries accounted for 95% of the value as follows: Thailand, $12.3 million; Sri Lanka, $1.9 million; Hong Kong, $1.2 million; India, $1.1 million; Switzerland, $1.0 million; the United Kingdom, $0.4 million; and France, $0.4 million. Natural pearls and parts from 12 countries increased 53% in value of imports; 4 countries accounted for 97% of the value as follows: Canada, $63,000; India, $365,000; Burma, $157,000; and Japan, $67,000. Cultured pearls, on the other hand, decreased 18% in value of imports, which were received from 16 countries, although Japan, at $7.0 million, accounted for 97% of the value. Imports of imitation pearls decreased 49% in value; Japan, at $469,000, accounted for 91% of the value. Coral, cut but unset, along with cameos suitable for use in jewelry, more than doubled in value of imports, which were received from 19 countries; 3 countries accounted for 97% of the value as follows: Italy, $4.9 million; Japan, $0.8 million; and Taiwan, $0.5 million.

Imports of other precious and semiprecious stones, rough and uncut, increased 37% in value and came from 41 countries of which 6 countries accounted for 75% of the value as follows: Brazil, $1.8 million; Colombia, $1.0 million; Australia, $1.0 million; the Republic of South Africa, $0.5 million; Tanzania, $0.3 million; and Venezuela, $0.2 million. Other precious and semiprecious stones, cut but unset, decreased only 1% in value and were imported from 58 countries, of which 7 countries accounted for 84% of the value as follows: Hong Kong, $10.6 million; Brazil, $3.6 million; West Germany, $3.1 million; Australia, $2.7 million; Taiwan, $1.7 million; India, $1.2 million; and Iran, $1.1 million. Synthetic gem stones, cut but unset, increased 27% in value and came from 19 countries of which 7 accounted for 99% of the value as follows: West Germany, $4.8 million; Switzerland, $0.7 million; Japan, $0.7 million; France, $0.6 million; Hong Kong, $0.6 million; Taiwan, $0.3 million; and Austria, $0.2 million. Imitation gem stones decreased 27% in value from 24 countries; 5 countries accounted for 99% of the value as follows: Austria, $3.3 million; West Germany, $2.8 million; Czechoslovakia, $1.1 million; Japan, $0.7 million; and Hong Kong, $0.3 million.

Table 1.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1974		1975	
	Quantity	Value	Quantity	Value
Diamonds:				
Rough or uncut	2,450	412,678	2,341	347,882
Cut but unset	2,083	347,362	2,236	374,237
Emeralds: Cut but unset	871	34,046	806	40,348
Coral, cut but unset, and cameos suitable for use in jewelry	NA	3,082	NA	6,475
Rubies and sapphires: Cut but unset	NA	20,960	NA	19,069
Marcasites	NA	249	NA	23
Pearls:				
Natural	NA	440	NA	673
Cultured	NA	8,874	NA	7,261
Imitation	NA	1,019	NA	515
Other precious and semiprecious stones:				
Rough and uncut	NA	4,646	NA	6,380
Cut but unset	NA	29,083	NA	28,718
Other n.s.p.f	NA	1,851	NA	1,935
Synthetic:				
Cut but unset ______ number	9,271	6,316	13,682	8,008
Other	NA	362	NA	610
Imitation gem stones	NA	11,352	NA	8,296
Total	NA	882,320	NA	850,430

NA Not available.

Table 2.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by country

(Thousand carats and thousand dollars)

Country	1973				1974				1975			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Angola	--	--	--	--	(1)	15	--	--	4	609	--	--
Belgium-Luxembourg	68	16,836	1,159	177,317	48	14,804	953	162,926	31	8,250	849	163,276
Brazil	(1)	6	2	409	1	585	4	642	5	982	3	491
Canada	1	276	1	91	(1)	(1)	(1)	52	--	--	1	156
Central African Republic	191	7,668	--	--	132	6,766	--	--	134	5,298	--	--
France	6	169	24	2,441	31	5,668	20	2,150	7	231	18	2,195
Germany, West	1	301	1	94	1	72	2	207	--	--	1	281
Hong Kong	--	--	6	1,006	(1)	65	5	772	--	--	6	847
India	(1)	21	213	23,099	--	--	221	26,709	--	--	300	37,211
Israel	34	7,838	852	128,204	37	8,052	774	128,856	33	5,523	902	147,114
Japan	1	36	2	286	1	77	4	854	1	77	2	428
Liberia	7	5,192	(1)	406	6	8,683	(1)	5	4	4,981	--	--
Netherlands	55	22,209	18	4,143	51	19,193	32	4,948	36	13,643	58	9,860
Portugal	(1)	40	--	--	1	408	(1)	1	5	670	2	473
Sierra Leone	[2]747	[2]78,919	(1)	40	453	57,577	1	82	272	32,696	(1)	83
South Africa, Republic of	427	83,707	24	12,833	389	68,948	23	9,786	927	189,885	21	7,777
Switzerland	1	181	5	1,429	2	251	8	1,587	(1)	42	4	1,087
U.S.S.R	--	--	30	5,931	--	--	15	3,609	--	--	43	9,215
United Kingdom	979	225,802	20	2,415	911	211,799	19	3,209	451	69,959	17	2,576
Venezuela	296	9,839	(1)	12	383	8,215	(1)	20	389	8,204	(1)	5
Western Africa, n.e.c	--	--	--	--	1	883	--	--	36	6,568	--	--
Zaire	--	--	--	--	2	200	(1)	18	3	152	--	--
Other	7	1,158	3	831	5	467	2	929	3	212	10	1,162
Total	[2]2,821	[2]460,198	2,360	360,987	2,450	412,678	2,088	347,362	2,341	347,882	2,236	374,237

[1] Less than ½ unit.
[2] Adjusted by the Bureau of Mines.

WORLD REVIEW

Angola.—The production of diamond in Angola declined in 1975 owing to the political chaos caused by the collapse of public authority following the exodus of the Portuguese. The principal diamond producing company was the Portuguese firm, Compania de Diamantes de Angola (Diamang), which was reported to be in financial difficulties.[10] Diamang's production was from alluvial diamond-bearing gravels in areas drained by the major river systems of central and southern Angola. Stripping was the mining method used, and was accomplished by mechanical excavators and hydraulic monitors, as well as manual shovels.

Australia.—It was estimated that 95% of the amount of opal used in jewelry in the world comes from six deposits in Australia.[11] More than half of the production is from the area of Coober Pedy. In 1973, the value of opal exported from Australia was officially reported to be $27 million, but unofficial estimates were much higher. It is simple to smuggle out high-quality opal following cash and carry deals. Mining methods have been mostly by hand digging to be gentle with the opal. Lately, however, bulldozers and rippers have been used to strip the surface, and then hand digging is used to remove opal as it is exposed.

The Mining Houses of Australia Ltd., having ceased sapphire mining operations, offered to sell its sapphire stockpile to shareholders to liquidate its inventories.[12] However, a strong recovery in the sapphire market led to Dominion Mining's resumption of full-scale operations at its Frazers Creek property in New South Wales.

Botswana.—The Government of Botswana and De Beers Botswana Mining Co. concluded negotiations relating to the terms governing diamond mining at Orapa and Letlhakine (formerly the DK 1 and DK 2 complex).[13] Production at Orapa will be increased to 4.5 million carats per year by 1979 from the present 2.4 million carats. The Letlhakine mine is expected to produce about 400,000 carats annually by 1979.

At Orapa in 1975, the tonnage treated was 3,359,832 short tons, compared with 2,953,628 tons treated in 1974.[14] The recovery grade was 79.19 carats per 110 short tons, compared with 92.03 carats per 110 tons in 1974. Two X-ray sorting machines were in use, and two additional machines were being installed in a new circuit.

Brazil.—Results of a 4-year aerial infrared photographic survey of the Amazon region indicated areas suitable for prospecting for diamond in the Tumucumaque mountains and in Roraima. This prompted Anglo American Corp. (AAC) to join Income (Bethlehem Steel Corp./Hanna Mining Corp.) to form Sopermi (40% AAC, 60% Income), an exploration firm which is active in Minas Gerais and Mato Grasso.[15]

Canada.—No occurrences of precious gem stones have been found in Canada, but a variety of other gem stone minerals are available. The main geological regions and some important gem stone areas were described in an article which was well illustrated by color photographs.[16]

Central African Republic.—The output of diamond in 1975 in the Central African Republic was 339,000 carats, about the same as in 1974, and the value was $14.7 million compared with $14.4 million in 1974. In spite of lower dollar exchange rates, the income was higher owing to improved gem stone quality and increased prices of diamond.

Diamond in the Central African Republic, to date, has been mined in alluvial fans, basins, water courses, and streambeds. Because these formations are not conducive to large-scale mining operations, most diamond mining has been by individuals and small groups. However, diamond recovery at these small operations has become more difficult, and a shift to large-scale operations was needed, requiring larger capital expenditures. To maintain and expand production, Diamond Distributors International Inc. (United States), Cominco, Ltd. (Canada), and the Government of the Cen-

[10] Mining Journal. Diamang, How Much Longer? V. 286, No. 7330, Feb. 13, 1976, p. 129.
[11] Hartley, W. D. Dreams of Striking It Rich Sustain Men Bitten by Opal Fever. Wall Street Journal, v. 185, No. 9, Jan. 14, 1975, pp. 1, 26.
[12] Mining Journal. Sapphire Dividends? V. 284, No. 7293, May 30, 1975, p. 422.
[13] Bureau of Mines. Diamond: Botswana. Mineral Trade Notes, v. 72, No. 11, November 1975, p. 4.
[14] De Beers Consolidated Mines Limited. 1975 Annual Report. 59 pp.
[15] Mining Journal. AAC: Brazilian Diamond Interest. V. 284, No. 7295, June 13, 1975, p. 463.
[16] Steacy, H. R. Canada's Beautiful, Little Known Gemstones. Canadian Geog. J., December 1974.

tral African Republic established a local firm, Société Centrafricaine d'Exploitation Diamantifére (SCED), in late 1973 to meet these objectives. SCED has had two successful years and has been largely responsible for maintaining the production of diamond in the Republic at the 1974–75 levels.

The quality of diamond is good as 60% to 70% are of gem grade. Most stones are exported uncut to Europe, Israel, or the United States. Skilled Central African artisans in Black Africa's only diamond cutting factory cut about 5% of the gem diamond production. In 1974, diamond exports to the United States were valued at $6.8 million for gem quality and $464,000 for industrial diamond. Diamond exports comprise an important element in the foreign exchange earnings and tax revenues of the Republic. Over the past 10 years about 30% of its foreign exchange earnings have been from diamond exports.

Colombia.—Bids were invited from private companies for mining rights at the three largest emerald deposits in the Department of Boyacá, at Muzo, Coscuez, and Peñas Blancas, which have been closed since Empresa Colombiana de Minas (Ecominas) ceased operations in July 1973.[17] The successful companies, which must be at least 51% Colombian owned, would have an initial lease for 5 years with the possibility of an extension for a further 3 years; Econominas will continue to be responsible for overall control of the deposits. The mining district was described as too rich for a poor country, leading to violence.[18]

Ghana.—The total production of diamond in Ghana is probably fifth in the ranking of countries in the world, but nearly 90% of Ghana's production is industrial grade.[19] Gem diamond in the 2- to 4-carat range was recovered in a dredging operation by Dunkwa Goldfields Co. on the Jimi River in the Ashanti region. Small gem stones were also recovered in the Bonsa Valley of Western Ghana. The First International Natura Corp., New York, with substantial U.S. investment, negotiated with the Government of Ghana for mining rights on a 25-square-mile area at the confluence of the Birim and Pra Rivers. The Government will have 55% equity in the project when negotiations are concluded.

Diamond production is marketed exclusively by the Government's Diamond Marketing Corp. (DMC). DMC buys all local diamond production, and grades, values, processes, and sells to end users abroad. The sales of diamond abroad were made with the assistance of Consolidated African Selection Trust in London. The majority of diamond exports were made to the United Kingdom, the Netherlands, and Belgium-Luxembourg.

Israel.—The diamond industry in Israel was said to be the world's largest.[20] Exports of polished diamond in 1975 were 2,701,388 carats, compared with 2,467,008 in 1974, an increase of 9.5% according to statistics of the Diamond Department of the Ministry of Commerce and Industry. The contemporary market demand for smaller stones resulted in a 2.4% decrease in the value of 1975 exports, $548.6 million compared with the record $562.2 million in 1974. The U.S. market accounted for $153 million out of Israel's total 1975 exports. In concentrating on the smaller stones, it was estimated that in 1975 Israel produced 85% of the world's supply of melées (gem diamonds of from 40 stones per carat to 2 stones per carat). The wider application of automated equipment in many plants plus increased individual effort made possible greater output with approximately the same number of workers.

Lesotho.—After nearly 2 years of negotiations, Prime Minister Leabua Jonathan and De Beers Consolidated Chairman Harry Oppenheimer signed an agreement which will open a new diamond mine in Lesotho.[21] Control of the mine will be by a newly formed company, De Beers Lesotho Mining Co., Ltd., in which Lesotho will hold 25% equity. De Beers investment commitment is U.S. $35 million over 2 years.

The agreement permits development of Lesotho's only identified kimberlite diamond pipe at Letseng la Terae in the northeastern district of Mohkotlong. Output of the mine, will be marketed through a second company to be formed by De Beers and registered in Lesotho. Lesotho will charge a sales tax of about 15% on mine production until De Beers recovers its capital costs. Depending on the mine profitability, the taxes may rise to 71.5% of profits on a graduated scale.

[17] Bolsa Review. News Review. April 1975, p. 220.
[18] Omang, J. Emeralds a Way of Life in Colombia. Washington Post, Sept. 2, 1975, p. D10.
[19] Bureau of Mines. Diamond: Ghana. Mineral Trade Notes, v. 72, No. 4, April 1975, p. 14–15.
[20] Israel Industry & Commerce & Export News. Israel's Diamond Industry, V. 27, March 1976, p. 5.
[21] Bureau of Mines, Diamond: Lesotho. Mineral Trade Notes, v. 72, No. 4, April 1975, pp. 15–16.

Malagasy Republic.—The Malagasy Service of Mines reported production and export of a variety of gem and ornamental stones which contributed to the foreign exchange earnings of the Republic. The list included agate, amazonite, amethyst, beryl (gem grade), citrine, garnet (gem grade), opal, tourmaline, jasper, labradorite, rose quartz, and smoky quartz. The exports were mostly to collectors interested in minerals from the Island of Madagascar.

Pakistan.—The Pakistan Mineral Development Corp. recovered about 3,000 carats of rubies at the Hunza ruby mines for testing and evaluation in Karachi.[22]

Sierra Leone.—The 51% Government-owned National Diamond Mining Co. commenced prospecting in new areas of the Southern Province to replace diamond deposits nearing exhaustion. Diamond Distributors, International, Inc., of New York, acquired a prospecting license for diamond and gold.

South Africa, Republic of.—The Central Selling Organization reported diamond sales in 1975 of 793.5 million rands (US $1,066 million), or 6.5% less than in 1974.[23] During 1975, production exceeded sales, and the excess was absorbed into stock. No breakdown of either gem stones or industrial diamond sales was given. During 1975, demand for the smaller size of gem diamond improved, but the demand for larger, more expensive stones remained weak. To meet the demand for smaller stones, production at mines where the average stone size is smaller was increased and that of mines where the average is larger was decreased.

At the dormant Kimberly mine rains have caused severe slope failures in the drainage tunnel which was started in November 1975 and is expected to be completed in 1977. Also in the Kimberly Division, mechanization was accelerated to replace manual operations wherever possible in underground sections and on the surface under a program to phase out migratory labor.

South-West Africa, Territory of.—The Consolidated Diamond Mines of South West Africa (Proprietary) Ltd. reported an increase in ore treated in 1975 to 13,498,048 short tons from 13,047,780 tons in 1974. The average stone size decreased from 0.88 carat in 1974 to 0.73 carat in 1975. Overburden stripped increased from 45,074,540 tons in 1974 to 46,389,670 tons in 1975. Diamond production was higher in 1975 at 1,747,739 carats, compared with 1,569,961 carats in 1974.

The application of a well-point dewatering system together with the use of a bucket wheel excavator enabled mining to proceed up to 492 feet seaward of the high water mark, and extending operations to 656 feet appeared feasible.

U.S.S.R.—Soviet geologists, according to the Novost Information Service of Moscow, have discovered additional reserves of turquoise, other semiprecious stones, and industrial stones in Uzbekistan in Central Asia. The other stones included lazurite, chalcedony, onyx, quartz, and rhodonite. The Ministry of Geology added that a stone processing plant was already under construction to produce 322,920 square feet of ornamental stone tiles per year. Production of these stones in Uzbekistan will increase three or four times by 1980.[24]

[22] Mining Journal. Industry in Action. Hunza Rubies Encouraging. V. 284, No. 7292, May 23, 1975, p. 403.
[23] De Beers Consolidated Mines Limited. 1975 Annual Report. 59 pp.
[24] Industrial Minerals. Company News & Mineral Notes. No. 93, June 1975, p. 51.

Table 3.—Diamond (natural): World production, by country [1]
(Thousand carats)

Country	1973			1974			1975 [p]		
	Gem	Industrial	Total	Gem	Industrial	Total	Gem	Industrial	Total
Africa:									
Angola	1,594	531	2,125	1,470	490	1,960	345	115	[e] 460
Botswana	362	2,054	2,416	408	2,310	2,718	362	2,052	2,414
Central Africa Republic	[r] 341	[r] 183	[r] 524	220	118	338	220	119	339
Ghana	[r] 231	[r] 2,076	[r] 2,307	257	2,315	2,572	233	2,095	2,328
Guinea [e]	25	55	80	25	55	80	25	55	80
Ivory Coast	120	180	300	112	167	279	84	125	209
Lesotho [2]	1	8	9	2	9	11	1	2	3
Liberia [3]	509	308	817	377	259	636	[4] 241	[4] 165	[4] 406
Sierra Leone	646	758	1,404	670	1,000	[e] 1,670	600	900	[e] 1,500
South Africa, Republic of:									
Premier mine	625	1,876	2,501	605	1,817	2,422	509	1,527	2,036
Other De Beers properties [5]	2,368	1,938	4,306	2,397	1,961	4,358	2,518	2,061	4,579
Other	455	303	758	438	292	730	408	272	680
Total	3,448	4,117	7,565	3,440	4,070	7,510	3,435	3,860	7,295
South-West Africa, Territory of	1,520	80	1,600	1,491	79	1,570	1,660	88	1,748
Tanzania	251	250	501	249	249	498	224	224	448
Zaire	[r] 1,082	11,858	12,940	1,143	12,468	13,611	1,076	11,734	12,810
Other areas:									
Brazil	[r] 56	[r] 57	[r] 113	127	127	254	135	135	[e] 270
Guyana	31	21	52	12	18	30	8	13	21
India	18	3	21	18	3	21	17	3	20
Indonesia [e]	12	3	15	12	3	15	12	3	15
U.S.S.R. [e]	1,900	7,600	9,500	1,900	7,600	9,500	1,950	7,750	9,700
Venezuela	315	463	778	279	970	1,249	239	821	1,060
World total	[r] 12,462	[r] 30,605	[r] 43,067	12,212	32,310	44,522	10,867	30,259	41,126

[e] Estimate. [p] Preliminary. [r] Revised.
[1] Total (gem plus industrial) diamond output for each country is actually reported except where indicated to be an estimate by footnote. In contrast, the detailed separate reporting of gem diamond and industrial diamond represents Bureau of Mines estimates in the case of every country except Central African Republic (1973), Lesotho (1973–75), Liberia (1973–74), Guyana (1973), and Venezuela (all years), where sources give both total output and detail. The estimated distribution of total output between gem and industrial diamond is conjectural in the case of a number of countries, based on unofficial information of varying reliability.
[2] Exports of diamond originating in Lesotho; excludes stone imported for cutting and subsequently reexported.
[3] Exports.
[4] Partial figure, January 1 through December 15 only.
[5] All company output from the Republic of South Africa except that credited to the Premier mine; excludes company output from the Territory of South-West Africa and Botswana.

TECHNOLOGY

Turquoise may be of inferior quality or may be confused with other materials to the disadvantage of the owner of the turquoise. For example, chrysocolla is identified frequently as turquoise. A simple test will help identify the sample correctly.[25] A drop of commercial grade of hydrochloric acid (HCl), commonly called muriatic acid (32% HCl), is placed on the sample. If it is chrysocolla, the acid will turn to a greenish-yellow color which can be easily observed by blotting it with a white tissue. No reaction will take place on fair to excellent quality turquoise. Azurite and malachite will change the acid's color and they will effervesce also.

American Indian turquoise jewelry can also be difficult to assess. Advice to prospective buyers included cautions against fakes, mass-produced or machine-made jewelry labeled "Indian" creation, and even stolen jewelry.[26] The quality of the turquoise in the jewelry was also described for the benefit of prospective buyers.[27] The geographical distribution of turquoise in

[25] O'Haire, R. T. A Simple Test, Chrysocolla or Turquoise? Arizona Bureau of Mines, Fieldnotes, v. 5, No. 2, June 1975, p. 9.
[26] Changing Times, The Kiplinger Magazine. The Big Rip-Off in Indian Jewelry. V. 29, No. 9, September 1975, p. 4.
[27] Albuquerque Journal. Turquoise Cost Up, But Watch Out. 93d Year, No. 3, Apr. 21, 1974, pp. 1–2.

the United States is limited to the margins of the Colorado Plateau of the Southwestern States. With the aid of instrumental neutron activation analysis to detect trace elements, researchers are able to tell which turquoise came from which mine.[28] The information obtained from a study of turquoise artifacts from a pre-Columbian Indian village contributed knowledge to the trading patterns of the inhabitants.

The Job Safety & Health magazine of the U.S. Department of Labor indicated 10,000 lasers were in use by industry, and the boring of holes in diamond was noted.[29] A proposed safety code required protective housings, safety interlocks, visual and audible warning signals to alert operators in case of interlock failure and other steps to eliminate exposure to any radiation or other hazards.

The current process equipment and products of the semiconductor crystal industry were reviewed and predictions were made for the future state-of-the-art.[30] The processes which were described included the Czochvalski, float zone, pedestal growth, and zone leveling and procedures such as edge defined ribbon growth, dendritic web growth, Schmid Viechnicki, and cold crucible melting.

Natural diamond and most manufactured diamond are formed at high pressure. It is possible to synthesize diamond by growing it from existing diamond in a low-pressure gas rich in carbon.[31] It was found advantageous to have the seed diamond in powder form to take advantage of the large surface per unit of weight. Powder having a particle size of up to 1 micrometer has a specific surface of about 10 square meters per grain. It was also found that, if the diamond particles are suspended in the gas, such as methane by applied vibrations, the growth would be improved; the method could also yield threads, whiskers, or fibers of diamond.

Information about the earth's deep interior is scanty, and even inferences drawn from seismic and electrical conductivity measurements include assumptions about the relevant mineral species. Recently geophysical investigations applied improved techniques to suggest major revisions in the accepted hypothesis pertaining to the earth's lower mantle. The key to the new techniques is a device developed at the National Bureau of Standards and is known as a diamond-anvil or diamond-window pressure cell.[32] The device is not new, but its refinements and applications are. In addition to the work at the National Bureau of Standards, groups at the Geophysical Laboratory of the Carnegie Institution of Washington and at the University of Rochester contributed studies of chemical and physical properties.

The most prominent characteristic of minerals and gems is color. The cause of the color in many of these materials is frequently unknown or misunderstood, and many erroneous early guesses as to the causes of specific colors in minerals have been repeatedly copied from one text to the next so that much misinformation is current. Twelve distinct causes of color were described in three articles,[33] and brief outlines of four theories—crystal field, molecular orbital, band, and physical optics—were included.

The tumbling process has been in use about 30 years for polishing gem stones. The technique is more popular now than ever before, and an evaluation of tumbling was presented.[34] The shape of a tumbler may be round, hexagonal, or barrel. The material of construction may be glass, ceramic, plastic, rubber, or steel. The tumbler may have a fixed speed of rotation, or it may be variable. Tumblers may be open or sealed. Tumblers may rotate on a fixed or a variable axis, or may vibrate, usually on a vertical axis. The stones for the tumbler should be of similar grain, density, toughness, hardness, and porosity. The load should be exact, although most tumblers work well when about two-thirds to three-

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[28] Science News. Archaeology. Snaketown Turquoise Trading. V. 108, Nos. 8–9, Aug. 23–30, 1975, p. 125.

[29] American Metal Market. Laws for Lasers. V. 82, No. 13, Jan. 20, 1975, p. 26.

[30] Lenzing, J. Survey of Semiconductor Crystal-Growing Processes and Equipment. Solid State Technology, v. 18 No. 2, February 1975, pp. 34–39, 43.

[31] Devjaguin, B. V. and D. B. Fedoseev. The Synthesis of Diamond at Low Pressure. Scientific American, v. 233, No. 5, November 1975, pp. 102–109.

[32] Science. Research News. High-Pressure Geophysics: A Window on the Lower Mantle. V. 190, No. 4218, Dec. 5, 1975, pp. 967, 968.

[33] Nassau, K. The Origins of Color in Minerals and Gems—Part I. Lapidary J., v. 29, No. 5, August 1975, pp. 920, 922, 924, 926, 928.

——. The Origins of Color in Minerals and Gems—Part II. Lapidary J., v. 29, No. 6, September 1975, pp. 1060, 1062, 1064, 1066, 1068, 1070.

———. The Origins of Color in Minerals and Gems—Part III. Lapidary J., v. 29, No. 7, October 1975, pp. 1250, 1252, 1253, 1254, 1256, 1258.

[34] Zertner, J. C. Tumblers, Tumbling and Tumbled Gems—Part I. Lapidary J., v. 29, No. 9, December 1975, pp. 1670–1691.

fourths full. The amounts of fluid or water, abrasive polishing media, and special additives are also variable. Because of all the possible variations, it was recommended that the instructions of the manufacturers be followed explicitly.

Gem Stones

By W. Timothy Adams[1]

The production value of gem stones and mineral specimens in the United States during 1976 was estimated to be $8.9 million, an increase of 2% over that of 1975. Most of the value was contributed by the few companies that operated deposits for emerald, jade, opal, sapphire, and turquoise. Amateur collectors were important even though their total contribution was surpassed by the commercial operators. The commercial operators sold mainly to wholesale or retail outlets and occasionally to jewelry manufacturers.

DOMESTIC PRODUCTION

Mines and collectors in 39 States produced gem materials estimated at $1,000 or more for each State. Ten States supplied 90% of the total value as follows: Arizona, $4.0 million; Nevada, $1.3 million; Maine, $1.1 million; Oregon, $525,000; California, $231,000; New Mexico, $210,000; Montana, $170,000; Texas, $168,000; Washington, $168,000; and Wyoming, $147,000.

Park authorities at the Crater of Diamonds Park in Arkansas reported the finding of 398 diamonds, of which 1 was 3 carats and 3 were 2 carats each. No value was placed on the stones.[2]

A report was published on the evaluation of diamond-containing weathered kimberlite pipes in Colorado and Wyoming.[3]

A 200-carat emerald crystal was found at the Big Crabtree emerald mine near Little Switzerland, N.C. The stone appeared to be of fine quality and could yield a stone of 40 carats if cut. It would be larger than the Carolina emerald of 14 carats. Peridot was mined by about 200 individuals of the San Carlos Apache Tribe at Peridot, Ariz., and no estimate of quantity and value of the peridot was available.

The production of turquoise of all grades and quantities reported was 221 tons, valued at $3.9 million and was principally from Arizona, Nevada, and Colorado. The great interest in Native American style jewelry continued throughout 1976. Many articles appeared in various publications describing the qualities of genuine turquoise and Native American jewelry.[4]

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[1]Physical scientist, Division of Nonmetallic Minerals.

[2]Arkansas Department of Parks and Tourism, Parks Division.

[3]McCallum, M. E. and C. D. Mabarak. Diamond in State-Line Kimberlite Diatremes, Albany County, Wyo.; Larimer County, Colo., Geol. Survey of Wyo., RI 12, September 1976, 36 pp.

[4]Hass, L. N. Turquoise — Blue Heaven in a Stone, Part I. Gems and Miner., No. 458, December 1975, pp. 8-9, 62-63, 76-77.

———. Part II. Gems and Miner., No. 459, January 1976, pp. 42, 62-64.

———. Part III. Gems and Miner., No. 460, February 1976, pp. 33-36.

Rowe, R. C. Turquoise — Genuine or False. Gems and Miner., No. 459, January 1976, pp. 35-37.

Hemrich, G. I. Turquoise Substitutes. Gems and Miner., No. 470, December 1976, pp. 17-20, 22.

Mine	Location	Operator
Emerald: Big Crabtree mine	Mitchell County, N.C	PBH Emerald Co. Box 163 Little Switzerland, N.C. 28749
Jade: Stewart Jewel Jade mine	Kobuk Village, Alaska	Stewart Jewel Jade Co. 531 4th Ave. Anchorage, Alaska 99501
Opal:		
Royal Peacock mine	Humboldt County, Nev	Harry W. Wilson Denio, Nev. 89404
Spencer Opal mine (dig-for-fee mine).	Clark County, Idaho	Mark L. Stetler 1862 Ranier St. Idaho Falls, Idaho 83401
Sapphire:		
Chaussee Sapphire mine (sold unscreened material to tourists in summer and assisted in screening).	Granite County, Mont	Chaussee Sapphire Corp. Box 706 Philipsburg, Mont. 59858
Sapphire Village mine (Yogo Gulch).	Judith Basin County, Mont.	Sapphire International Corp. Box 30 Utica, Mont. 59452
Turquoise:		
Aurora mine	Lander County, Nev	Carico Lake Mining Co. Box 3426 Albuquerque, N. Mex. 87110
Black Spider mine	do	Grillos Mining Co. 2221 10th St. Lubbock, Tex. 79401
Blue Eagle mine	Mineral County, Nev	E. Loving and D. Lester Box 155 Mina, Nev. 89422
Blue Jim mine	Lander County, Nev	James Elquist Box 255 Battle Mountain, Nev. 89820
Blue Spider mine	do	John Lee & Co. 5101 North 40th St., Apt. 119 Phoenix, Ariz. 85018
Boundary mine	Mineral County, Nev	D. Brannon and R. H. Herrington Box 377 Mina, Nev. 89422
Duval Corp. mine	Mohave County, Ariz	L. W. Hardy Co., Inc. 3809 East Highway 66 Kingman, Ariz. 86401
Morenci mine	Greenlee County, Ariz	W. O. Brown 230 West 66 Ave. Gallup, N. Mex. 87301
Pinto Valley mine	Gila County, Ariz	L. W. Hardy Co., Inc. 3809 East Highway 66 Kingman, Ariz. 86401
Red Mountain mine	Lander County, Nev	J. M. Johnson 102 West 9th Pl. Mesa, Ariz. 85201 Turquoise Nugget (colessee) Box 1118 Flagstaff, Ariz. 86001
Royal Blue mine	Esmeralda County, Nev	R. C. Wilcox Box 1311 Tonopah, Nev. 89040
Shoshone and Ackerman mines	Churchill County, Nev	Lombardo Turquoise Co., Inc. 1300 East Main St. Austin, Nev. 89310
Turquoise Chief mine	Lake County, Colo	N. F. Reed Albuquerque, N. Mex. 87110
Villa Grove mine	Saguache County, Colo	G. Musick Box 174 Villa Grove, Colo. 81155

CONSUMPTION

Domestic gem stone output went to amateur and commercial rock, mineral, and gem stone collections, objects of art, and jewelry. Apparent consumption of gem stones (domestic production plus imports minus exports and reexports) was $705 million, 51% more than that of 1975.

PRICES

Typical costs to a retail jeweler in December 1976 for representative better quality gem stones as reported by 15 typical importers were as follows:[5]

[5]Jewelers' Circular — Keystone. JC-K's Colored Stone Price Index. V. 147, No. 5, February 1977, p. 84.

Gem stone	Carat weight	Median price per carat	Price range per carat
Amethyst	10	$15	$11-$17.50
Aquamarine	8	120	75-260
Cat's eye	5	1,100	750-1,100
Citrine	10	8	5-10
Emerald	1	2,875	1,500-5,000
Garnet, green	1	475	400-600
Man's sky blue star	10	300	190-450
Opal, black	3	438	300-500
Opal, white, fiery	5	62	60-70
Peridot	10	50	45-60
Ruby	2	1,875	1,250-3,500
Sapphire	2	725	400-1,200
Tanzanite	5	300	150-250
Tourmaline, green	10	55	55-100
Tourmaline, pink	10	100	75-125

NOTES.—Ten-carat cat's eyes and 15-carat peridot, both of which were on the 1974 list, became unavailable during 1975, but the median price per carat of the smaller stones held at the levels of the larger stones.

No survey was made of diamond prices; price trends indicated higher prices for cut diamond 1 carat and smaller, but no change in larger cut diamond.

FOREIGN TRADE

Exports of all gem materials amounted to $326.7 million, and reexports to $155.5 million. Diamond accounted for 94% of the value of exports and 92% of the reexports. Exports of diamond totaled 312,853 carats valued at $306.1 million. Of this total, diamond cut but unset, suitable for gem stones not over 0.5 carat, was 53,375 carats valued at $21.1 million; and cut, but unset, over 0.5 carat was 258,738 carats valued at $284.9 million.

Reexports of diamond amounted to 1,198,805 carats, valued at $142.7 million, in categories as follows: Rough or uncut, suitable for gem stones, not classified by weight, 1,025,183 carats valued at $88.9 million; cut but unset, not over 0.5 carat, 45,127 carats valued at $9.2 million; cut but unset, over 0.5 carat, 128,450 carats, valued at $44.6 million.

The 10 leading recipients of diamond exports accounted for 89% of the carats and 98% of the value and were as follows: Hong Kong, 98,102 carats valued at $132.5 million; the Netherlands, 39,033 carats valued at $39.7 million; Switzerland, 32,480 carats valued at $37.2 million; Japan, 46,924 carats valued at $33.5 million; Belgium, 25,827 carats valued at $25.8 million; France, 6,288 carats valued at $14.5 million; West Germany, 5,416 carats valued at $7.1 million; the United Kingdom, 4,671 carats valued at $4.7 million; Israel, 9,670 carats valued at $3.2 million; and Canada, 8,952 carats valued at $2.3 million.

The eight leading recipients of diamond reexports accounted for 96% of the carats and 97% of the value and were as follows: Belgium, 432,030 carats valued at $41.1 million; Israel, 403,017 carats valued at $34.3 million; the Netherlands, 213,537 carats valued at $25.2 million; the United Kingdom, 32,830 carats valued at $11.7 million; Switzerland, 7,832 carats valued at $8.9 million; France, 20,884 carats valued at $6.9 million; Japan, 26,764 carats valued at $5.6 million; and Hong Kong, 10,797 carats valued at $4.5 million.

Exports of all other gem materials amounted to $20.6 million. Of this total, pearls, natural and cultured, not set or strung, were valued at $0.6 million. Natural precious and semiprecious stones, unset, were valued at $18.0 million; and synthetic or reconstructed stones, unset, were valued at $2.0 million. Reexports of all other gem materials amounted to $12.8 million in categories as follows: Pearls, $0.8 million; natural precious and semiprecious stones, unset, $11.8 million; synthetic or reconstructed stones, unset, $0.1 million.

Imports of gem materials increased about 39% in value over those of 1975. Diamond accounted for 86% of the total value of gem material imports.

Although rough and uncut diamond imports were reported from 24 countries, over 99% of the value was from 9 countries as follows: The Republic of South Africa, 1,194,128 carats, $257.2 million; the United Kingdom, 494,884 carats, $113.8 million; Sierra Leone, 331,554 carats, $42.9 million; the Netherlands, 50,393 carats, $20.5 million; Israel, 38,573 carats, $8.2 million; Belgium-Luxembourg, 37,885 carats, $6.7 million; Venezuela, 260,066 carats, $6.0 million; Liberia, 2,790 carats, $2.9 million; and the Central African Republic, 36,006 carats, $2.2 million.

Cut but unset diamond, not over 1/2 carat, was imported from 38 countries; however, the imports of this category from 10 countries amounted to 99% of total carats and value as follows: Israel, 1,100,253 carats, $178.7 million; Belgium, 1,011,991 carats, $157.1 million; India, 498,996 carats, $64.7 million; the Netherlands, 68,419 carats, $9.6 million; the U.S.S.R., 35,794 carats, $8.1 million; the Republic of South Africa, 13,747 carats, $3.7 million; Switzerland, 12,673 carats, $1.7 million; the United Kingdom, 11,243 carats, $1.6 million; France, 9,276 carats, $1.9 million; and Hong Kong, 8,981 carats, $1.3 million. Cut but unset diamond, over 1/2 carat was imported from 30 countries; the imports from 9 countries amounted to 99% of the total carats and 98% of the value as follows: Belgium, 156,083 carats, $66.8 million; Israel, 102,563 carats, $32.5 million; the Republic of South Africa, 8,178 carats, $6.0 million; the Netherlands, 9,717 carats, $3.3 million; the U.S.S.R., 6,660 carats, $2.5 million; the United Kingdom, 2,661 carats, $2.0 million; Switzerland, 1,142 carats, $1.1 million; India, 3,389 carats, $0.8 million; and Hong Kong, 860 carats, $0.7 million.

Imports of emeralds increased 45% in quantity and 37% in value. Emerald was imported from 33 countries; the imports from 9 countries amounted to 96% of the carats and 94% of the value as follows: Colombia, 57,252 carats, $21.6 million; India, 578,780 carats, $9.7 million; Switzerland, 28,457 carats, $6.9 million; Brazil, 207,620 carats, $3.8 million; Israel, 76,805 carats, $2.7 million; the United Kingdom, 76,069 carats, $2.5 million; Hong Kong, 49,730 carats, $2.1 million; West Germany, 34,817 carats, $1.7 million; and France, 3,745 carats, $1.1 million. Ruby and sapphire were imported from 34 countries; the imports from 7 countries amounted to 91% of the value as follows: Thailand, $15.6 million; Sri Lanka, $2.3 million; India, $2.0 million; Switzerland, $2.0 million; Hong Kong, $1.8 million; West Germany, $0.7 million; and Canada, $0.4 million. Natural pearls and parts from 11 countries increased 12% in value of imports; 5 countries accounted for 91% of the value as follows: India, $371,000; Japan, $104,000; France, $85,000; Burma, $82,000; and Hong Kong, $48,000. Cultured pearls increased 52% in value of imports which were received from 20 countries of which Japan, at $10.6 million, accounted for 95% of the value. Imports of imitation pearls increased 32% in value; Japan, at $569,000, accounted for 84% of the value. Coral, cut but unset, and cameos suitable for use in jewelry increased slightly in value of imports, which were received from 20 countries; 3 countries accounted for 94% of the value as follows: Italy, $3.4 million; Taiwan, $1.5 million; and Japan, $1.2 million.

Imports of other precious and semiprecious stones, rough and uncut, increased 30% in value and came from 46 countries of which 7 countries accounted for 78% of the value as follows: Brazil, $2.5 million; Australia, $2.0 million; Colombia, $1.1 million; Hong Kong, $0.3 million; India, $0.2 million; the Republic of South Africa, $0.2 million; and Zambia, $0.2 million. Other precious and semiprecious stones, cut but unset increased 26% in value and were imported from 59 countries, of which 7 countries accounted for 87% of the value as follows: Hong Kong, $15.4 million; Brazil, $5.3 million; West Germany, $3.5 million; Australia, $2.9 million; Taiwan, $1.5 million; Iran, $1.0 million; and India, $1.0 million. Synthetic gem stones, cut but unset, increased 26% in value and came from 17 countries of which 6 countries accounted for 96% of the value as follows: West Germany, $5,639 million; France, $1,226 million; Switzerland, $1,191 million; Japan, $1,099 million; Taiwan, $0.272 million; and Hong Kong, $0.259 million. Imitation gem stones increased 9% in value and came from 18 countries, of which 5 countries accounted for 98% of the value as follows: Austria, $4,959 million; West Germany, $2,618 million; Czechoslovakia, $0.961 million; Japan, $0.252 million; and Hong Kong, $0.106 million.

Table 1.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1975		1976	
	Quantity	Value	Quantity	Value
Diamonds:				
Rough or uncut	2,341	347,882	2,464	462,657
Cut but unset	2,236	374,287	3,087	549,182
Emeralds: Cut but unset	806	40,348	1,165	55,286
Coral, cut but unset, and cameos suitable for use in jewelry	NA	6,475	NA	6,497
Rubies and sapphires: Cut but unset	NA	19,069	NA	27,165
Marcasites	NA	23	NA	20
Pearls:				
Natural	NA	673	NA	755
Cultured	NA	7,261	NA	11,062
Imitation	NA	515	NA	680
Other precious and semiprecious stones:				
Rough and uncut	NA	6,330	NA	8,266
Cut but unset	NA	28,718	NA	35,278
Other n.s.p.f	NA	1,935	NA	2,565
Synthetic:				
Cut but unset ______ number	13,682	8,008	18,705	10,115
Other	NA	610	NA	766
Imitation gem stones	NA	8,296	NA	9,072
Total	NA	850,430	NA	1,179,366

NA Not available.

WORLD REVIEW

Australia.—Turquoise was discovered in Australia in 1967. The deposits are located in the remote central region of the Northern Territory approximately 265 miles northeast of the railhead at Alice Springs. The turquoise occurs in a series of Cambrian siltstone-mudstone beds that form part of the Sandover Beds of the Georgina Basin. A range of phosphate types is produced from the mine. Microscopic and X-ray diffusion examination have shown the typical high-grade material to be composed of very-fine-grained, close-packed nodules of turquoise. The turquoise has been formed by the chemical combination of phosphates and alumina in the phosphate-rich beds and copper leached from the overlying copper-rich tuffaceous siltstones. Mining is by open-cut methods. Specimens up to three-quarters ton have been recovered. Proven reserves are considerable, and continuity of supply is offered. A wide range of material is available for gem cutters and the carving trade. The area is not open to collectors and hobbyists.[6]

New markets for Australian opals are being opened both at home and in Japan. Stones from Cooper Pedy and Andamooka are being used in a variety of styles in watch bracelets and pendants. A new manufacturing process is reported to insure high durability of the stone.[7]

Botswana.—A new tax regime instituted by the Government of Botswana established an effective partnership between the Government and the De Beers Group. The Orapa mine produced 2,360,945 carats of diamond from 3,428,985 tons of ore in 1976. Construction work is in progress at Orapa to increase the capacity of the mine from 2.3 million carats to 4.5 million carats per year. The new Letlhakine mine, 24 miles southeast of Orapa was commissioned, and production began at the rate of 320,000 carats per year. The mine treated diamondiferous gravels surrounding the pipe. Design work was in progress for the second stage of development to treat the kimberlite. Prospecting continued at a kimberlite pipe discovered in Jwaneng in the south of the country. The pipe is overlain by 150 feet of overburden and represents a considerable technical achievement. A drilling program has established that the pipe is large and contains diamond in economic quantities.[8]

Burma.—The Mogok ruby that made Burma one of the gem capitals of the world has also been the cause of the country's plunder by smugglers and black marketeers. The gem industry was nationalized in 1969, and 18 kinds of precious stones including rubies, sapphires, and jade were brought under official control. Officials admit that thieves are still active despite strong security at the mines.[9]

[6]Cumming, J. Australian Turquoise. Lapidary J., v. 30, No. 7, October 1976, pp. 1634-1636.

[7]Mining Journal Conferences. New Uses for Opal. V. 287, No. 7375, Dec. 24, 1976, p. 510.

[8]De Beers Consolidated Mines Ltd. 1976 Annual Report, 59 pp.

[9]Maung, C. T. The Curse of the Burmese Ruby. Wash. Post, Apr. 18, 1976, p. H-3.

Table 2.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by country

(Thousand carats and thousand dollars)

Country	1974				1975				1976			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Angola	(1)	15	--	--	4	609	--	--	--	--	--	--
Belgium-Luxembourg	43	14,804	953	162,926	31	8,250	849	153,276	38	6,651	1,168	223,858
Bolivia	--	--	--	--	--	--	--	--	5	99	--	--
Brazil	1	535	4	642	5	982	8	491	1	79	4	690
Canada	(1)	(1)	(1)	52	--	--	1	156	(1)	6	(1)	90
Central African Republic	182	6,766	--	--	134	5,298	--	--	36	2,204	--	--
France	31	5,668	20	2,150	7	231	18	2,195	6	643	9	1,957
Germany, West	1	72	2	207	--	--	1	281	(1)	(1)	4	1,214
Hong Kong	(1)	65	5	772	--	--	5	847	1	825	10	1,962
India	--	--	221	26,709	--	--	300	87,211	--	--	502	65,432
Israel	87	8,052	774	128,856	38	5,528	902	147,114	39	8,239	1,203	211,146
Japan	1	77	4	864	1	77	2	428	1	51	6	1,001
Liberia	6	8,683	(1)	5	4	4,981	--	--	3	2,871	--	--
Netherlands	51	19,193	32	4,948	36	13,643	58	9,860	50	20,524	78	12,849
Portugal	1	408	(1)	1	5	570	2	478	--	--	--	--
Sierra Leone	468	57,577	1	82	272	32,696	(1)	83	331	42,861	1	129
South Africa, Republic of	389	68,948	23	9,786	927	189,885	21	7,777	1,194	257,249	22	9,674
Switzerland	2	261	8	1,587	(1)	42	4	1,087	1	29	14	2,796
U.S.S.R	--	--	15	8,609	--	--	43	9,215	--	--	43	10,607
United Kingdom	911	211,799	19	3,209	451	69,959	17	2,576	495	113,756	14	3,630
Venezuela	388	8,215	(1)	20	389	8,204	(1)	5	260	5,987	(1)	79
Western Africa, n.e.c	1	383	--	--	36	6,568	--	--	(1)	172	--	--
Zaire	2	200	(1)	18	3	152	--	--	--	--	--	--
Other	5	467	2	929	8	212	10	1,162	8	411	9	2,068
Total	2,450	412,678	2,083	347,362	2,341	347,882	2,236	374,237	2,464	462,657	3,087	549,182

[1]Less than 1/2 unit.

Significant quantities of Burmese jadeite ends up in Thailand through various smuggling routes. The price of fine apple and emerald green jadeite is such that a market has been created for the once-neglected yellow, red, and apricot colors. Much of the yellow and red material being offered is not jadeite but dyed quartz. The fraud may be detected by concoidal fractures on a chipped edge rather than the fibrous fracture displayed by jadeite.[10]

Colombia.—Two years ago small emeralds of little commercial value were discovered in alluvial sands near the small town of Yacopi. The discovery coincided with the closing of Muzo, the major emerald mine in Colombia. The increasing production from the Yacopi area gives evidence to the belief that soon something of real value will be discovered there. A major find at Yacopi would give Colombia a new source of foreign exchange.[11]

Guatemala.—Rough Maya jade will be made available to wholesale gem distributors and rockhounds. The jadeite is of excellent carving quality. The colors range from a pearly white and a richer green to a dark green that appears black when polished. The quality of the jade has been evaluated, and it compares favorably with Wyoming jade. Larger rough-cut boulders have been exported to Hong Kong for statue carving.[12]

Lesotho.—The Letseng-la-Terai mine began producing at a rate of 4,000 tons of ore per day. Systematic mining began in May with the object of exposing hard kimberlite at depth and stockpiling the overlying soft weathered kimberlite. At yearend, 500,000 tons of the weathered kimberlite had been stockpiled. The profitability of the mine depends on the production of a comparatively small quantity of large, high-quality stones.[13]

India.—The Indian diamond industry, which is export-oriented and cottage based, has grown twelvefold in the past decade and now provides employment to approximately 150,000 workers, mostly skilled artisans. The United States has emerged as one of the principal buyers of Indian diamond accounting for more than 27% of India's exports. India's share in the world diamond trade is about 7% to 8% in terms of value and 1.2% to 1.5% in terms of caratage. A combination of skills developed over the years and low production costs have enabled India to specialize in the polished small diamonds known as "makeables." The bulk of India's raw material requirments, namely, rough diamonds, is supplied by the Diamond Trading Company (DTC), London. The outlook for the industry is encouraging.[14]

Iran.—Iranian production of turquoise from March 21, 1975 to March 20, 1976, was reported as 68.2 short tons. Proven reserves were reported as 11,000 short tons and resources as 22,000 short tons.[15]

Pakistan.—The Government of Pakistan decided to set up an organization to buy uncut emeralds, diamonds, and other precious stones from the mines at Swat in the North West Frontier Province and export them in finished form. The mines have been sealed by the police and mining operations suspended for the present. Of the 800 carats of emerald produced per month, a large proportion was said to be smuggled out of the country.[16]

South Africa, Republic of.—The Central Selling Organization reported diamond sales in 1976 of $1,555 million, 46% greater than in 1975. During 1976, sales exceeded production, and the excess was provided from stocks. The Central Selling Organization increased the price of diamond twice in 1976, by 3% in January and 6% in September. The demand for the smaller sizes and the lower qualities of larger diamonds was very strong in 1976. Toward the end of the year, there was improvement in demand for better quality large stones. No breakdown of gem stones or industrial diamond sales was given.[17]

South-West Africa, Territory of.—The Consolidated Diamond Mines of South-West Africa (Proprietary) Ltd. reported an increase in ore treated in 1976 to 14,167,067 short tons, from 13,498,048 tons in 1975. The average stone size increased from 0.73 carat per stone to 0.95 carat per stone in 1976. Overburden stripped increased from 46,389,670 short tons in 1975 to 54,996,027 tons in 1976. Diamond production decreased to 1,693,994 carats in 1976 from 1,747,739 carats in 1975.

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[10]Greenspan, J. The Latest Ripoff: Yellow-Red Burma Jade. Lapidary J., v. 29, No. 11, February 1976, p. 2084.

[11]World Mining. Colombian Miners Seek Emeralds at Yacopi as Famed Muzo Mine Closed. V. 29, No. 4, April 1976, pp. 88-89.

[12]Swezey, W. R. Ancient Maya Jade Deposits Rediscovered. Lapidary J., v. 30, No. 3, pp. 742-746.

[13]De Beers Consolidated Mines Ltd. 1976 Annual Report, 59 pp.

[14]U.S. Embassy, New Delhi, India. State Department Airgram A-87, Dec. 23, 1976, 8 pp.

[15]U.S. Embassy, Tehran, Iran. State Department Airgram A-225, Dec. 29, 1976, Enclosure 1: 1 pp.

[16]Mining Journal. Production Smuggling in Swat. V. 286, No. 7337, Mar. 5, 1976, p. 183.

[17]De Beers Consolidated Mines Ltd. 1976 Annual Report, 59 pp.

Further refinements made to the dewatering systems and stability improvements to the sea wall enabled operations to advance 150 feet further seaward of the high water mark. Fewer minor breakdowns were experienced with the bucketwheel excavator during the year, but three major component failures decreased overall availability.

Thailand.—Many of Thailand's precious and semiprecious stone mines are nearing depletion, resulting in a marked increase in importation of blue sapphires from Australia. Smuggling of gem stones from Burma and Cambodia also increased.[18]

U.S.S.R.—Soviet geologists are reported to have made diamond finds in ancient Timan paleozoic deposits west of the Urals.[19]

The Frankfurt diamond bourse has gone into receivership. German promoters attempted to make Frankfurt a world diamond market using cutters from Idar-Oberstein to challenge the dominance of Israel, Antwerp, New York, and Bombay. Breaking into a trade that is divided between De Beers and the many Israeli and Belgian craftsmen was too big a task for the Germans even with Soviet help.

It is reported that the U.S.S.R. has opened an export office in Antwerp under the name of RUSSALMAZ MV. It is also reported that the U.S.S.R. is selling the bulk of its finished goods to the Diamond Trading Co. marketing network since attempts to compete directly had failed.[20]

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[18] U.S. Embassy, Bangkok, Thailand. State Department Airgram A-140, June 16, 1976, 8 pp.
[19] Mining Journal. Industry in Action: Exploration. V. 287, No. 7352, July 16, 1976, p. 51.
[20] McInnes, N. A Soviet Investment. Barron's, v. 56, No. 1, Jan. 5, 1976, p. 4.

Table 3.—Diamond (natural): World production, by country[1]

(Thousand carats)

Country	1974 Gem	1974 Industrial	1974 Total	1975 Gem	1975 Industrial	1975 Total	1976[p] Gem	1976[p] Industrial	1976[p] Total
Africa:									
Angola	1,470	490	1,960	345	115	[e]460	495	165	[e]660
Botswana	408	2,310	2,718	360	2,037	2,397	354	2,007	2,361
Central African Republic	220	118	338	220	119	339	221	119	[e]340
Ghana	257	2,315	2,572	233	2,095	2,328	228	2,055	2,283
Guinea[e]	25	55	80	25	55	80	25	55	80
Ivory Coast	112	167	279	84	125	209	22	38	60
Lesotho[2]	2	9	11	1	2	3	1	2	[e]3
Liberia[3]	377	259	636	[4]241	[4]165	[4]406	250	150	[e]400
Sierra Leone[e]	670	1,000	1,670	600	900	1,500	600	900	1,500
South Africa, Republic of:									
Premier mine	605	1,817	2,422	509	1,527	2,036	458	1,375	1,833
Other De Beers properties[5]	2,397	1,961	4,358	2,518	2,061	4,579	2,549	2,086	4,635
Other	438	292	730	408	272	680	332	222	554
Total	3,440	4,070	7,510	3,435	3,860	7,295	3,339	3,683	7,022
South-West Africa, Territory of	1,491	79	1,570	1,660	87	1,747	1,609	85	1,694
Tanzania	249	249	498	224	224	448	225	225	[e]450
Zaire	[r]620	[r]12,991	13,611	395	12,415	12,810	591	11,230	11,821
Other areas:									
Brazil	127	127	254	135	135	[e]270	135	135	[e]270
Guyana	12	18	30	8	13	21	6	8	14
India	18	3	21	17	3	20	17	3	20
Indonesia[e]	12	3	15	12	3	15	12	3	15
U.S.S.R	1,900	7,600	9,500	1,950	7,750	9,700	2,000	7,900	9,900
Venezuela	279	970	1,249	239	821	1,060	190	643	833
World total	[r]11,689	[r]32,833	44,522	10,184	30,924	41,108	10,320	29,406	39,726

[e] Estimate. [p] Preliminary. [r] Revised.

[1] Total (gem plus industrial) diamond output for each country is actually reported except where indicated to be an estimate by footnote. In contrast, the detailed separate reporting of gem diamond and industrial diamond represents Bureau of Mines estimates in the case of every country except Lesotho (1974-75), Liberia (1974), Venezuela (all years), and Zaire (1974-75) where sources give both total output and detail. The estimated distribution of total output between gem and industrial diamond is conjectural in the case of a number of countries, based on unofficial information of varying reliability.

[2] Exports of diamond originating in Lesotho; excludes stone imported for cutting and subsequently reexported.

[3] Exports.

[4] Partial figure; January 1 through December 15 only.

[5] All company output from the Republic of South Africa except for that credited to the Premier mine; also excludes company output from the Territory of South-West Africa and Botswana.

TECHNOLOGY

Ruby crystals were subjected to a static pressure greater than 1 megabar in a diamond-windowed pressure cell. The pressure was monitored continuously by observing the spectral shift of the sharp fluorescent Ri ruby line excited with a calcium-helium gas-diffusion laser beam. One megabar appears to be the highest pressure ever reported for a static experiment in which an interval calibration was employed. The accessibility of this pressure range, coupled with the high temperature already reached, makes it possible to experiment directly at the conditions of the earth's core.[21]

General Electric (GE) scientists successfully tested a new machine that can apply pressures greater than 8 million pounds per square inch. To achieve and maintain these pressures, GE created a pair of tungsten carbide pistons tipped with the company's manufactured industrial diamonds. The apparatus will be used to study changes that occur in materials under high pressures and temperatures.[22]

Two distinct suites of minerals included in natural diamond are described. It is indicated that they probably represent different physical and chemical conditions during diamond growth. Detailed mineralogical and chemical study of the minerals included in diamond during its growth can provide significant data regarding the chemistry and physics of the upper mantle, as well as providing insight into the genesis of diamond.[23]

A detailed analysis of the composition of gaseous inclusions in seven Arkansas diamonds ranging in size from 0.37 to 2.06 carats and containing other inclusions was made by mass spectrographic techniques. The released gases were found to be of variable compositon and similar to those reported earlier from diamonds of African origin. Based on the tentative assumption that the gases are genetically related to the host diamond, a theoretical gas-solid diamond growth model was presented, which can account for the observed compositional variations in the included gases.[24]

There are three significant features in the typical appearance of opal that provide clues to the mechanism responsible for the color display: (1) The color is associated with small grains, and throughout each grain the color is fairly uniform, (2) the color of the grains changes as the orientation of the stone is changed with respect to the light source and the observer, and (3) generally the colors are spectrally pure. Electron micrographs revealed regular geometric patterns of tiny holes across the entire surface of a grain. These arrays of holes are sufficiently regular to act as three-dimensional diffraction gratings that give rise to the stones' characteristic fire.[25]

The Spencer mines in Idaho produced gem opal, which not only has the intense color of Australian doublets and triplets, but has an additional feature of displaying a star of brilliant colors. There are three types of stars to be found among the Idaho gems: A cat's eye stone that exhibits a single streak of dispersed colors across the triplet, a three-ray star, and a six-ray star. Stars such as these have not been reported for Australian opal.[26]

Two major techniques, flux and hydrothermal, have been used to grow emerald crystals, and various solvents have been employed. The lithium molybdate flux has proved to be commercially viable in the hands of Chatham and Gilson. Hydrothermal work, using two acid mineralizers, which gave satisfactory growth, did not prove to be commercially viable.[27]

Color changes were observed on gamma-ray irradiation of over 500 colorless, pink, blue, and green tourmalines. The only significant changes observed were the development or intensification of pink or the development of yellow superimposed on the preexisting color. Some of these colors are stable to heat, and some are not.[28]

The well-known brown color produced by the irradiation of topaz has been reexamined particularly with respect to the kinetics

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[21] Mao, H. K. and P. M. Bell. High Pressure Physics: The 1-Megabar Mark on the Ruby Ri Static Pressure Scale. Science, v. 191, No. 4229, Feb. 27, 1976, pp. 851-852.

[22] American Metal Market/Metalworking News. GE Machine Able to Generate 8 Million Pounds of Pressure. V. 83, No. 111, June 7, 1976, p. 27.

[23] Meyer, H. O. A. and H. M. Tsai. Mineral Inclusions in Diamond: Temperature and Pressure of Equilibrium. Science, v. 191, No. 4229, Feb. 27, 1976, pp. 849-851.

[24] American Mineralogist. Experimental Results and a Theoretical Interpretation of Gaseous Inclusions Found in Arkansas Natural Diamonds. V. 60, No. 5-6, May-June, 1975, pp. 413-418.

[25] Darragh, P. J., A. J. Gaskin, and J. V. Sanders. Opal. Sci. Am., v. 234, No. 4, April 1976, pp. 84-85, 88-95.

[26] Sanders, J. V. Star Opal From Idaho. Lapidary J. v. 29, No. 11, February 1976, pp. 1986, 1988, 1990, 1992, 2008, 2010.

Nassau, K. Synthetic Emerald: The Confusing History and the Current Technologies. Part I, Lapidary J., v. 30, No. 1, April 1976, pp. 196-202.

[27] Nassau, K. Synthetic Emerald: The Confusing History and the Current Technologies. Part II. Lapidary J., v. 30, No. 2, May 1976, pp. 468, 470, 472, 488, 490, 492.

[28] Nassau, K. Gamma Ray Irradiation Induced Changes in the Color of Tourmalines. Am. Mineralogist, v. 60, No. 7-8, July-August 1976, pp. 710-713.

of the color formation. The known color is produced at two different rates. Heating to 200 for a few hours removes essentially all the color of the specimens tested.[29]

A completely new comparison microscope assists the geologist and mineralogist in the accurate identification of minerals by color. The Lovibond-Nelson microcolorimeter is based on an optically linked pair of microscopes using a single light source. Accurately graded glass filters are calibrated to the Lovibond subtractive color system and give an optical match with a sample.[30]

An automatic cutting machine, The Piermatic, an English invention, cuts small diamond stones with efficiency and consistency of make. Machines are in use in Israel, New York, and Puerto Rico. Use of the machine is usually limited to stones of about 30 points.[31]

Modern technology in the form of aerial photographs offers major assistance to mineral collectors. Photograph prints available from film libraries show settlers' homesteads, derelict railways, ghost towns, or any kind of habitation or clearing. Fifty-year-old bush trails show plainly no matter how overgrown they have become. Careful study of photographs will often save many miles of wandering in search of prospective sites.[32]

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[29]Nassau, K. and B. E. Prescott. Blue and Brown Topaz Produced by Gamma Irradiation. Am. Mineralogist, v. 60, No. 7-8, July-August 1976 pp. 705-709.

[30]Mining Journal. Methods and Machines. Microcolorimeter for Mineral Identification. V. 286, No. 7342, May 7, 1976, p. 363.

[31]Jeweler's Circular-Keystone. Gemstones. Automatic Diamond Cutting in N.Y. V. 146, No. 7, June 1976, p. 46.

[32]Hutchinson, W. and J. Hutchinson. Genuine Treasure Maps. Lapidary J., v. 30, No. 3, June 1976, pp. 818-821.

Gem Stones

By W. Timothy Adams[1]

The value of gem stones and mineral specimens produced in the United States during 1977 was estimated to be $8.9 million, the same as that of 1976. Production in the domestic commercial mining industry decreased, with the shutdown of many turquoise mines and the sapphire mine in Montana. Amateur collectors accounted for much of the activity in many States. Commercial operators sold mainly to wholesale or retail outlets and also to jewelry manufacturers.

DOMESTIC PRODUCTION

Mines and collectors in 39 States produced gem materials estimated at $1,000 or more in value for each State. Nine States supplied 90% of the total value, as follows: Arizona, $4.5 million; Maine, $1 million; Nevada, $1 million; Oregon, $520,000; California, $230,000; Wyoming, $200,000; New Mexico, $170,000; Texas, $160,000; and Washington, $160,000.

Park authorities at the Crater of Diamonds Park in Arkansas reported 91,849 people visited the park and found 371 diamonds. The largest was a 4-carat, 25 point canary yellow stone, but no value was placed on the stone. A campground for visitors with 60 class A campsites with utility hookups is scheduled for completion this year.[2]

A 2,400-pound boulder of Wyoming jade was displayed in the lobby of the First National Bank Building in Denver, Colo. The material came from a 1-mile-wide, 4-mile-long jade strain discovered in southwestern Wyoming. Much of the jade carved in Hong Kong is supplied from Wyoming and imported into this country as finely carved Oriental jewelry.[3]

The second largest ruby ever found in the Cowee Valley near Franklin, N.C., was discovered at the Gregory Ruby Mine, a dig-for-fee mine. The stone weighed 456 carats and is conservatively valued at $20,000. It is 3-inches in diameter, 1 inch thick, 85% ruby, and the value could exceed $100,000 if a star is formed when the stone is cut.[4]

The Maine Tourmaline Necklace was donated to the State of Maine by the Maine Retail Jewelers' Association on May 25, 1977. Two years in the making, the necklace is made of Maine native gold and 24 pink and green Maine tourmalines with the center drop stone weighing 24.58 carats. The necklace will be available for the First Lady of Maine to wear at official functions.[5]

Peridot was produced by about 200 individuals of the San Carlos Apache Tribe at Peridot, Ariz. Twenty tons of crude materials valued at $17,000 was reported for 1977. Of this, it is estimated that 7% remains as salable material after processing into faceted and tumble-polished gem stones. The major portions of the finished stones are in the lower priced tumble-polished category. A report was completed on the olivine resources on Peridot Mesa at the request of the San Carlos Apache Tribe.[6]

The production of turquoise of all grades and quantities reported was 44 tons and was principally from Arizona, Nevada, and Colorado. About 10% of the turquoise produced was gem-grade material, which sold for $10 to $100 per carat and averaged about $200 per pound. Lower grade turquoise suitable for stabilizing treatment sold for about $35 per pound of rough material. The value for all types and grades of turquoise in 1977 was estimated at $4.5 million. The market for turquoise seems to be decreasing somewhat in the face of high prices and suspicion as to whether the material offered is a synthetic made of other material and colored to look like turquoise.

CONSUMPTION

Domestic gem stone output went to amateur and commercial rock, mineral, and gem stone collections, objects of art, and jewelry. Apparent consumption of gem stones (domestic production plus imports minus exports and reexports) was $1,044.7 million, 48% more than that of 1976.

PRICES

Typical costs to retail jewelers in December 1977 for representative better quality gem stones as reported by colored-stone dealers in various U.S. cities were as follows:[7]

Gem stone	Carat weight	Price range per carat	Median prices per carat: Early December	Median prices per carat: Early November
Amethyst	10	$17.50- $36	$30	$30
Aquamarine	5	110- 500	150	150
Cat's eye	5	1,000- 2,400	1,600	1,600
Citrine	10	8- 30	16	16
Emerald:				
Medium to better	1	1,500-16,000	5,000	5,000
Commercial	1	250- 7,000	1,500	1,500
Garnet, green	1	700- 1,400	1,026	1,026
Opal, black	3	500- 1,200	766	766
Opal, white	5	120- 220	150	150
Peridot	5	75- 120	90	90
Ruby:				
Medium to better	1	700- 9,000	2,000	2,000
Commercial	1	250- 3,500	700	700
Sapphire:				
Medium to better	1	450- 3,600	1,000	1,000
Commercial	1	100- 1,600	326	326
Star sapphire:				
Sky-blue		160- 1,600	600	600
Grey		46- 330	190	190
Tanzanite	5	500- 600	550	550
Topaz	5	220- 440	360	360
Tourmaline, green	5	60- 130	90	90
Tourmaline, pink	5	50- 160	125	125

Typical costs to retail jewelers in December 1977 for representative diamonds as reported by diamond dealers in various U.S. cities were as follows:[8]

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Price range per carat	Medium price per carat: Early December	Medium price per carat: Early November
0.04-0.08	G-1	VS_1	$630-$1,088	$824	$744
.04- .08	G-1	SI_1	550- 832	730	634
.09- .16	G-1	VS_1	660- 1,198	940	850
.09- .16	G-1	SI_1	604- 954	800	708
.17- .22	G-1	VS_1	816- 1,246	1,050	1,000
.17- .22	G-1	SI_1	680- 1,016	902	864
.23- .28	G-1	VS_1	848- 1,418	1,206	1,150
.23- .28	G-1	SI_1	794- 1,292	1,000	952
.29- .35	G-1	VS_1	1,132- 1,618	1,312	1,304
.29- .35	G-1	SI_1	906- 1,546	1,100	1,028
.46- .55	G-1	VS_1	1,486- 2,536	2,090	1,940
.46- .55	G-1	SI_1	1,100- 2,000	1,680	1,528
.69- .79	G-1	VS_1	1,738- 3,826	2,852	2,616
.69- .79	G-1	SI_1	1,338- 2,650	2,234	2,104
.95-1.15	G-1	VS_1	2,420- 6,244	4,410	4,410
.95-1.15	G-1	SI_1	1,984- 5,632	3,410	3,232
1.00	D	FL	17,000-21,000	20,000	16,000

[1]Gemological Institute of America color grades: D—colorless; G-1—traces of color.
[2]Clarity: FL—no blemishes; VS_1—very slightly included; SI_1—slightly included.

FOREIGN TRADE

Exports of all gem materials amounted to $356.6 million, and reexports to $245.7 million. Diamond accounted for 94% of the value of exports and 95% of the reexports. Exports of diamond totaled 316,160 carats valued at $336.0 million. Of this total, diamond cut but unset, suitable for gem stones not over 0.5 carat, was 63,968 carats valued at $26.4 million; and cut, but unset, over 0.5 carat was 246,351 carats valued at $308.3 million.

Reexports of diamond amounted to 1,240,469 carats, valued at $232.9 million, in categories as follows: Rough or uncut, suitable for gem stones, not classified by weight, 1,113,988 carats valued at $146.0 million; cut but unset, not over 0.5 carat, 49,679 carats valued at $15.5 million; cut but unset, over 0.5 carat, 76,802 carats, valued at $71.4 million.

The 11 leading recipients of diamond exports accounted for 97% of both the carats and the value and were as follows: Hong Kong, 107,902 carats valued at $131.6 million; Belgium, 32,664 carats valued at $45.2 million; Switzerland, 25,452 carats valued at $41.8 million; Japan, 33,190 carats valued at $35.8 million; the Netherlands, 24,327 carats valued at $32.1 million; France, 6,011 carats valued at $18.8 million; the United Kingdom, 9,809 carats valued at $7.2 million; Israel, 18,360 carats valued at $7.0 million; Canada, 11,789 carats valued at $5.8 million; India, 31,758 carats valued at $0.4 million; and Austria, 4,381 carats valued at $0.3 million.

The nine leading recipients of diamond reexports accounted for 99% of the carats and 98% of the value and were as follows: Israel, 466,101 carats valued at $73.6 million; Belgium, 395,545 carats valued at $69.0 million; the Netherlands, 185,544 carats valued at $30.6 million; Switzerland, 9,111 carats valued at $13.3 million; the United Kingdom, 40,444 carats valued at $12.2 million; France, 14,288 carats valued at $10.6 million; Japan, 15,981 carats valued at $8.9 million; Hong Kong, 12,408 carats valued at $7.9 million; and India, 84,874 carats valued at $2.0 million.

Exports of all other gem materials amounted to $20.6 million. Of this total, pearls, natural and cultured, not set or strung, were valued at $0.5 million. Natural precious and semiprecious stones, unset, were valued at $18.2 million; and synthetic or reconstructed stones, unset, were valued at $1.9 million. Reexports of all other gem materials amounted to $12.8 million in categories as follows: Pearls, $1.1 million; natural precious and semiprecious stones, unset, $11.6 million; synthetic or reconstructed stones, unset, $0.1 million.

Imports of gem materials increased 39% in value over those of 1976. Diamond accounted for 88% of the total value of gem material imports.

Although rough and uncut diamond imports were reported from 28 countries, 99% of the value was from 7 countries as follows: The Republic of South Africa, 1,096,493 carats, $315.8 million; the United Kingdom, 1,280,769 carats, $238.6 million; Sierra Leone, 185,869 carats, $40.5 million; the Netherlands, 29,152 carats, $12.5 million; Israel, 56,567 carats, $11.2 million; Belgium, 22,348 carats, $7.6 million; and Venezuela, 154,814 carats, $5.4 million.

Cut but unset diamond, not over 1/2 carat, was imported from 33 countries; however, the imports of this category from 7 countries amounted to 98% of total carats and value as follows: Israel, 1,145,413 carats, $256.2 million; Belgium, 1,106,815 carats, $223.3 million; India, 765,432 carats, $129.3 million; the U.S.S.R., 35,207 carats, $9.8 million; the Netherlands, 46,784 carats, $9.0 million; the Republic of South Africa, 20,707 carats, $7.6 million; and the United Kingdom, 26,520 carats, $4.2 million. Cut but unset diamond, over 1/2 carat, was imported from 28 countries; the imports from 8 countries amounted to 99% of both the total carats and value as follows: Belgium, 150,059 carats, $84.5 million; Israel, 115,087 carats, $48.1 million; the Republic of South Africa, 12,900 carats, $9.3 million; the U.S.S.R., 9,239 carats, $4.2 million; the Netherlands, 7,608 carats, $3.5 million; the United Kingdom, 4,479 carats, $2.8 million; Switzerland, 766 carats, $1.6 million; and India, 3,905 carats, $1.2 million.

Emerald imports increased 34% in quantity and 16% in value. Emerald was imported from 34 countries; the imports from 10 countries amounted to 98% of the carats and 95% of the value as follows: Colombia, 73,948 carats, $25.1 million; India, 968,937 carats, $12.5 million; Switzerland, 26,198 carats, $7.3 million; Israel, 68,644 carats,

$3.6 million; Hong Kong, 68,717 carats, $3.1 million; the United Kingdom, 57,877 carats, $2.9 million; Brazil, 212,974 carats, $2.4 million; the Federal Republic of Germany, 30,318 carats, $1.9 million; France, 5,368 carats, $1.4 million; and Belgium, 12,706 carats, $0.8 million. Imports of ruby and sapphire were imported from 32 countries; the imports from 10 countries amounted to 96% of the value as follows: Thailand, $22.5 million; Switzerland, $2.0 million; Sri Lanka, $1.9 million; Hong Kong, $1.6 million; India, $1.6 million; Belgium, $0.5 million; Burma, $0.5 million; Israel, $0.5 million; the United Kingdom, $0.5 million; and Canada, $0.4 million. Natural pearls and parts from 12 countries decreased 28% in value of imports; 5 countries accounted for 92% of the value as follows: India, $369,000; Burma, $36,000; Japan, $35,000; Italy, $33,000; and Hong Kong, $27,000. Imports of cultured pearls increased 65% in value, and were received from 17 countries; Japan, at $17.6 million, accounted for 96% of the value. Imports of imitation pearls increased 39% in value; Japan, at $748,000, accounted for 79% of the value. Coral, cut but unset, and cameos suitable for use in jewelry decreased 32% in value of imports, which were received from 15 countries; 3 countries accounted for 95% of the value as follows: Italy, $1.8 million; Taiwan, $1.8 million; and Japan, $0.6 million.

Imports of other precious and semiprecious stones, rough and uncut, increased 26% in value and came from 43 countries, 7 of which accounted for 80% of the value as follows: Brazil, $3.9 million; Australia, $1.5 million; Colombia, $0.8 million; Kenya, $0.7 million; Switzerland, $0.7 million; Zaire, $0.4 million; and Israel, $0.3 million. Other precious and semiprecious stones, cut but unset, increased 1% in value and were imported from 65 countries, of which 5 countries accounted for 84% of the value as follows: Hong Kong, $17.8 million; Brazil, $4.2 million; the Federal Republic of Germany, $3.9 million; Australia, $2.7 million; and Taiwan, $1.2 million. Synthetic gem stones, cut but unset, increased 3% in value and came from 17 countries, 6 of which accounted for 94% of the value as follows: The Federal Republic of Germany, $6.4 million; Japan, $1.1 million; Switzerland, $1.1 million; France, $0.7 million; Austria, $0.3 million; and Israel, $0.2 million. Imitation gem stones increased 19% in value and came from 22 countries, of which 5 countries accounted for 94% of the value as follows: Austria, $6.0 million; the Federal Republic of Germany, $2.8 million; Czechoslovakia, $0.7 million; Japan, $0.3 million; and the United Kingdom $0.3 million.

Table 1.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1976 Quantity	1976 Value	1977 Quantity	1977 Value
Diamonds:				
Rough or uncut	2,464	462,657	2,909	638,205
Cut but unset	3,087	549,182	3,502	806,332
Emeralds: Cut but unset	1,165	55,286	1,563	64,375
Coral, cut but unset, and cameos suitable for use in jewelry	NA	6,497	NA	4,410
Rubies and sapphires: Cut but unset	NA	27,165	NA	33,544
Marcasites	NA	20	NA	58
Pearls:				
Natural	NA	755	NA	544
Cultured	NA	11,062	NA	18,260
Imitation	NA	680	NA	942
Other precious and semiprecious stones:				
Rough and uncut	NA	8,266	NA	10,448
Cut but unset	NA	35,278	NA	35,617
Other n.s.p.f	NA	2,565	NA	3,273
Synthetic:				
Cut but unset number	18,705	10,115	15,753	10,391
Other	NA	766	NA	864
Imitation gem stones	NA	9,072	NA	10,841
Total	NA	1,179,366	NA	1,638,104

NA Not available.

Table 2.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by country

(Thousand carats and thousand dollars)

Country	1975				1976				1977			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Belgium-Luxembourg	31	8,250	849	153,276	38	6,651	1,168	223,858	22	7,592	1,257	307,766
Bolivia	--	--	--	--	5	99	--	--	--	--	--	--
Brazil	5	982	3	491	1	79	4	690	(1)	91	4	860
Canada	--	--	1	156	(1)	6	(1)	90	(1)	49	1	704
Central African Empire	134	5,298	--	--	36	2,204	--	--	51	3,539	--	--
France	7	231	18	2,195	6	643	9	1,957	8	683	9	1,577
Germany, Federal Republic of	--	--	1	281	(1)	(1)	4	1,214	(1)	8	4	906
Ghana	2	58	--	--	(1)	16	--	--	8	64	--	--
Hong Kong	--	--	5	847	1	825	10	1,962	1	98	9	1,741
India	--	--	300	37,211	--	--	502	65,432	(1)	1	769	130,501
Ireland	--	--	(1)	64	--	--	--	--	1	413	2	305
Israel	33	5,523	902	147,114	39	8,239	1,208	211,146	57	11,177	1,260	304,263
Italy	--	--	1	219	1	82	2	292	--	--	2	641
Japan	1	77	2	428	1	51	6	1,001	(1)	27	1	286
Liberia	4	4,981	--	--	3	2,871	--	--	1	228	--	--
Mauritania	--	--	--	--	--	--	(1)	47	5	45	(1)	23
Netherlands	36	13,643	58	9,860	50	20,524	78	12,849	29	12,465	54	12,489
Portugal	5	570	2	473	--	--	--	--	--	--	--	--
Sierra Leone	272	32,696	(1)	83	331	42,861	1	129	186	40,467	4	881
South Africa, Republic of	927	189,885	21	7,777	1,194	257,249	22	9,674	1,096	315,790	33	16,905
Switzerland	(1)	42	4	1,087	1	29	14	2,796	6	811	8	3,003
Tunisia	--	--	--	--	--	--	--	--	--	--	3	548
U.S.S.R	--	--	43	9,215	--	--	43	10,607	--	--	44	14,089
United Kingdom	451	69,959	17	2,576	495	113,756	14	3,630	1,281	238,608	32	7,073
Venezuela	389	8,204	(1)	5	260	5,987	(1)	79	155	5,381	--	--
Western Africa, n.e.c	36	6,568	--	--	(1)	172	--	--	(1)	23	--	--
Other	r8	r915	r9	r879	r2	r313	r7	r1,729	2	645	6	1,771
Total	2,341	347,882	2,236	374,237	2,464	462,657	3,087	549,182	2,909	638,205	3,502	806,332

r Revised.

1 Less than 1/2 unit.

WORLD REVIEW

Angola.—The Government of Angola increased its holdings in Compania de Diamantes de Angola (Diamang) from 200,000 shares to over 1.5 million shares. This gave the Government a 60.85% majority interest. Foreign companies with interests in Diamang will not be affected by the takeover.[9]

Australia.—Subject to obtaining the necessary government approval, Conzinc Riotinto of Australia (CRA) Exploration Pty. was attempting to increase its 35% interest in venture prospecting for diamonds in the Kimberley's, Western Australia.[10] Promising diamond finds in the Kimberley region of West Australia led to a confrontation between Western Australia's State Government and the Federal Government's Director of Aboriginal Affairs. Exploration permits issued by the State to CRA Exploration Pty., DeBeers Consolidated Ltd., and Broken Hill Pty. Ltd. were rejected by the Director under his authority over aboriginal lands. It is believed that diamondiferous kimberlite pipe has been discovered.[11]

Botswana.—Agreement has been reached between the Government of Botswana and DeBeers Consolidated Mines Ltd. on the basic final arrangements for the development and operation of the large diamond mine at Jwaneng. Development of the mine and infrastructure is expected to take about 4 years.[12]

Central African Empire.—Diamond output increased to 301,000 carats. In 1976, total diamond production was 286,000 carats, half of the 524,000 carats mined as recently as 1972. Exports totaled 269,000 carats valued at $14.4 million. Exports maintained their value, reflecting the emphasis on gem-quality stones. Part of the decline in production was due to legal difficulties between the leading alluvial diamond mining company, Société Centrafricaine d' Exploitation Diamantifere (SCED), and the Central African Empire Government. Questions relating to SCED status under the nation's investment and tax code led to a temporary suspension of mining.[13]

Colombia.—Colombia supplies 90% of the world's emeralds. Legal production is estimated at $25 million, which represents about 10% of the nation's total exports. Fewer than 1% of the emeralds found are judged to be of top quality.[14]

Greenland.—Fiscanex Ltd., Willowdale, Ontario, Canada, marketed ruby corundum as individual crystals or dots of crystals in a variety of rock matrix types. These stones have exceptionally good color and fluoresce strongly under longwave ultravioletlight but somewhat less under shortwave ultravioletlight. The firm anticipates entering the reconstituted ruby material market since the quality of the material is suitable for recrystallized laser applications.

Israel.—Exports of cut diamonds for the first 9 months of 1977 increased 42%. The diamonds were valued at $708 million with the expectation that exports will total more than $1,000 million in 1977.[15]

Pakistan.—Rich deposits of rubies occur in the Hunza area of northern Pakistan. In order to properly explore the occurrences, Pakistan Mineral Development Corp. took responsibility for the Hunza ruby project in 1974. The main marble formation having ruby mineralization was reported to have a stratigraphic thickness of 2,500 feet and was traced for an uninterrupted strike length of more than 12 miles. Average weight of individual ruby crystals being produced is slightly less than a carat. Crystals up to 2 carats are not uncommon. Color of the stones ranges from dull red or brownish, pink, purple to red, bright red, and dark pigeon-blood red.[16]

South Africa, Republic of.—Preliminary data on diamond production for 1977 showed an increase of 14%. The total for 1977 was 8,033,000 carats; 4,171,000 carats of industrial diamond and 3,862,000 carats of gem stones. The upward trend in sales has prompted DeBeers Consolidated Mines Ltd. to expand its exploration program and accelerate mine development at ongoing operations. The Finsch open pit in northern Cape Province is being expanded to increase production from 2.0 million to 3.0 million carats per year by 1979. The Langhoogle underground mine, Cape Province, is being reopened and is expected to supply 60,000 carats per year beginning in July 1978. The Koingnaas mine on the Cape Province coast was scheduled to begin production in July 1978 and produce 500,000 carats per year.[17] Expansion was also scheduled for the Kimberley District mines, however, the Dutoitspan and Bultfontein mines were temporarily closed by flooding. Mine personnel were transferred to the two other mines in the district. Production is expected to be maintained at the 1976 level of over 1 million carats.[18]

Demand for the smaller sized gem stones increased rapidly in 1977. The Central Selling Organization announced price increases of 15% and 17% during 1977 for a compound increase of nearly 35% for the year. Increased prices and demand provided Central Selling Organization sales of approximately $2.1 billion in 1977, a 33% increase over 1976.[19]

South-West Africa, Territory of.—A new diamond deposit was claimed in the Hunsberge area, east of the Restricted Diamond Area No. 1.[20]

Zaire.—Société Minière de Bakwanga (Miba), Zaire's principal producer of low-grade industrial diamond, is operated by the Zairian Government. Miba has an export quota of 13.5 million carats per year, which is set by Zaire—British Diamond Distributors, Ltd., an affiliate of the Central Selling Organization. Miba has suffered from supply problems along with a cash squeeze that prevented it from making normal reinvestments to upgrade and maintain capital equipment to overcome a substantial shortage of exports below that allowed by the quota.[21]

Zambia.—The Kafubu emerald mine is to be developed on a commercial scale. Recent geological surveys have shown that the emerald deposits south of Kalulushi may be more extensive and of much greater value than originally anticipated. The mine has been clandestinely operated by small workers.[22]

Table 3.—Diamond (natural): World production, by country[1]

(Thousand carats)

Country	1975			1976			1977[p]		
	Gem	Industrial	Total	Gem	Industrial	Total	Gem	Industrial	Total
Africa:									
Angola	743	248	991	255	85	340	265	88	353
Botswana	359	2,038	2,397	358	2,026	2,384	404	2,287	2,691
Central African Empire	220	119	339	172	114	286	182	119	301
Ghana	233	2,095	2,328	228	2,055	2,283	230	2,070	[e]2,300
Guinea[e]	25	55	80	25	55	80	25	55	80
Ivory Coast	84	125	209	24	36	60	26	39	[e]65
Lesotho	[2]1	[2]2	[2]3	[2]1	[2]4	[2]5	6	22	[e]28
Liberia	[3]244	[3]162	[3]406	[3]176	[3]144	[3]320	163	163	326
Sierra Leone	293	439	732	192	289	481	180	270	[e]450
South Africa, Republic of:									
Premier mine	509	1,527	2,036	458	1,375	1,833	502	1,508	2,010
Other De Beers properties[4]	2,518	2,061	4,579	2,549	2,086	4,635	2,796	2,287	5,083
Other	408	272	680	333	222	555	564	376	940
Total	3,435	3,860	7,295	3,340	3,683	7,023	3,862	4,171	8,033
South-West Africa, Territory of	1,660	[r]88	[r]1,748	1,609	85	1,694	1,901	100	2,001
Tanzania	224	224	448	219	219	438	187	188	[e]375
Zaire	[r]395	12,415	12,810	591	11,230	11,821	561	10,652	11,213
Other areas:									
Brazil	131	131	262	38	38	76	100	100	[e]200
Guyana	8	13	21	6	8	14	7	10	17
India	17	3	20	17	3	20	19	3	[e]22
Indonesia[e]	[r]3	[r]12	15	3	12	15	3	12	15
U.S.S.R	1,950	7,750	9,700	2,000	7,900	9,900	2,100	8,200	10,300
Venezuela	239	821	1,060	190	643	833	160	540	700
World total	[r]10,264	[r]30,600	[r]40,864	9,444	28,629	38,073	10,381	29,089	39,470

[e]Estimate. [p]Preliminary. [r]Revised.

[1]Total (gem plus industrial) diamond output for each country is actually reported except where indicated to be an estimate by footnote. In contrast, the detailed separate reporting of gem diamond and industrial diamond represents Bureau of Mines estimates in the case of every country except Lesotho (1975-76), Liberia (1977), Venezuela (1975 and 1976), and Zaire (1975), where sources give both total output and detail. The estimated distribution of total output between gem and industrial diamond is conjectural in the case of a number of countries, based on unofficial information of varying reliability.

[2]Exports of diamond originating in Lesotho; excludes stone imported for cutting and subsequently reexported.

[3]Exports.

[4]All company output from the Republic of South Africa except for that credited to the Premier mine; also excludes company output from the Territory of South-West Africa and Botswana.

TECHNOLOGY

Grading and demonstrating cut diamonds is said to be fast and accurate when using the Gem Proportionscope. When the diamond is placed in the optical field of the instrument, any deviation from ideal proportions is said to be clearly visible. Comparisons can be easily made for establishing the grade of a diamond's cut.[23]

Six isolated and totally enclosed inclusions were recovered from an Arkansas diamond by burning in air at 850°C. They are identified as (a) three euhedral crystals of chromian diopside, (b) a euhedral bicrystal of chromian diopside plus orthopyroxene with minor included matter, (c) anhedral olivine plus a small amount of attached unidentified glassy silicate rich in silicon and aluminum with minor iron, titanium, zinc, and potassium, (d) finely polycrystalline periclase plus minor magnetite. X-ray diffraction, and chemical and morphological data are given. The periclase may have existed in the diamond as magnesite; if so, the observed inclusions bear resemblance to equilibrium phases recently reported for silicate plus carbonate reactions under mantle-like conditions. Interpretation of pressure-temperature equilibrium conditions for the diamond inclusion system based on the silicate-carbonate reaction and the two-pyroxene geothermometer suggests $5x10^4$ kbars and 1,300°C, but the olivine plus vitreous-like phase inclusion may indicate a pressure well below $5x10^4$ kbars.[24]

When does a science come of age? When it grows so fast and in so many parts of the world that its members need abstracts. These data will be useful in two types of laboratories: (1) The research laboratory where the goal is new syntheses through flame, flux, and pressure; and (2) the testing laboratory, which is under constant challenge to identify manmade materials and treatments. More than 1,750 entries are arranged in the alphabetical order of mineral species. However, garnet-type synthetics such as yttium-aluminum garnet (YAG) and gadolinium-gallium garnet (GGG) are grouped together, as are double, triplets, and information about synthesis in general. Treatments such as irradiation, staining, coating, and heating are also covered. Each entry gives the color, type, manufacturer, identification data, and the name and date of the publication or patent describing it. The abstracted journals and monographs are worldwide and date from the 1880's.[25]

For many years it was said that opal could not be synthesized. However, synthetics are now available from several sources. When the synthetics first came on the market, gemologists had to develop methods of differentiating them from natural opals. One of the first indications was that synthetic opals were too perfect as compared with most natural opals, but better methods were necessary. A series of tests was devised and are presented to assist in the identification of synthetic opal.[26]

Faceting may be described as the technique of cutting a gem stone with a number of flat polished surfaces arranged in a given pattern and at predetermined angles. The main reason for faceting a stone is that this style of cutting takes advantage of the inherent brilliance of the material being cut. The amount of brilliance a gem shows depends on the quantity of light reflected from its surface and, even more important, the amount of internal reflection. Faceted gems are usually cut from transparent materials to take advantage of their property of reflecting light. Even though stones are faceted primarily for their brilliance, many of the more valuable stones are cut for their color. If color is the main feature, even if a stone has just a little potential brilliance, it will look better faceted. The potential brilliance of a gem is very important in determining the style of cut that will help the stone achieve its potential brilliance. There are two basic styles of cuts—the brilliant and the step (or emerald) cut. Brilliant cuts are preferred for stones having a high refractive index and a high dispersion; the step cut is effective for colored gems having a low to medium refractive index. The evaluation of equipment, materials, methodology, and techniques were discussed in a recent publication.[27]

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Gem Stones

By G. David Baskin[1]

The value of gem stones and mineral specimens produced in the United States during 1978 was estimated to be $8.9 million. Production in 1979 decreased to an estimated $8.2 million. During both years, turquoise production decreased while tourmaline and sapphire production increased. Amateur collectors accounted for much of the activity in many States. Commercial operators produced rough jade, jasper, agate, sapphire, turquoise, opal, and tourmaline, which they sold mainly to wholesale or retail outlets and also to jewelry manufacturers.

DOMESTIC PRODUCTION

Mines and collectors in 39 States produced gem materials with an estimated value of $1,000 or more in each State in 1978. Nine States supplied 89% of the total value, as follows: Arizona, $4.6 million; Maine, $1 million; Nevada, $1 million; Oregon, $600,000; California, $240,000; Wyoming, $200,000; New Mexico, $180,000; Texas, $170,000; and Washington, $170,000. In 1979, estimated production in Arizona and Oregon decreased to $4 million and $500,000, respectively, while other values remained the same.

Park authorities at the Crater of Diamonds Park in Pike County, Ark., reported 120,000 people visited the park in 1978 and found 608 diamonds. The largest was an 8.5-carat, brown stone of undetermined value. Most of the stones are off-white to brown; however, yellow, pink, and green stones are also found. During 1979, the park had 85,400 visitors, and 411 diamonds were found. The largest stone found weighed 5.1 carats. The decrease in attendance reflected a general decrease in tourism around the country; however, "dig for fee" operations remained popular.

In 1978, new tourmaline pockets were found in the Mt. Mica pegmatites near West Paris, Maine. The green and blue crystals should yield several cut stones up to 100 carats each. Some of the tourmaline from the Dunton Quarry, Oxford County, was used to create miniature sculptures of animal life native to North America. The gem carvings, some made with several colors of Maine tourmaline, were completed in Idar-Oberstein, the Federal Republic of Germany, and exhibited at national gem shows in the United States.[2] In 1979, one of the largest gem tourmaline-bearing cavities ever discovered in the United States was found at Mt. Mica.

In San Diego County, Calif., tourmaline is being produced at the reopened Himalaya Mine. The Tourmaline Queen and Pala Chief mines, in the same county, continue to produce fine gem-quality and specimen tourmaline and morganite.

Small quantities of rare red beryl crystals are being mined in a rhyolite in the Wah Wah Mountains in Beaver County, Utah. Much of the material is sold as mineral specimens; however, some fine cut stones have been available. The finer stones, none weighing over 3 carats, have sold for $3,000 per carat.

In Mitchell County, N.C., a small pocket of emerald was found at the old Crabtree mine. Several of the crystal specimens would yield fair to good cut stones weighing 1 to 1.5 carats.

Sapphire mining continued at Yogo Gulch, Mont. The mine is producing some very fine blue stones. Three carats has been the maximum size cut stone available.

In Rabun County, Ga., and Macon County, N.C., small quantities of gem-quality smoky quartz have been found.

Gem-quality aquamarine has been found in decomposed pegmatite in the mountains near Pierce, Idaho.

CONSUMPTION

Domestic gem stone output went to amateur and commercial rock, mineral, and gem stone collections, objects of art, and jewelry. Apparent consumption (domestic production plus imports minus exports and reexports) in 1978 was $1,447 million, 39% more than that of 1977. During 1979, apparent consumption decreased to $1,238 million.

PRICES

A sampling of prices which colored-stone dealers in various U.S. cities charged their customers during December 1979 follows:[3]

Gem stone	Carat weight	Price range per carat	Median price per carat: Early December 1979	Median price per carat: December 1978[1]
Amethyst	10	$14- $28	$15	$15
Aquamarine	5	55- 300	168	100
Cat's eye (chrysobery])	2	290-1,500	850	800
Citrine	10	8- 18	12	9
Emerald:				
Medium to better	1	1,600-4,675	3,150	2,700
Commercial	1	250-1,500	900	900
Garnet, green (tsavorite, demantoid)	1	425- 850	600	475
Opal, black	3	350- 750	500	400
Opal, white	5	60- 125	75	75
Peridot (variety of olivine)	5	45- 90	65	55
Ruby:				
Medium to better	1	950-4,000	1,830	1,250
Commercial	1	450-1,550	590	500
Sapphire:				
Medium to better	1	450-2,500	750	600
Commercial	1	90- 630	225	150
Star sapphire:				
Sky-blue	5	80- 900	250	250
Grey	5	25- 150	100	83
Tanzanite (blue-violet zoisite)	5	300- 700	500	413
Topaz	5	150- 265	245	193
Tourmaline, green	5	30- 110	70	48
Tourmaline, pink	5	30- 145	80	70

[1]Adjusted from Keystone prices formerly published.

A sampling of prices which diamond dealers in various U.S. cities charged their customers in December 1979 follows:[4]

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Price range per carat	Median price per carat Early December 1979	Median price per carat December 1978[3]
0.04-0.08	G-I	VS_1	$450- $755	$587	$611
.04- .08	G-I	SI_1	385- 615	540	546
.09- .16	G-I	VS_1	475- 872	640	731
.09- .16	G-I	SI_1	425- 695	595	643
.17- .22	G-I	VS_1	740- 1,495	980	945
.17- .22	G-I	SI_1	675- 1,315	895	850
.23- .28	G-I	VS_1	840- 1,745	1,220	1,115
.23- .28	G-I	SI_1	700- 1,535	1,090	982
.29- .35	G-I	VS_1	935- 1,980	1,400	1,242
.29- .35	G-I	SI_1	775- 1,690	1,120	1,065
.46- .55	G-I	VS_1	1,600- 2,488	1,950	1,565
.46- .55	G-I	SI_1	1,250- 2,140	1,540	1,348
.69- .79	G-I	VS_1	2,000- 3,185	2,605	2,035
.69- .79	G-I	SI_1	1,500- 2,746	2,103	1,861
1.00-1.15	D	FL	35,000-38,500	37,000	22,500
1.00-1.15	E	VVS_1	14,000-19,500	17,000	NA
1.00-1.15	G	VS_1	4,428- 7,500	6,100	NA
1.00-1.15	H	VS_2	3,500- 5,700	4,650	NA
1.00-1.15	I	SI_1	2,500- 4,300	3,170	NA

NA Not available.
[1]Gemological Institute of America color grades: D—colorless; E—rare white; G-I—traces of color.
[2]Clarity: FL—no blemishes; VVS_1—very, very slightly included; VS_1—very slightly included; VS_2—very slightly included, but more visible; SI_1—slightly included.
[3]Adjusted from Keystone price formerly published.

The retail price of a finest quality, 1-carat diamond tripled between December 1976 and December 1978. This was due in part to devaluation of the U.S. dollar and the fact that the diamond market became very speculative early in 1978. In order to dampen speculation in the resale of rough gem-quality stones, De Beers Consolidated Mining, the South African company controlling 85% of the world's diamonds, imposed a 40% surcharge on its April sales of rough stones; during May, June, and July, the surcharge was reduced to 25%, 15%, and 10%, respectively. The surcharge had the desired effect in that it quelled speculation and suspected hoarding of rough diamond at a time when De Beers' supplies were believed to be limited. Following the removal of the surcharge, De Beers raised prices an average of 30%. In September 1979, De Beers' prices again rose an overall 13%; the largest increase affected cut stones weighing over one-half carat.

Emerald prices decreased in 1979 approximately 10% in all but the finest qualities. An increase in the supply of Zambian stones brought the decline.

Other precious and semiprecious stones also increased in price and popularity. Many buyers turned to colored stones as fine diamonds became more expensive.

FOREIGN TRADE

The following section contains foreign trade statistics for 1978 and for 1979 (in parentheses).

Exports by the United States of all gem materials amounted to $492.7 ($661.0) million, and reexports to $290.7 ($279.0) million. Diamond accounted for 93% (94%) of the value of exports and 96% (94%) of the reexports. Exports of diamond totaled 332,199 (213,481) carats valued at $457.1 million ($623.1 million). Of this total, diamond cut but unset, suitable for gem stones not over 0.5 carat, was 49,057 (59,300) carats valued at $41.7 million ($69.5 million); and cut but unset, over 0.5 carat was 170,316 (145,864) carats valued at $402.1 million ($552.5 million). Exports of uncut diamond were 112,826 (8,317) carats valued at $13.3 million ($1.1 million).

Reexports of diamond amounted to 1,266,998 (982,027) carats valued at $279.6 million ($261.5 million), in categories as follows: Rough or uncut, suitable for gem stones, not classified by weight, 1,179,038 (913,981) carats valued at $169.1 million ($150.1 million); cut but unset, not over 0.5 carat, 37,742 (42,841) carats valued at $18.8 million ($25.1 million); cut but unset, over 0.5 carat, 50,218 (25,205) carats, valued at $91.7 million ($86.3 million).

Exports of all other gem materials by the United States amounted to $27.5 million

($37.7 million). Of this total, pearls, natural and cultured, not set or strung, were valued at $3.9 million ($0.8 million). Natural precious and semiprecious stones, unset, were valued at $21.7 million ($33.9 million); and synthetic or reconstructed stones, unset, were valued at $1.9 million ($3.0 million). Reexports of all other gem materials amounted to $12.3 million ($18.4 million) in categories as follows: Pearls, $1.2 million (less than $0.1 million); natural precious and semiprecious stones, unset, $10.9 million ($18.2 million); synthetic or reconstructed stones, unset, $0.2 million ($0.2 million).

In 1978, imports by the United States of gem materials increased 36% in value over those of 1977; diamond accounted for 88% of the total value of gem material imports. In 1979, imports of gem materials decreased 2% in value from those of the previous year; diamond accounted for 86% of the total value of gem material imports.

Although rough and uncut diamond imports were reported from 31 (27) countries, 99% (99%) of the value was from 9 countries. Cut but unset diamond, not over 0.5 carat, was imported from 41 (40) countries; however, the imports of this category from 10 countries amounted to 99% (98%) of total carats and value. Cut but unset diamond, over 0.5 carat, was imported from 28 (33) countries; the imports from 8 countries amounted to 99% (99%) of the total carats and 98% (99%) of the value.

Emerald imports increased 5% (39%) in quantity and 28% (28%) in value. Emerald was imported from 42 (40) countries; the imports from 12 countries amounted to 97% (97%) of the carats and 93% (95%) of the value. Rubies were imported from 34 (31) countries; the imports from 9 countries amounted to 98% (98%) of the value. Sapphires were imported from 34 (35) countries; the imports from 10 countries amounted to 98% (97%) of the value.

Natural pearls and parts from 12 (18) countries increased 54% (192%) in value of imports; 5 countries accounted for 93% (79%) of the value as follows: India, $291,000 ($820,326); Burma, $215,000 ($238,694); Japan, $136,000 ($566,669); China, mainland, $89,000 ($196,720); and Hong Kong, $50,000 ($110,357). Imports of cultured pearls increased 49% (46%) in value, and were received from 18 (23) countries; Japan, at $24.6 ($36.2) million, accounted for 90% (91%) of the value. Imports of imitation pearls decreased 2% (increased 43%) in value; Japan, at $582,000, ($1,223,763) accounted for 63% (93%) of the value. Coral, cut but unset, and cameos suitable for use in jewelry decreased 3% (18%) in value of imports, which were received from 17 (16) countries; 3 countries accounted for 95% (91%) of the value as follows: Taiwan, $2.2 million (1.5 million); Italy, $1.4 million ($1.4 million); and Japan, $0.5 million ($0.3 million).

Imports of other precious and semiprecious stones, rough and uncut, increased 52% (21%) in value and came from 51 (48) countries, of which 9 countries accounted for 82% (83%) of the value. Other precious and semiprecious stones, cut but unset, increased 34% (decreased 7%) in value and were imported from 55 (54) countries, of which 5 countries accounted for 86% (83%) of the value. Synthetic gem stones, cut but unset, increased 48% (46%) in value and came from 20 (28) countries, of which 7 accounted for 93% (88%) of the value. Imitation gem stones increased 25% (2%) in value and came from 20 (22) countries, of which 5 countries accounted for 93% (94%) of the value.

Table 1.—U.S. exports and reexports of diamond (exclusive of industrial diamond), by country

Country	1978 Quantity (carats)	1978 Value (millions)	1979 Quantity (carats)	1979 Value (millions)
Exports:				
Belgium-Luxembourg	46,153	$60.4	33,589	$110.5
Canada	3,875	2.7	5,503	4.9
France	6,087	17.2	4,606	26.2
Hong Kong	107,790	203.6	73,854	243.1
India	8,427	.6	340	.2
Israel	59,501	17.8	23,966	21.4
Japan	33,493	56.9	35,792	72.0
Netherlands	11,758	14.9	565	1.5
Switzerland	28,730	49.1	18,249	104.2
United Kingdom	11,113	12.5	4,349	14.1
Other	15,772	21.4	12,668	25.0
Total	332,199	457.1	218,481	623.1
Reexports:				
Belgium-Luxembourg	485,011	83.7	354,873	86.4
France	13,649	8.1	9,688	8.3
Hong Kong	36,812	27.4	12,812	22.1
India	119,643	2.7	126,763	3.2
Israel	373,393	74.5	295,662	63.9
Japan	12,270	12.1	10,528	11.3
Netherlands	96,693	27.1	53,468	8.9
Switzerland	14,242	16.1	13,076	27.6
United Kingdom	94,773	22.6	94,273	24.7
Other	20,512	5.3	10,884	5.1
Total	1,266,998	279.6	982,027	261.5

Table 2.—U.S. imports for consumption of diamond (cut but unset), by kind and country

Kind and country	1978 Quantity (carats)	1978 Value (millions)	1979 Quantity (carats)	1979 Value (millions)
Cut but unset, not over 0.5 carat:				
Belgium-Luxembourg	865,804	$271.1	557,859	$187.0
France	6,170	2.1	3,583	1.4
Hong Kong	6,153	2.1	10,172	2.1
India	1,050,948	241.6	769,769	172.9
Israel	876,100	305.0	676,353	241.9
Sierra Leone	5,223	1.7	4,565	2.2
South Africa, Republic of	26,217	16.1	20,655	13.8
Switzerland	7,428	5.7	13,277	7.0
United Kingdom	25,804	8.6	14,141	6.0
U.S.S.R	20,120	9.2	12,651	6.0
Other	25,201	7.7	27,778	10.8
Total	2,915,168	869.9	2,110,803	651.1
Cut but unset, over 0.5 carat:				
Belgium-Luxembourg	145,857	131.1	127,277	138.1
India	6,803	3.3	5,390	2.1
Israel	91,985	63.5	77,190	66.3
Netherlands	3,816	4.1	2,794	2.6
South Africa, Republic of	12,723	17.1	9,545	19.8
Switzerland	4,948	8.5	5,181	10.7
United Kingdom	7,382	8.7	4,551	7.8
U.S.S.R	4,511	3.5	1,530	1.9
Other	2,108	3.2	2,072	2.3
Total	279,632	243.0	235,530	251.6

Table 3.—U.S. imports of precious and semiprecious gem stones, by kind and country

Kind and country	1978 Quantity (carats)	1978 Value (millions)	1979 Quantity (carats)	1979 Value (millions)
Emerald:				
Belgium-Luxembourg	35,186	$0.3	4,175	$0.4
Brazil	107,901	4.1	94,237	4.8
Colombia	66,095	31.4	205,129	45.1
Germany, Federal Republic of	29,790	2.2	21,511	2.5
Hong Kong	139,235	5.7	126,097	8.0
India	908,706	13.9	1,673,987	14.4
Israel	106,285	8.3	71,718	13.8
Japan	13,478	.1	876	.3
South Africa, Republic of	52,381	.1	2,551	1.0
Switzerland	81,681	9.0	13,352	6.8
Tanzania	18,853	.03	--	--
United Kingdom	34,749	1.6	5,188	2.6
Other	48,304	5.5	58,410	5.4
Total	1,642,644	82.2	2,277,231	105.1
Ruby:				
Burma	NA	.1	NA	.3
Germany, Federal Republic of	NA	.6	NA	.4
Hong Kong	NA	1.2	NA	2.1
India	NA	1.2	NA	1.7
Israel	NA	.4	NA	.4
Sri Lanka	NA	.5	NA	.3
Switzerland	NA	.9	NA	1.0
Thailand	NA	17.8	NA	23.0
United Kingdom	NA	.3	NA	.2
Other	NA	.4	NA	.6
Total	NA	23.4	NA	30.0
Sapphire:				
Australia	NA	.2	NA	.1
Burma	NA	.1	NA	.04
Germany, Federal Republic of	NA	.4	NA	.4
Hong Kong	NA	1.6	NA	1.4
India	NA	.8	NA	.9
Israel	NA	.1	NA	.2
Sri Lanka	NA	3.9	NA	3.4
Switzerland	NA	1.2	NA	1.2
Thailand	NA	14.8	NA	15.0
United Kingdom	NA	.4	NA	.2
Other	NA	.4	NA	.7
Total	NA	23.4	NA	23.5
Other:				
Rough, uncut:				
Australia	NA	1.2	NA	1.6
Brazil	NA	3.7	NA	3.1
Colombia	NA	2.1	NA	1.8
Israel	NA	.9	NA	.6
Kenya	NA	.4	NA	.8
Netherlands	NA	.4	NA	--
South Africa, Republic of	NA	.6	NA	3.3
Switzerland	NA	1.7	NA	3.0
Zambia	NA	2.1	NA	1.8
Other	NA	2.7	NA	3.2
Total	NA	15.8	NA	19.2
Cut but unset:				
Australia	NA	2.5	NA	2.4
Brazil	NA	12.2	NA	11.2
Germany, Federal Republic of	NA	5.2	NA	5.3
Hong Kong	NA	19.9	NA	17.2
Taiwan	NA	1.5	NA	.5
Other	NA	6.5	NA	7.7
Total	NA	47.8	NA	44.3

NA Not available.

Table 4.—Value of U.S. imports of synthetic and imitation gem stones, by country

(Million dollars)

Country	1978	1979
Synthetic, cut but unset:		
Austria	1.9	5.1
France	.9	4.0
Germany, Federal Republic of	6.9	2.8
Japan	1.3	.3
Korea, Republic of	.7	.9
Switzerland	1.7	3.8
Taiwan	.9	.5
Other	1.2	5.2
Total	15.5	22.6
Imitation:		
Austria	6.3	8.2
Czechoslovakia	1.1	1.3
Germany, Federal Republic of	4.8	3.1
Japan	.4	.3
Switzerland	.3	.1
Other	1.1	.8
Total	13.5	13.8

Table 5.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1977		1978		1979	
	Quantity	Value	Quantity	Value	Quantity	Value
Diamonds:						
Rough or uncut	2,909	638,205	2,463	848,651	2,120	956,340
Cut but unset	3,502	806,332	3,193	1,112,907	2,347	902,755
Emeralds: Cut but unset	1,563	64,375	1,643	82,297	2,277	105,064
Coral, cut but unset, and cameos suitable for use in jewelry	NA	4,410	NA	4,287	NA	3,511
Rubies and sapphires: Cut but unset	NA	33,544	NA	46,858	NA	53,513
Marcasites	NA	58	NA	40	NA	134
Pearls:						
Natural	NA	544	NA	840	NA	2,453
Cultured	NA	18,260	NA	27,152	NA	39,655
Imitation	NA	942	NA	926	NA	1,321
Other precious and semiprecious stones:						
Rough and uncut	NA	10,448	NA	15,888	NA	19,198
Cut but unset	NA	35,617	NA	47,809	NA	44,319
Other n.s.p.f	NA	3,273	NA	3,951	NA	4,763
Synthetic:						
Cut but unset number (thousands)	15,753	10,391	17,883	15,386	20,223	22,579
Other	NA	864	NA	1,074	NA	1,485
Imitation gem stones	NA	10,841	NA	13,506	NA	13,814
Total	XX	1,638,104	XX	[1]2,221,511	XX	2,170,904

NA Not available. XX Not applicable.

[1]Data do not add to total shown because of independent rounding.

Table 6.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by country

(Thousand carats and thousand dollars)

Country	1977				1978				1979			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Belgium-Luxembourg	22	7,592	1,257	307,766	26	9,968	1,012	402,190	40	12,042	685	325,055
Bolivia	--	--	--	--	--	--	--	--	1	150	--	--
Brazil	(1)	91	4	860	9	1,274	4	1,253	18	2,201	7	2,875
Canada	(1)	49	1	704	--	--	2	1,249	9	171	2	1,087
Central African Empire	51	3,539	--	--	66	6,458	--	--	75	5,267	--	--
France	8	683	9	1,577	(1)	8	6	2,183	(1)	339	4	1,491
Germany, Federal Republic of	(1)	8	4	906	--	--	1	368	--	--	2	1,318
Ghana	8	64	--	--	(1)	4	--	--	--	--	--	--
Hong Kong	1	98	9	1,741	(1)	1	7	3,164	--	--	11	3,066
India	(1)	1	769	130,501	(1)	100	1,058	244,885	1	83	776	175,016
Ireland	1	413	2	305	--	--	--	--	--	--	--	--
Israel	57	11,177	1,260	304,263	50	17,719	968	368,424	59	18,406	754	308,177
Italy	--	--	2	641	--	--	1	651	--	--	(1)	113
Japan	(1)	27	1	286	2	15	3	1,124	--	--	1	558
Liberia	1	228	--	--	70	14,286	(1)	2	32	7,726	--	--
Mauritania	5	45	(1)	23	--	--	--	--	(1)	65	--	--
Netherlands	29	12,465	54	12,489	44	15,585	8	5,770	15	11,158	7	4,163
Sierra Leone	186	40,467	4	881	146	52,386	5	1,688	123	51,628	5	2,165
South Africa, Republic of	1,096	315,790	33	16,905	1,221	550,442	39	32,725	1,134	671,526	30	33,591
Switzerland	6	811	8	3,003	5	743	12	14,198	6	6,871	18	17,666
Tunisia	--	--	3	548	--	--	(1)	115	--	--	--	--
U.S.S.R	--	--	44	14,089	(1)	1	25	12,668	(1)	22	14	7,928
United Kingdom	1,281	238,608	32	7,073	497	155,544	33	17,266	266	145,389	19	13,797
Venezuela	155	5,381	--	--	313	20,819	(1)	4	308	20,324	(1)	61
Other Africa, n.e.c	(1)	23	--	--	2	775	2	261	27	1,367	(1)	234
Other	2	645	6	1,771	12	2,523	7	2,719	4	1,605	12	4,394
Total	2,909	638,205	3,502	806,332	2,463	848,651	3,193	1,112,907	[2]2,120	956,340	2,347	902,755

[1]Less than 1/2 unit.

[2]Data do not add to total shown because of independent rounding.

WORLD REVIEW

Angola.—The Angola Diamond Co. mines diamond on concessions comprising 50,000 square kilometers in the northeastern region of the country. After a considerable drop in production because of internal strife in 1976 and 1977, partial recovery was achieved in 1978, with the mining of more than 700,000 carats of gem-quality diamond.[5] A 137-carat diamond was found in the Lucapa mine area in North Lunda Province.[6]

Australia.—Diamond exploration in the Kimberley region of Western Australia stirred much excitement during 1978 and 1979. More than 5,700 claims of 120 hectares each were staked by 23 exploration groups representing 45 to 55 different companies. The most promising results were shown by the Ashton Joint Venture, which is managed by a subsidiary of Conzinc Riotinto of Australia Ltd. Initial sampling of several of the 28 kimberlite pipes located in 1978 yielded more than 4,200 stones of industrial and gem-quality. The largest stone found weighed 5.7 carats, but the average weight was less than 0.1 carat. In October 1979, a group managed by Conzinc Riotinto found a pipelike structure of diamond-bearing kimberlite in the Lake Argyle area in Western Australia near the Northern Territory border. The pipe, covering 111 acres at the surface yields about 150 carats for each 100 metric tons of kimberlite ore. Alluvial deposits in the same area have much higher yield. The prospect has yielded more than 5,000 carats; the largest stone weighed 7.03 carats. The quality of the stones has not been ascertained. The claims will not be firmly evaluated until 1980 when more extensive bulk sampling and sample processing will be complete.[7 8]

A large ruby field was discovered at Ambalindum Station northeast of Alice Springs in central Australia. The property owner has said that it is among the three most important ruby discoveries in the world.[9]

A sapphire deposit near Mt. Garnett in north Queensland is yielding stones up to 10 carats. The area has been set aside by the Government for hand miners.[10]

Annual value of opal production at Lightning Ridge in northern New South Wales has reached $A7 million. Prices up to $5,000 per carat for black opals are reported to have been offered. Prices are said to be increasing 20% annually. It is hoped that with increased open cut mining at Lightning Ridge, this area will eventually rival the South Australia production from the opal fields at Coober Pedy.[11]

Botswana.—The Jwaneng mine now being developed will reportedly add 6 million carats to the annual diamond production of Botswana by 1985, making that country one of the world's major producers ranking behind Zaire and the Soviet Union. Located in the Kalahari Desert, the mine is a joint project between the Botswana Government and De Beers Consolidated Mines Ltd. The Government will receive 77.5% of the profits.[12]

The diamond mines at Orapa and Letlhakane were recently expanded. The Orapa mine increased its output from 2.5 million to 4.1 million carats, and an expansion to the facilities at Letlhakane raised production from 330,000 to 400,000 carats per year at the end of 1979. The mines are operated by Debswana, a joint company owned equally by De Beers and the Botswana Government.[13]

Central African Empire.—Diamond production in 1978 was 284,240 carats, 70% being gem-quality. Total production decreased 5.6% from the 1977 level, while increased prices resulted in the value of production rising 49% to $35 million.[14] An Israeli-Iranian-Swiss group obtained a 30,000-square-kilometer concession for diamond exploration and evaluation; however, the group's project was dissolved when political instability in Iran increased.[15]

Colombia.—In the first 7 months of 1979, Colombia exported emeralds worth $75 million. Total production in 1978 was $40 million compared with $2 million in 1973, when some state-owned mines at Muzo, Coscuez, and Penas Blancas, beset by theft and violence, were occupied by the army. These have since been taken over by private consortia and returned to full production.[16]

India.—Buying and selling diamonds became much easier with the formation of two new facilities. The Hindustan Diamond Co., Ltd., has been set up jointly by the Indian Government (50%), the Bank of Bermuda's UK branch (30%), and the Industrial Investment Trust, Ltd. (20%). The company will be involved in obtaining and distributing rough diamonds on a regular basis to the country's diamond industry. The service will be particularly beneficial to the 10,000 small processing units and artisans. A diamond exchange is being set up in Bombay with the claim that this will eliminate loss of revenue caused by having to go through Antwerp or Hong Kong for sales to the international market.[17] A task force organized by the Government has set an export target of Rs210 billion by 1982-83, a 300% increase over present levels.[18]

Due to substantial cuts in imports by the United States and Europe, export values for December 1978 were only one-half those of November. During the first half of 1979, diamond exports recovered enough to allow reinstatement of some of the 150,000 workers laid off during the recession.[19 20]

Israel.—In 1978, exports of polished diamonds totaled 2,570,000 carats with a net value of $1,317 million, a 31% increase over the 1977 export values.[21] Exports from January through November of 1979 had a value of $1,129 million, a 7% decrease compared to the same period in the previous year.

Kenya.—A 3-year survey carried out under a bilateral agreement between Austria and Kenya has resulted in estimates that the gem stone belt of Kenya, running from the Taiti Hills to the Tanzanian border, contains rubies worth between K Sh 40 million and 80 million.[22] Minable deposits yield fine rubies up to 1 carat and rivaling the Burmese rubies in color. An aquamarine occurrence is producing light-blue clean stones selling for $30 to $100 per carat. Traders in Kenya have accumulated substantial quantities of Tanzanian tsavorite (green garnet) for which they are asking unusually high prices.

Lesotho.—Two exceptionally large fine diamonds were recovered at the Letseng-laterai mine high in the Maluti Mountains. In February 1978, a 98-carat stone was found followed by a 130.4-carat stone in July. According to De Beers, the mine's profits depend on the occasional large stone, since most of the ore is low grade.[23]

Pakistan.—Three years' exploration has turned up several major gem deposits in northern Pakistan. An area of 30 square miles in the Hunza Valley contains rich lodes of ruby, emerald, sapphire, quartz, garnet, tiger's eye, moonstone and pyrite.[24]

The Government of Pakistan formed the Gemstone Corp. for the mining, cutting, polishing, marketing, and export of the country's gems. As a subsidiary of the Pakistan Mineral Development Corp., the new corporation will manage the Swat emerald mine, the Hunza ruby mines, and the lapidary center in Peshawar. From July 1977 to June 1978, 42.2 million carats of rubies was recovered at the Hunza deposits.[25 26]

Rhodesia, Southern.—Pilot plant testing of a diamond deposit near Beitbridge is underway. The prospect belongs to De Beers Consolidated Mines, Ltd.[27]

South Africa, Republic of.—Diamond production in 1978 is estimated at 7.7 million carats with 3.6 million carats being of gem-quality. This represents a 1% increase from total production in 1977. The 1979 total production is estimated to have decreased slightly to 7.64 million carats.

De Beers continued plans to increase diamond production from all its mining interests to over 20 million carats by the mid-1980's.[28] In South Africa, De Beers' plans include increasing ore production and plant capacity and improving diamond recovery techniques. Marked improvement in recovery methods in the last 10 years has led to the retreatment of old mine dumps in and around Kimberley, a move intended to extend the life of the older underground mines, some of which were expected to be exhausted before 1990.[29]

The Premier mine, one of De Beers' most important producers, yielded a white diamond totaling 353.9 carats uncut. It has been cut and shaped as a tear-drop pendant. The company also announced reaching an agreement with the South African Government for the further development of the mine, which has produced over 78 million carats including 280 stones weighing over 100 carats each. The mine will be extended below a 75-meter-thick barren gabbro sill which cuts across the kimberlite pipe at the 400-meter level. The kimberlite below the sill is expected to yield 14 million tons of ore at a grade of 72 carats per hundred tons.[30 31]

In northwestern Cape Province the Koingnaas mine began production planned at 540,000 carats per year with an apparent operating life of 15 years. The alluvial deposit will yield small stones averaging 0.25 carat or less. Discovered in 1962, the deposit could not be economically mined until the recent sharp increases in diamond prices and improvement in market conditions for small stones.[32]

The Finsch mine, in the same province, will increase its ore production by about 40% to 420,000 tons per month. In addition, the treatment plant plans to increase capacity and substantially improve diamond recovery. On the basis of a 6-day working week, the new capacity is aimed at increasing the mine's diamond production of 2.4 million carats per year by about 1 million carats per year.[33] Gem stone recoveries presently run at about 15% of the total diamond production.

Domestic diamond cutting labor was expected to increase to 4,500 by the end of 1979, a 400% expansion over the number employed in early 1978. The industry could soon handle 5 million carats per year.[34]

An expansion program has begun that will increase the De Beers/Sibeka synthetic industrial diamond production capacity to more than 60 million carats annually. This would amount to 60% of the 1978 synthetic diamond world market. The three-phase program, which includes plants in the Republic of South Africa, Ireland, and Sweden, is expected to be complete in 1980.[35]

Sri Lanka.—As part of the jewelry export drive to be implemented by the export development board, Sri Lanka is once again to import diamonds. This move follows a ban on diamond imports (which has lasted over two decades) and is one of several moves initiated by the board in an attempt to achieve jewelry exports in 1980 worth $1 million.[36]

Tanzania.—Salmon-pink to cinnamon-orange "malaya" garnet is being mined in the Umba Valley. Stones larger than 10 carats are rare and may bring several hundred dollars per carat.

U.S.S.R.—Diamond exports, estimated at $750 million in 1978 are the Soviet Union's fourth largest hard currency earner.[37] An estimated 10.6 million carats were mined in 1978, 20% being of gem-quality.

The Soviets introduced a new ornamental gem stone in the United States. Charoite is a lilac-purple stone composed of calcium potassium silicate with areas of greenish black massive or acicular aegirine-augite and orange tinkasite. With a hardness of 5 to 6 (Moh's scale) it is well suited for carving and cabbing.[38]

A large turquoise deposit was found in Armenia. Fine green turquoise and chrysoprase finds are reported in Kazakhstan. Several new nephrite deposits have been found; colors range from white and chocolate brown to emerald green. New blue topaz and aquamarine finds have also been reported.

The Soviet Union, while increasing its production of natural precious and semiprecious stones, is also synthesizing and marketing fine-quality emerald and amethyst.

Zaire.—Diamond production (11.2 million carats in 1978) was reported to be unaffected by unrest in Shaba Province. The diamond-producing areas of Kasai are 200 miles north of the troubled area. Zaire markets its diamonds (95% to 97% industrial quality) through De Beers' Central Selling Organization.

Zambia.—Emerald deposits in the Ndola District may be exploited by Mukashala Ltd., a company formed by five Zambian chiefs. If a mining license is granted, the company will employ villagers presently mining illegally.[39]

Table 7.—Diamond (natural): World production, by type and country[1]

(Thousand carats)

Country	1976 Gem	1976 Industrial	1976 Total	1977 Gem	1977 Industrial	1977 Total	1978[p] Gem	1978[p] Industrial	1978[p] Total	1979[e] Gem	1979[e] Industrial	1979[e] Total
Africa:												
Angola	255	85	340	265	88	353	525	175	700	562	188	750
Botswana	358	2,026	2,384	404	2,287	2,691	418	2,367	2,785	500	2,840	3,340
Central African Empire	172	114	286	178	119	297	199	85	284	210	90	300
Ghana	228	2,055	2,283	[r]230	[r]1,717	1,947	142	1,281	1,423	150	1,350	1,500
Guinea[e]	25	55	80	25	55	80	25	55	80	27	58	85
Ivory Coast	[r]22	[r]38	60	[r]7	[r]11	[r]18	--	10	10	--	5	5
Lesotho	1	4	5	7	35	42	13	53	66	14	56	70
Liberia[2]	[r]163	[r]162	[r]325	163	163	326	128	180	308	130	180	310
Sierra Leone	[r]433	[r]650	[r]1,083	423	538	961	283	424	707	285	425	710
South Africa, Republic of:												
Premier mine	458	1,375	1,833	502	1,508	2,010	496	1,487	1,983	495	1,485	1,980
Other De Beers properties[3]	2,549	2,086	4,635	2,796	2,287	5,083	2,903	2,376	5,279	2,900	2,300	5,200
Other	333	222	555	[r]330	[r]220	[r]550	279	186	465	275	185	460
Total	3,340	3,683	7,023	[r]3,628	[r]4,015	[r]7,643	3,678	4,049	7,727	3,670	3,970	7,640
South-West Africa, Territory of, (Namibia)	1,609	85	1,694	1,901	100	2,001	1,803	95	1,898	1,850	100	1,950
Tanzania	219	219	[2]438	[r]204	[r]204	[r] [2]408	146	147	[2]293	145	145	290
Zaire	591	11,230	11,821	561	10,652	11,213	562	10,688	11,250	560	10,600	11,160
Other areas:												
Brazil	38	38	76	[r]33	[r]32	[r]65	43	43	86	45	45	90
Guyana	6	8	14	7	10	17	7	10	17	7	10	17
India	17	3	20	[r]15	3	[r]18	14	2	16	14	2	16
Indonesia[e]	3	12	15	3	12	15	3	12	15	3	12	15
U.S.S.R.[e]	2,000	7,900	9,900	2,100	8,200	10,300	2,150	8,400	10,550	2,200	8,500	10,700
Venezuela	[r]195	[r]654	[r]849	[r]204	[r]483	[r]687	278	460	738	285	465	750
World total	[r]9,675	[r]29,021	[r]38,696	10,358	28,724	39,082	10,417	28,536	38,953	10,657	29,041	39,698

[e]Estimate. [p]Preliminary. [r]Revised.

[1]Total diamond output (gem plus industrial) for each country is actually reported except where indicated by a footnote to be estimated. In contrast, the detailed separate production data for gem diamond and industrial diamond are Bureau of Mines estimates in the case of every country except Central African Empire (1976-78), Liberia (1976-78), Sierra Leone (1977 and 1978), and Venezuela (1978), for which source publications give details on grade as well as totals. The estimated distribution of total output between gem and industrial diamond is conjectural in the case of a number of countries, based on unofficial information of varying degrees of reliability.

[2]Total exports.

[3]All company output from the Republic of South Africa, except for that credited to the Premier mine; excludes De Beers Group output from Botswana, Lesotho, and the Territory of South-West Africa (Namibia).

TECHNOLOGY

Some diamonds that were once graded as high-quality industrial are now used as low-quality gem stones. This trend is due to increased demand and rising prices as well as increased use of diamond improvement techniques. Stones of poor brown or yellow color can, in some cases, be irradiated and/or heat treated to improve the color to rich coffee, canary yellow, and other colors; small inclusions can be removed with laser treatment, which burns a minute path to the material and oxidizes it.

Heat and irradiation (ultraviolet, X-ray, gamma ray, electron bombardment) are widely used on many precious and semiprecious stones to improve their color.

Heat treatment in aquamarine, topaz, zircon, and tanzanite is very common. With some stones, treatment is permanent and undetectable; others may fade with time and exposure to daylight.[40]

Cubic zirconia, the newest and best of the diamond simulants, increased in popularity and availability. The material consists of zirconium oxide with a compound such as yttrium oxide or calcium oxide added to stabilize the cubic structure. With a very high melting point of 2,750° C, a special technique, skull melting, must be used to obtain large uncontaminated crystals. World production was estimated at 15 million carats of rough in 1978. U.S. consumers purchased an estimated 1 million carats ($40 to $60 million estimated sales) in 1978.[41]

A properly cut cubic zirconia may be indistinguishable from a diamond in an unaided visual examination. However, simple tests of physical properties such as specific gravity, surface wettability, thermal conductivity, and hardness will reveal the difference.

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Gem Stones

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The value of gem stones and mineral specimens produced in the United States during 1980 was estimated to have decreased more than 15% to $6.9 million from the 1979 value of $8.2 million. All types of gem stones production, except for opal, decreased during the year. Amateur collectors accounted for much of the activity in many States. Commercial operators produced rough jade, jasper, agate, sapphire, turquoise, opal, peridot, emerald, onyx, obsidian, and tourmaline, which they sold mainly to wholesale or retail outlets and also to jewelry manufacturers.

DOMESTIC PRODUCTION

Mines and collectors in 40 States produced gem materials with an estimated value of $1,000 or more in each State in 1980. Ten States supplied 89% of the total value, as follows: Arizona, $3.1 million; Maine, $900,000; Nevada, $900,000; Oregon, $450,000; California, $210,000; Wyoming, $190,000; Texas, $160,000; New Mexico, $150,000; Washington, $150,000; and Arkansas, $140,000.

Park authorities at the Crater of Diamonds Park in Pike County, Ark., reported that approximately 75,000 people visited the park in 1980 and found 582 diamonds. The largest was a 5.2-carat stone of undetermined value. Most of the stones are off-white to brown; however, yellow, pink, and green stones are also found. The decrease in attendance during the year, reflecting a general nationwide decrease in tourism, was compounded by the heat wave which affected the region; however, "dig for fee" operations remained popular.

CONSUMPTION

Domestic gem stone output went to amateur and commercial rock, mineral, and gem stone collections, objects of art, and jewelry. Apparent consumption (domestic production plus imports minus exports and reexports) in 1980 was $1,791 million, 38% more than that of 1979.

PRICES

A sampling of prices that colored-stone dealers in various U.S. cities charged their cash customers during December 1980 follows:

Gem stone	Carat weight	Price range per carat 1980	Median price per carat[1]	
			December 1979	Early December 1980
Amethyst	10	$14- $28	$15	$15
Aquamarine	5	55- 300	168	168
Cat's eye (chrysoberyl)	2	290-1,500	850	850
Citrine	10	8- 18	12	12
Emerald:				
Medium to better	1	1,600-5,000	3,150	3,500
Commercial	1	225-2,500	900	900
Garnet, green (tsavorite, demantoid)	1	425-1,250	600	725
Opal, black	3	350- 750	500	500
Opal, white	5	60- 125	75	75
Peridot (variety of olivine)	5	45- 90	65	56
Ruby:				
Medium to better	1	950-4,500	1,830	2,750
Commercial	1	350-1,800	590	850
Sapphire:				
Medium to better	1	475-2,500	750	1,200
Commercial	1	150- 900	225	425
Star sapphire:				
Sky-blue	5	80- 900	250	250
Grey	5	25- 150	100	100
Tanzanite (blue-violet zoisite)	5	500-1,200	500	590
Topaz	5	150- 265	245	245
Tourmaline, green	5	40- 145	70	75
Tourmaline, pink	5	40- 150	80	80

[1]Jewelers' Circular-Keystone, v. 151, No. 2, February 1980, p. 196; v. 152, No. 1, January 1981, p. 126. These figures represent a sampling of net prices that colored stone dealers in various U.S. cities charged their cash customers during the month.

A sampling of prices that diamond dealers in various U.S. cities charged their customers in December 1980 follows:

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Price range per carat 1980	Median price per carat[3]	
				December 1979	Early December 1980
0.04-0.08	G-I	VS_1	$450- $755	$587	$570
.04- .08	G-I	SI_1	350- 615	540	520
.09- .16	G-I	VS_1	475- 849	640	655
.09- .16	G-I	SI_1	375- 681	595	585
.17- .22	G-I	VS_1	725- 1,710	980	1,080
.17- .22	G-I	SI_1	600- 1,510	895	975
.23- .28	G-I	VS_1	950- 1,970	1,220	1,385
.23- .28	G-I	SI_1	771- 1,720	1,090	1,150
.29- .35	G-I	VS_1	1,000- 2,270	1,400	1,550
.29- .35	G-I	SI_1	800- 1,905	1,120	1,375
.46- .55	G-I	VS_1	1,600- 3,215	1,950	2,738
.46- .55	G-I	SI_1	1,050- 2,645	1,540	1,950
.69- .79	G-I	VS_1	2,000- 5,200	2,605	3,556
.69- .79	G-I	SI_1	1,400- 3,450	2,103	2,530
1.00-1.15	D	FL	42,000-54,000	37,000	[4]53,000
1.00-1.15	E	VVS_1	16,000-24,000	17,000	[4]23,000
1.00-1.15	G	VS_1	6,000- 9,000	6,100	[4]8,600
1.00-1.15	H	VS_2	4,000- 6,500	4,650	[4]5,650
1.00-1.15	I	SI_1	2,500- 3,900	3,170	[4]3,550

[1]Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; G-I—traces of color.
[2]Clarity: FL—no blemishes; VVS_1—very, very slightly included; VS_1—very slightly included; VS_2—very slightly included, but more visible; SI_1—slightly included.
[3]Jewelers' Circular-Keystone, v. 151, No. 2, February 1980, p. 194; v. 152, No. 1, January 1981, p. 124. These figures represent a sampling of net prices that diamond dealers in various U.S. cities charged their customers during the month.
[4]Representative of early November 1980 sales. December sales are nonrepresentative.

FOREIGN TRADE

The following section contains foreign trade statistics tables 1-6 for 1979 and 1980. Table 7 contains world production statistics for 1976-80.

Table 1.—U.S. exports and reexports of diamond (exclusive of industrial diamond), by country

Country	1979 Quantity (carats)	1979 Value (millions)	1980 Quantity (carats)	1980 Value (millions)
Exports:				
Belgium-Luxembourg	33,589	$110.5	31,797	$95.9
Canada	5,503	4.9	7,041	5.1
France	4,606	26.2	5,112	31.0
Hong Kong	73,854	243.1	69,927	240.5
Israel	23,966	21.4	21,164	16.2
Japan	35,792	72.0	28,039	64.2
Switzerland	18,249	104.2	24,110	127.3
United Kingdom	4,349	14.1	5,068	19.5
Other	13,573	26.7	18,385	43.6
Total	213,481	623.1	210,643	643.3
Reexports:				
Belgium-Luxembourg	354,873	86.4	333,186	119.2
France	9,688	8.3	6,922	6.9
Hong Kong	12,812	22.1	36,345	40.6
India	126,763	3.2	199,201	6.7
Israel	295,662	63.9	262,625	93.2
Japan	10,528	11.3	61,579	7.3
Netherlands	53,468	8.9	42,987	6.8
Switzerland	13,076	27.6	18,323	44.6
United Kingdom	94,273	24.7	109,024	18.4
Other	10,884	5.1	43,918	54.2
Total	982,027	261.5	1,114,110	397.9

Table 2.—U.S. imports for consumption of diamond (cut but unset), by kind and country

Kind and country	1979 Quantity (carats)	1979 Value (millions)	1980 Quantity (carats)	1980 Value (millions)
Cut but unset, not over 0.5 carat:				
Belgium-Luxembourg	557,859	$187.0	531,251	$223.6
India	769,769	172.9	854,526	198.9
Israel	676,353	241.9	787,535	322.8
South Africa, Republic of	20,655	13.8	34,751	25.6
Switzerland	13,277	7.0	9,528	4.6
Other	72,890	28.5	53,202	22.9
Total	2,110,803	651.1	2,270,793	798.4
Cut but unset, over 0.5 carat:				
Belgium-Luxembourg	127,277	138.1	155,280	242.2
India	5,390	2.1	5,155	2.7
Israel	77,190	66.3	89,015	117.8
Netherlands	2,794	2.6	2,565	4.9
South Africa, Republic of	9,545	19.8	28,638	43.1
Switzerland	5,181	10.7	3,678	16.6
United Kingdom	4,551	7.8	5,475	15.4
Other	3,602	4.2	6,309	14.9
Total	235,530	251.6	296,105	457.6

Table 3.—U.S. imports of precious and semiprecious gem stones, by kind and country

Kind and country	1979 Quantity (carats)	1979 Value (millions)	1980 Quantity (carats)	1980 Value (millions)
Emerald:				
Brazil	94,237	$4.8	240,198	$7.5
Colombia	205,129	45.1	81,910	55.7
France	6,215	1.0	5,073	1.5
Germany, Federal Republic of	21,511	2.5	38,618	3.0
Hong Kong	126,097	8.0	56,073	8.6
India	1,673,987	14.4	3,025,578	18.6
Israel	71,718	13.8	88,234	21.2
Switzerland	13,352	6.8	27,310	12.0
United Kingdom	5,188	2.6	6,032	7.2
Other	59,797	6.1	31,864	6.1
Total	2,277,231	105.1	3,600,890	141.4
Ruby:				
Burma	NA	.3	NA	.8
Germany, Federal Republic of	NA	.4	NA	.9
Hong Kong	NA	2.1	NA	13.5
India	NA	1.7	NA	3.1
Israel	NA	.4	NA	.5
Sri Lanka	NA	.3	NA	.9
Switzerland	NA	1.0	NA	3.3
Thailand	NA	23.0	NA	58.1
United Kingdom	NA	.2	NA	1.3
Other	NA	.6	NA	2.6
Total	NA	30.0	NA	85.0
Sapphire:				
Burma	NA	.4	NA	.3
Germany, Federal Republic of	NA	.4	NA	.6
Hong Kong	NA	1.4	NA	4.9
India	NA	.9	NA	1.6
Sri Lanka	NA	3.4	NA	6.8
Switzerland	NA	1.2	NA	1.7
Thailand	NA	15.0	NA	31.8
United Kingdom	NA	.2	NA	.8
Other	NA	1.3	NA	2.4
Total	NA	24.2	NA	50.9
Other:				
Rough, uncut:				
Australia	NA	1.6	NA	2.0
Brazil	NA	3.1	NA	4.5
Colombia	NA	1.8	NA	1.8
Israel	NA	.6	NA	.1
Kenya	NA	.8	NA	.5
South Africa, Republic of	NA	3.3	NA	3.2
Switzerland	NA	3.0	NA	3.5
Zambia	NA	1.8	NA	1.9
Other	NA	3.2	NA	2.8
Total	NA	19.2	NA	20.3
Cut but unset:				
Australia	NA	2.4	NA	2.4
Brazil	NA	11.2	NA	17.4
Germany, Federal Republic of	NA	5.3	NA	7.9
Hong Kong	NA	17.2	NA	17.1
Taiwan	NA	.5	NA	1.0
Other	NA	7.7	NA	11.1
Total	NA	44.3	NA	56.9

NA Not available.

Table 4.—Value of U.S. imports of synthetic and imitation gem stones, by country

(Million dollars)

Country	1979	1980
Synthetic, cut but unset:		
Austria	5.1	0.9
France	4.0	.8
Germany, Federal Republic of	2.8	7.5
Japan	.3	.3
Korea, Republic of	.9	5.3
Switzerland	3.8	2.1
Taiwan	.5	.9
Other	5.2	1.9
Total	22.6	19.7
Imitation:		
Austria	8.2	8.5
Czechoslovakia	1.3	.8
Germany, Federal Republic of	3.1	3.1
Japan	.3	.3
Switzerland	.1	.8
Other	.8	.2
Total	13.8	13.7

Table 5.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1979		1980	
	Quantity	Value	Quantity	Value
Diamonds:				
Rough or uncut	2,120	956,340	[1]1,594	995,212
Cut but unset	2,347	902,755	2,567	1,255,983
Emeralds: Cut but unset	2,277	105,064	3,601	141,413
Coral: Cut but unset, and cameos suitable for use in jewelry	NA	3,511	NA	3,544
Rubies and sapphires: Cut but unset	NA	53,513	NA	226,426
Marcasites	NA	134	NA	136
Pearls:				
Natural	NA	2,453	NA	3,829
Cultured	NA	39,655	NA	77,375
Imitation	NA	1,321	NA	1,965
Other precious and semiprecious stones:				
Rough and uncut	NA	19,198	NA	20,323
Cut but unset	NA	44,319	NA	56,927
Other n.s.p.f	NA	4,763	NA	7,430
Synthetic:				
Cut but unset[2]	20,223	22,579	17,848	19,714
Other	NA	1,485	NA	1,277
Imitation gem stones	NA	13,814	NA	13,689
Total	XX	2,170,904	XX	2,825,243

NA Not available. XX Not applicable.

[1]Includes 16,544 carats of other natural diamond, advanced, in 1980.

[2]Quantity in thousands of stones.

Table 6.—U.S. imports for consumption of diamond (exclusive of industrial diamond), by country

(Thousand carats and thousand dollars)

Country	1979				1980			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Belgium-Luxembourg	40	12,042	685	325,055	33	19,494	687	466,235
Central African Empire	75	5,267	--	--	66	7,082	--	--
India	1	83	776	175,016	(1)	22	860	201,703
Israel	59	18,406	754	308,177	24	12,471	877	440,559
Liberia	32	7,726	--	--	5	10,491	--	--
Netherlands	15	11,158	7	4,163	12	6,879	5	6,029
Sierra Leone	123	51,628	5	2,165	85	49,165	4	2,627
South Africa, Republic of	1,134	671,526	30	33,591	908	662,142	63	68,726
Switzerland	6	6,871	18	17,666	19	11,582	13	21,145
United Kingdom	266	145,389	19	13,797	201	193,541	18	21,276
Venezuela	308	20,324	(1)	61	205	16,810	(1)	144
Other Africa, n.e.c.	27	r1,432	(1)	234	15	1,052	1	478
Other	32	4,488	53	22,830	21	4,481	38	27,061
Total	r2,118	956,340	2,347	902,755	1,594	995,212	[2]2,567	1,255,983

r Revised.
[1] Less than 1/2 unit.
[2] Data do not add to total shown because of independent rounding.

Table 7.—Diamond (natural): World production, by type and country[1]

(Thousand carats)

Country	1976 Gem	1976 Industrial	1976 Total	1977 Gem	1977 Industrial	1977 Total	1978 Gem	1978 Industrial	1978 Total	1979[p] Gem	1979[p] Industrial	1979[p] Total	1980[e] Gem	1980[e] Industrial	1980[e] Total
Africa:															
Angola	255	85	340	265	88	353	525	175	700	562	188	750	750	250	1,000
Botswana	358	2,026	2,384	404	2,287	2,691	418	2,367	2,785	659	3,735	4,394	765	4,336	[2]5,101
Central African Republic	172	114	286	178	119	297	199	85	284	205	110	315	180	99	279
Ghana	228	2,055	2,283	230	1,717	1,947	142	1,281	1,423	125	1,128	1,253	100	1,100	1,200
Guinea[e]	25	55	80	25	55	80	25	55	80	27	58	85	27	57	84
Ivory Coast	22	38	60	7	11	18	--	10	10	5	32	37	6	34	40
Lesotho	[r]4	[r]1	5	[r]39	[r]3	42	[r]62	[r]5	67	48	4	52	50	4	[2]54
Liberia[3]	163	162	325	163	163	326	128	180	308	170	132	302	170	130	300
Namibia	1,609	85	1,694	1,901	100	2,001	1,803	95	1,898	1,570	83	1,653	1,482	78	[2]1,560
Sierra Leone	433	650	1,083	423	538	961	[r]353	[r]426	779	419	436	855	400	450	850
South Africa, Republic of:															
Finsch Mine	441	1,762	2,203	485	1,941	2,426	526	2,104	2,630	517	2,068	2,585	581	2,326	[2]2,907
Premier Mine	458	1,375	1,833	502	1,508	2,010	496	1,487	1,983	[r]520	[r]1,561	2,081	510	1,529	[2]2,039
Other De Beers properties[4]	[r]1,460	[r]972	[r]2,432	[r]1,617	[r]1,040	[r]2,657	[r]1,638	[r]1,011	2,649	[r]2,054	[r]1,166	3,220	1,829	1,210	[2]3,039
Other	[r]499	[r]56	555	[r]495	[r]55	550	[r]418	[r]47	465	[r]448	[r]50	498	483	54	[2]537
Total	[r]2,858	[r]4,165	7,023	[r]3,099	[r]4,544	7,643	[r]3,078	[r]4,649	7,727	[r]3,539	[r]4,845	8,384	3,403	5,119	[2]8,522
Tanzania	219	219	[3]438	204	204	[3]408	146	147	[3]293	145	145	[e]290	120	120	240
Zaire[5]	[r]498	[r]11,323	11,821	[r]533	[r]10,681	[r]11,214	[r]640	[r]10,603	11,243	294	8,440	8,734	400	8,300	8,700
Other areas:															
Australia	--	--	--	--	--	--	--	--	--					48	48
Brazil[6]	[r]214	[r]47	[r e]261	[r]274	[r]46	[r e]320	[r]291	[r]49	[r e]340	[r]305	[r]55	[r e]360	305	55	360
Guyana	6	8	14	7	10	17	7	10	17	6	10	16	6	10	16
India	17	3	20	15	3	18	14	2	16	13	2	15	12	2	14
Indonesia[e]	3	12	15	3	12	15	3	12	15	3	12	15	3	12	15

See footnotes at end of table.

Table 7.—Diamond (natural): World production, by type and country[1] —Continued

(Thousand carats)

Country	1976			1977			1978			1979[p]			1980[e]		
	Gem	Industrial	Total	Gem	Industrial	Total	Gem	Industrial	Total	Gem	Industrial	Total	Gem	Industrial	Total
Other areas: —Continued															
U.S.S.R.[e]	2,000	7,900	9,900	2,100	8,200	10,300	2,150	8,400	10,550	2,200	8,500	10,700	2,250	8,600	10,850
Venezuela	195	654	849	204	483	687	r269	r487	756	247	556	803	250	575	825
World total	r9,279	r29,602	r38,881	r10,074	r29,264	r39,338	r10,253	r29,038	39,291	r10,542	r28,471	39,013	10,679	29,379	40,058

eEstimated. pPreliminary. rRevised.

1Table includes data available through May 12, 1981. Total diamond output (gem plus industrial) for each country is actually reported except where indicated by a footnote to be estimated. In contrast, the detailed separate production data for gem diamond and industrial diamond are Bureau of Mines estimates in the case of every country except the Central African Republic (1976-78), Liberia (1976-78), Sierra Leone (1977 and 1978), and Venezuela (1978), for which source publications give details on grade as well as totals. The estimated distribution of total output between gem and industrial diamond is conjectural, and for most countries is based on the best available data at time of publication. Mainland China also produces some natural diamond, but output is not reported.

2Reported figure.

3Total exports.

4All company output from the Republic of South Africa, except for that credited to the Finsch and Premier Mines for the years indicated; excludes De Beers Group output from Botswana, Lesotho, and Namibia.

5Excludes very substantial quantities produced and exported illicitly; estimates of these quantities are quite variable, but for recent years, the principal Zairian producer indicates 5 to 6 million carats annually (gem plus industrial) and may have exceeded this level in 1979 and 1980.

6Series revised to reflect the substantial output by small miners (garimpos), which is estimated as follows in thousand carats: 1976—185; 1977—254; 1978—269; 1979—280; 1980—280 (1976 and 1977 estimates from the Brazilian Ministry of Mines and Energy; 1978-80 estimates by U.S. Bureau of Mines).

Gem Stones

By J. W. Pressler[1]

The value of gem stones and mineral specimens produced in the United States during 1981 was estimated to be $7.6 million. During the year, turquoise production decreased while tourmaline and sapphire production increased. Amateur collectors accounted for much of the activity in many States. Commercial operators produced rough jade, jasper, agate, sapphire, turquoise, opal, and tourmaline, which they sold mainly to wholesale or retail outlets and also to jewelry manufacturers.

DOMESTIC PRODUCTION

Mines and collectors in 46 States produced gem materials with an estimated value of $1,000 or more in each State in 1981. Ten States supplied 90% of the total value, as follows: Arizona, $3.3 million; Nevada, $1.0 million; Maine, $700,000; Oregon, $600,000; California, $300,000; Wyoming, $250,000; and Arkansas, New Mexico, Texas, and Washington, $200,000 each. In 1981, estimated production increased 33% in New Mexico and Washington, 25% in Texas, 20% in Oregon, 5% in Nevada, and 3% in Arkansas, but decreased 12% in Maine.

Park authorities at the Crater of Diamonds Park in Pike County, Ark., reported that approximately 97,000 people visited the park in 1981 and found 1,327 diamonds with a total weight of 244 carats. This was an increase of 99% compared with the old record of 668 stones found in 1975. The largest was an 8.3-carat white stone of undetermined value. The next three largest diamonds, one brown and two whites, ranged from 5.90 to 6.25 carats. The principal factor contributing to this new record was the introduction of new concentrating and screening techniques that enable diggers to recover more of the smaller (1- to 24-point) diamonds. The average for all diamonds found was 18 points. Ticket sales and total attendance were up substantially from the 75,000 tickets sold in 1980. The "dig for fee" operations remained popular.

In Pala, San Diego County, Calif., Pala Gem Mines produced tourmaline at their Stewart lithia mine. The other small mines, in the same county, continued to produce fine gem-quality and specimen tourmaline, kunzite, and morganite.

Montana continued to lead the other States in the production of corundum, particularly gem-quality sapphire. Gemco International produced 35,000 carats of sapphires in 1980 from Yogo Gulch, Fergus County, with a high percentage of prize blues. A 500-ton-per-day recovery plant was planned to be onstream by 1982. Three other pay-as-you-dig or fee placer operations were active: Eldorado Bar and Castle's Sapphire Mine near Helena, and Gem Mountain Sapphire Mine near Philipsburg. Gem-quality rubies and sapphires are also found in the Cowee Valley near Franklin, N.C. A 163-carat ruby is believed to be one of the largest rubies ever found in the area.

The largest single emerald ever found in North America was a 1,438-carat crystal from the Rist Mine near Hiddenite, N.C., in 1969. Each year, many small emeralds are found by visitors there, as well as from the Crabtree Mine near New Switzerland, N.C.

CONSUMPTION

Domestic gem stone output went to amateur and commercial rock, mineral, and gem stone collections, objects of art, and jewelry. Apparent consumption (domestic production plus imports minus exports and reexports) in 1981 was $1,812 million, 1% more than that of 1980.

PRICES

Yearend domestic sales of commercial-grade gem diamonds (inexpensive commercial-grade stones up to 1 carat) surged during the Christmas season, but there was a reduced market for better quality certificate stones over 1.0 carat.

The U.S. price of 1.0-carat, D-flawless, investment-grade diamond plummeted during the year, decreasing more than 60% from an alltime high in October 1980 of $54,250 to a $20,000-to-$25,000 range at yearend 1981.

Colored stones languished during the year, with commercial materials being more popular, and expensive stones experienced poor sales. Average prices of some high-quality stones—emerald, black opal, and ruby—decreased 30% to 50%, while others—sapphire, star sapphire, tanzanite, and tourmaline—increased 56% to 80%.

Table 1.—Prices of U.S. cut diamonds, by size and quality

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Price range per carat 1981	Median price per carat[3]	
				December 1980	Early December 1981
0.04-0.08	G-I	VS_1	$375- $650	$570	$467
.04- .08	G-I	SI_1	325- 550	520	400
.09- .16	G-I	VS_1	475- 750	655	550
.09- .16	G-I	SI_1	400- 615	585	470
.17- .22	G-I	VS_1	600- 1,205	1,080	837
.17- .22	G-I	SI_1	510- 1,045	975	687
.23- .28	G-I	VS_1	750- 1,375	1,385	900
.23- .28	G-I	SI_1	640- 1,215	1,150	800
.29- .35	G-I	VS_1	875- 1,795	1,550	1,200
.29- .35	G-I	SI_1	740- 1,535	1,375	917
.46- .55	G-I	VS_1	1,300- 2,285	2,738	1,800
.46- .55	G-I	SI_1	1,000- 2,000	1,950	1,500
.69- .79	G-I	VS_1	1,600- 3,010	3,556	2,300
.69- .79	G-I	SI_1	1,200- 2,420	2,530	1,850
1.00-1.15	D	FL	(4)	[5]53,000	26,500
1.00-1.15	E	VVS_1	10,000-16,050	[5]23,000	11,250
1.00-1.15	G	VS_1	4,600- 8,480	[5]8,600	5,075
1.00-1.15	H	VS_2	3,500- 5,700	[5]5,650	3,800
1.00-1.15	I	SI_1	2,600- 4,000	[5]3,550	2,750

[1]Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; G-I—traces of color.

[2]Clarity: FL—no blemishes; VVS_1—very, very slightly included; VS_1—very slightly included; VS_2—very slightly included, but more visible; SI_1—slightly included.

[3]Jewelers' Circular-Keystone, v. 152, No. 1, January 1981, p. 124; v. 153, No. 2, February 1982, p. 150. These figures represent a sampling of net prices that diamond dealers in various U.S. cities charged their customers during the month.

[4]Not enough sales reported to quote prices. Last quoted as $36,000-$44,000 in July 1981 Jewelers' Circular-Keystone. Quoted at yearend in The Diamond Registry Bulletin, New York, N.Y., as $20,000-$25,000.

[5]Representative of early November 1980 sales. December sales are nonrepresentative.

Table 2.—Prices of U.S. cut colored gem stones, by size

Gem stone	Carat weight	Price range per carat 1981	Median price per carat[1] December 1980	Median price per carat[1] Early December 1981
Amethyst	10	$10- $25	$15	$18
Aquamarine	5	40- 300	168	187
Cat's eye	2	(2)	850	(2)
Citrine	10	12- 45	12	16
Emerald:				
Medium to better	1	1,200-4,000	3,500	2,500
Commercial	1	800-2,500	900	1,175
Garnet, green	1	400-1,000	725	625
Opal, black	3	200- 300	500	250
Opal, white	5	45- 125	75	80
Peridot	5	45- 100	55	65
Ruby:				
Medium to better	1	1,200-5,000	2,750	1,650
Commercial	1	600-3,000	850	700
Sapphire:				
Medium to better	1	450-2,500	1,200	1,500
Commercial	1	250- 800	425	750
Star sapphire:				
Sky-blue	5	350- 500	250	450
Gray	5	80- 200	100	102
Tanzanite	5	400-1,000	590	850
Topaz	5	75- 350	245	237
Tourmaline, green	5	45- 150	75	125
Tourmaline, pink	5	65- 200	80	125

[1]Jewelers' Circular-Keystone, v. 152, No. 1, January 1981, p. 126; v. 153, No. 2, February 1982, p. 152. These figures represent a sampling of net prices that colored stone dealers in various U.S. cities charged their cash customers during the month.
[2]Not reported.

FOREIGN TRADE

U.S. imports of rough and polished natural diamonds, excluding industrial diamonds, attained a record $2.2 billion declared custom value in 1981. Total polished diamond imports, principally from Belgium (36%) and Israel (29%), increased 43% to $1.8 billion, a new alltime record. The over-0.5-carat category, mostly from Belgium (42%), Israel (19%), and Switzerland (17%), increased 66% to $760 million, and the less-than-0.5-carat group, mostly from Israel (37%), Belgium (31%), and India (24%), increased 30% to $1.04 billion. However, imports of rough natural diamond, principally from the Republic of South Africa (70%), the United Kingdom (9%), and Sierra Leone (4%), decreased 41% in caratage and 59% in value in 1981 compared with that of 1980. The decrease in carat value from $731 in 1980 to $359 in 1981 for South African imports was an indication that De Beers Consolidated Mines Ltd. was withholding the better quality rough stones from the market.

The total value of emerald imports decreased 7% to $132 million in 1981. The total value of rubies and sapphires imported in 1981 increased 30% to $177 million, compared with the revised figure of $136 million in 1980.

Table 3.—U.S. exports and reexports of diamond (exclusive of industrial diamond), by country

Country	1980 Quantity (carats)	1980 Value (millions)	1981 Quantity (carats)	1981 Value (millions)
Exports:				
Belgium-Luxembourg	31,797	$95.9	47,781	$49.4
Canada	7,041	5.1	9,020	7.1
France	5,112	31.0	5,909	23.0
Germany, Federal Republic of	2,452	7.5	3,037	6.8
Hong Kong	69,927	240.5	47,802	134.8
Israel	21,164	16.2	16,253	11.8
Japan	28,039	64.2	31,415	66.8
Netherlands	739	5.7	371	4.3
Singapore	6,836	13.7	6,585	12.3
Switzerland	24,110	127.8	16,930	98.4
United Kingdom	5,068	19.5	5,278	18.3
Other	8,358	16.7	6,729	8.3
Total	210,643	643.3	197,110	441.3
Reexports:				
Belgium-Luxembourg	338,186	119.2	[1]1,973,297	142.0
France	6,922	6.9	4,315	5.2
Hong Kong	36,345	40.6	55,118	44.9
India	199,201	6.7	323,785	7.2
Israel	262,625	93.2	386,840	79.3
Japan	61,579	7.3	79,813	19.5
Netherlands	42,987	6.8	41,324	3.2
Switzerland	18,323	44.6	28,182	58.5
United Kingdom	109,024	18.4	43,719	39.1
Other	43,918	54.2	81,484	13.9
Total	1,114,110	397.9	3,017,877	412.8

[1]Artificially inflated in 1981 by auction of 1,477,365 carats of U.S. Government stockpile industrial diamond stones with subsequent reexport as gem stones to Belgium-Luxembourg.

Table 4.—U.S. imports of diamond for consumption, by kind and country

Kind and country	1980 Quantity (carats)	1980 Value (millions)	1981 Quantity (carats)	1981 Value (millions)
Rough or uncut, natural:[1]				
Belgium-Luxembourg	32,587	$19.5	28,122	$12.2
Central African Republic	66,308	7.1	19,869	2.2
Israel	23,635	12.5	21,609	6.7
Liberia	5,023	10.5	3,717	2.7
Sierra Leone	85,352	49.2	37,872	23.8
South Africa, Republic of	907,749	662.1	656,362	282.5
Switzerland	18,988	11.6	7,943	4.1
United Kingdom	201,138	193.5	80,010	56.9
Venezuela	204,513	16.8	67,351	6.0
Other	48,310	12.4	10,430	6.5
Total	1,593,603	995.2	933,285	403.1
Cut but unset, not over 0.5 carat:				
Belgium-Luxembourg	531,251	223.6	777,054	319.9
Hong Kong	10,128	3.6	19,370	10.0
India	854,526	198.9	1,120,122	246.0
Israel	787,535	322.8	958,153	383.3
South Africa, Republic of	34,751	25.6	45,150	27.9
Switzerland	9,528	4.6	29,660	13.8
United Kingdom	12,192	5.9	17,571	10.8
Other	30,882	13.4	68,851	25.5
Total	2,270,793	798.4	3,035,931	1,037.2
Cut but unset, over 0.5 carat:				
Belgium-Luxembourg	155,280	242.2	206,171	319.3
Hong Kong	1,298	3.4	5,899	26.2
India	5,155	2.7	11,409	6.3
Israel	89,015	117.8	138,107	146.7
Netherlands	2,555	4.9	8,288	16.0
South Africa, Republic of	28,638	43.1	26,463	48.2
Switzerland	3,678	16.6	18,688	125.6
United Kingdom	5,475	15.4	11,112	40.1
Other	5,011	11.5	11,927	31.4
Total	296,105	457.6	438,064	759.8

[1]Includes some natural advanced diamond.

Table 5.—U.S. imports of precious and semiprecious gem stones, by kind and country

Kind and country	1980 Quantity (carats)	1980 Value (millions)	1981 Quantity (carats)	1981 Value (millions)
Emerald:				
Belgium-Luxembourg	1,777	$0.7	6,645	$3.2
Brazil	240,198	7.5	48,977	5.8
Canada	2,587	.7	18,788	1.2
Colombia	81,910	55.7	121,708	40.2
France	5,073	1.5	9,759	2.2
Germany, Federal Republic of	38,618	3.0	41,795	4.6
Hong Kong	56,073	8.6	120,313	12.2
India	3,025,578	18.6	1,572,510	15.8
Israel	88,234	21.2	96,870	22.8
Pakistan	793	.4	4,661	1.2
South Africa, Republic of	6,200	1.1	14,787	1.4
Switzerland	27,310	12.0	49,721	1.1
Thailand	6,779	.5	31,940	2.6
United Kingdom	6,032	7.2	7,097	4.6
Other	13,728	2.7	152,098	12.7
Total	3,600,890	141.4	2,297,659	131.6
Ruby:				
Belgium-Luxembourg	NA	.2	NA	1.4
Burma		.8		3.3
Canada		.1		1.2
France		.7		1.4
Germany, Federal Republic of		.9		3.1
Hong Kong		13.5		9.1
India		3.1		4.7
Switzerland		3.3		12.0
Thailand		58.1		47.6
United Kingdom		1.3		4.7
Other		3.0		5.3
Total	NA	85.0	NA	93.8
Sapphire:				
Australia	NA	.4	NA	2.6
France		.3		2.2
Germany, Federal Republic of		.6		2.4
Hong Kong		4.9		8.4
India		1.6		3.3
Sri Lanka		6.8		7.5
Switzerland		1.7		11.1
Thailand		31.8		34.8
United Kingdom		.8		5.1
Other		2.0		5.6
Total	NA	50.9	NA	83.0
Other:				
Rough, uncut:				
Australia	NA	2.0	NA	1.2
Brazil		4.5		3.2
Colombia		1.3		2.2
South Africa, Republic of		3.2		1.6
Switzerland		3.5		.7
Zambia		1.9		2.5
Other		3.4		6.3
Total	NA	20.3	NA	17.7
Cut but unset:				
Australia	NA	2.4	NA	3.5
Brazil		17.4		36.4
Germany, Federal Republic of		7.9		11.0
Hong Kong		17.1		17.6
India		2.7		2.4
Switzerland		.4		1.0
Taiwan		1.0		.9
Thailand		1.5		2.8
Other		6.5		5.4
Total	NA	56.9	NA	81.0

NA Not available.

Table 6.—Value of U.S. imports of synthetic and imitation gem stones, by country

(Million dollars)

Country	1980	1981
Synthetic, cut but unset:		
Austria	0.9	1.7
France	.8	1.2
Germany, Federal Republic of	7.5	5.8
Korea, Republic of	5.3	8.2
Switzerland	2.1	2.6
Other	3.1	3.1
Total	19.7	22.6
Imitation:		
Austria	8.5	7.7
Czechoslovakia	.8	.8
Germany, Federal Republic of	3.1	3.8
Other	1.3	1.0
Total	13.7	13.3

Table 7.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stone	1980 Quantity	1980 Value	1981 Quantity	1981 Value
Diamonds:				
Rough or uncut[1]	1,594	995,212	935	404,354
Cut but unset	2,567	1,255,983	3,474	1,796,908
Emeralds: Cut but unset	3,601	141,413	2,298	131,560
Coral: Cut but unset, and cameos suitable for use in jewelry	NA	3,544	NA	3,630
Rubies and sapphires: Cut but unset	NA	r135,914	NA	176,758
Marcasites	NA	136	NA	498
Pearls:				
Natural	NA	3,829	NA	2,008
Cultured	NA	77,375	NA	105,942
Imitation	NA	1,965	NA	1,966
Other precious and semiprecious stones:				
Rough and uncut	NA	20,328	NA	17,697
Cut but unset	NA	56,927	NA	87,325
Other n.s.p.f	NA	7,430	NA	665
Synthetic:				
Cut but unset[2]	17,848	19,714	28,846	22,646
Other	NA	1,277	NA	961
Imitation gem stones	NA	13,689	NA	13,332
Total	XX	r2,734,731	XX	2,766,250

rRevised. NA Not available. XX Not applicable.

[1]Includes 16,544 carats of other natural diamond, advanced, valued at $1.15 million in 1980, and 1,823 carats valued at $1.26 million in 1981.

[2]Quantity in thousands of stones.

WORLD REVIEW

Angola.—Prior to Angola's independence in 1974, annual diamond production was 2.4 million carats, and by 1979, production had fallen to 840,000 carats. A revitalization of this country's important diamond mining industry, spearheaded by Companhia de Diamantes de Angola (Diamang), bolstered by increasing prices, caused annual production of diamonds to climb to 1.5 million carats, with export earnings of $400 million in 1980. Diamang was 77.1% owned by the Government, with the remainder held by British, South African, United States, Belgian, and Swiss interests, with marketing handled by De Beers.[2]

Australia.—Exploration and evaluation of the Argyle prospect by the CRA-Ashton Joint Venture continued during the year with drilling and bulk sampling of the kimberlite pipe AK-1, and bulk sampling of the Upper Smoke Creek, Lower Smoke Creek, and the Limestone Creek alluvial deposits. Cumulative totals for all work performed (including 1980), indicate that 152,000 carats have been recovered from 37,800 short tons of the AK-1 pipe, and 102,000 carats have been recovered from 52,100 tons of the alluvials. Composite sorting of these diamonds showed a quality of 10% gem, 30% near-gem, and some high-quality industrials, and the balance industrials. A representative sampling has been evaluated by the Central Selling Organization at $8.00 per carat, depending on the bort value assumed.

The final feasibility study commenced at yearend for the design and construction of a large-scale commercial plant with an initial capacity of 2.5 million short tons per year. Large-diameter core drilling for kimberlite sampling and geological continuity of the pipe progressed to depths of 145 meters. With these assumptions, diamond production should start in 1985 at a level of 10 to 15 million carats per year, slightly better in the initial years until the alluvials are processed, and with a project life of 20 to 30 years. This mine alone would easily surpass Zaire as the world's largest producer of industrials and would have a strong impact upon the world market. At yearend, an agreement was made by the Central Selling Organization with the Ashton Joint Venture and the Australian Government to market most of the production, with some concessions to allow domestic sales, and the development of a cutting and polishing center in Perth.[3]

Australia produces five types of precious gem stones—black, gray, and white fire opal, sapphires, diamonds, chrysoprase, and rubies. The Aga emerald mine in Western Australia is a recent development. Although it has been an intermittent producer since 1909 with exports to India, recent exploration revealed an increased potential for emerald production. Recovery of gem-quality was about 11%, and the largest crystal found so far was 9.6 carats. The lower grade emeralds were being sold to the United States.[4]

Belgium.—Total imports of diamonds by Belgium reached 54 million carats in 1981, a 17% increase compared with that of the previous year; however, total value decreased 3.4% compared with that of 1980. Total exports were 48 million carats valued at $3.1 billion, a caratage increase of 8.5% and value increase of 7.4% compared with that of 1980. The major market for Belgium diamonds continued to be the United States, which received 1 million carats in 1981. The Central Selling Organization's share of Belgium's rough stone imports had gradually fallen from 89% in 1977 to 68% in 1981.[5] Price setting of investment-grade diamonds was being done twice daily by an important Antwerp-based diamond dealer.[6]

Botswana.—At yearend 1981, De Beers asked Botswana to stockpile diamonds because of the world slump in prices. De Beers had a 50% interest in De Beers Botswana Mining Co. in the operation of the Orapa and Letlhakane Mines, and the new Jwaneng Mine near Gabarone in the southern part of the state. The Jwaneng Mine, scheduled to have a rated capacity of 5.3 million short tons per year, was to be onstream in the second half of 1982. It is expected to have a higher recovery grade than that of any other mine in the Group, and to produce diamonds of medium quality. De Beers reported it to be probably the most important kimberlite pipe discovered anywhere in the world since Kimberley more than a century ago.[7]

Brazil.—Most of the gem diamond production in Brazil has come from independent prospectors called "garimpeiros" who produce about 120,000 carats per year. A conservative estimate for 1981 indicated total state production of 228,000 carats of gem and 372,000 carats of industrial diamond, mostly from Minas Gerais and Mato Grosso Provinces.[8]

China.—OCTHA, a South African diamond mining, cutting, and marketing group, is investing $3 million in China to establish the first diamond cutting and polishing operation in China.[9]

Colombia.—Econominas, the Colombian state mining organization, reported that legal exports of emeralds in 1980 were valued at $196 million, principally to Japan, the United States, and Taiwan. Emerald exports accounted for almost 50% of the total mineral exports from Colombia. However, it was estimated that this was only 40% of the real amount exported, the remainder being smuggled out of the country illegally.[10]

Ghana.—The Akwatia diamond mine, 65 miles from the Ghanaian capital of Accra, was facing several financial difficulties. The mine, which started operations in 1924, was no longer profitable, and its closing was a possibility. In 1973, the mine had produced 2.4 million carats annually and only produced about 1.0 million carats in 1981. However, at yearend the Government underwrote a $15 million loan to Ghana Consolidated Diamond Co. to modernize its plant and improve its economic viability. Also at yearend, the Government of India announced an agreement to purchase rough diamonds from the Diamond Marketing Corp. of Ghana, and it was estimated that this would result in additional margins for Ghana, compared with the previous sales through the Diamond Trading Co. of London.[11]

Guinea.—A $70 million alluvial diamond venture was being developed in the Kissidougou Banankor area close to the border of Sierra Leone, an area noted for high-quality diamonds. Initial production was expected to begin in August 1983 at an annual production level of 200,000 carats and increase to 500,000 carats per year by 1985. The project was a joint venture between Bridge Oil of Australia (45%) and the Republic of Guinea (50%). The remaining 5% was to be shared by Simonius Vischer and Industrial Diamond Co. of Switzerland, with marketing performed by Aredor Sales managed by Industrial Diamond Co.[12]

A diamond of 800 carats was discovered in Guinea in 1981. The diamond, the largest found in the country since 1958, was of industrial quality.[13]

India.—The discovery of three large diamonds in the Vajrakarur area of Andhra Pradesh has led the Geological Survey of India to embark on a 3-year program of intensive diamond exploration. The Majhagawan diamond mines of the Panna district have yielded a total of 233,000 carats of diamonds worth $20 million since 1960. The Panna area has also produced about 3,200 carats of crude emerald per year.[14]

The Gem and Jewellery Export Promotion Council in India reported that exports of gem stones and jewelry rose by 8% to $700 million in 1980-81. The council fixed a new target of $860 million for 1981-82, with most of the revenue from cut and polished gem diamonds, which ranks as India's top foreign exchange earning commodity. India already led the world in quantity of diamond exports and was ranked third after Israel and Belgium in terms of value.[15]

Israel.—The Israeli diamond cutting, polishing, and trading industry, one of the most important in the world, was severely affected by the recent decline in world gem sales. The industry has been the nation's largest industrial export business, with exports totaling $1.4 billion at its peak. At its peak in 1979, 700 companies employed 12,000 people, compared with about 600 companies employing 8,000 people in 1981. Exports in 1981 were about $950 million, 68% lower than the peak year of 1979.[16]

Israel accounts for about 50% of world production of cut emeralds, and exports have grown in value from $2.6 million in 1971 to $10 million in 1977. It is expected that exports exceeded $50 million in 1981.[17]

Ivory Coast.—Diamond mining of both gem and industrial quality in the Ivory Coast has been centered in the Tortiya and Seguela regions. Société Anonyme de Recherches et d'Exploitations Minières en Côte d'Ivoire's operation at Tortiya began in 1948 and continued until 1975, when it closed because of high costs. The Seguela Mine was successfully operated by the Watson Society from 1971 to 1977. The Ivory Coast has not produced any diamonds in the past 2 years.[18]

Lesotho.—At the Letseng-la-Terai Mine of De Beers Lesotho Mining Co., Ltd., the tonnage treated was down slightly to about 2.1 million short tons, and the grade was practically the same at 2.80 carats per 110 short tons. The percentage of gem diamonds remained high at 93%, and the diamonds larger than 10 carats in size represented 12% of the production.[19] Commercial operations at other diamond-bearing kimberlites in this small, landlocked country surrounded by the Republic of South Africa had been organized into two labor-intensive cooperatives with portable washing plants, which provided profitable work for over 1,100 employees.[20]

The Lesotho Government's Bureau of Statistics reported that 1980 production, 105,245 carats of diamonds, was valued at $274.88 per carat.[21]

Namibia.—Responding to poor market conditions, curtailment of the mining and treatment operations of Consolidated Diamond Mines (Pty.) Ltd., a subsidiary of De Beers, resulted in a 25% reduction in total tonnage treated, and a reduction of 20% in diamond production from 1.6 million carats in 1980 to 1.25 million carats in 1981. These beach placers near Oranjemund yield diamonds of 95% gem-quality, and contributed as much as 18% of De Beers pretax profits in 1979.[22]

The T.O.N.M. Oil and Gas Exploration Corp. has acquired a 50% interest in African Coast Diamond and Minerals (Pty.) Ltd. (ACDM). ACDM has mining rights to 90 square miles along the Atlantic coast of Namibia. A large-scale pilot plant with

Sortex equipment is located between the Hoarusib and Hoanib Rivers. Reserves have been estimated to be 2 to 6 million carats.[23]

It was reported that three kimberlite pipes had been discovered near the western border of the Republic of South Africa with Namibia, and De Beers inaugurated an extensive prospecting program across the frontier in the northeastern corner of Namibia.[24]

Sierra Leone.—During 1981, the National Diamond Mining Co., Ltd. (DIMINCO) of Sierra Leone mined principally alluvial deposits to produce about 595,000 carats of diamonds. Over 50% of the diamonds were of gem-quality, including some very large stones, which has resulted in illicit operations and theft. DIMINCO estimates that as much as 50% of the diamonds mined have been smuggled out. DIMINCO initiated an Alluvial Diamond Mining Scheme to have frequent sights in Freetown with payment in hard currency to detract from the smuggling. In the July sights, DIMINCO sold almost 45,000 carats for $188 per carat, not including a special sale of a 119-carat diamond for $1.1 million. A new joint venture of the Sierra Leone Government (60%), the Kuwait Foreign Trading, Contracting and Investment Co. (30%), and Sierra Leone Selection Trust (10%) was formed to mine the diamond-bearing kimberlites in the Kono area, to be initiated in 1981 and fully operational by 1985.[25]

South Africa, Republic of.—De Beers continued its widespread reconnaissance and prospecting program in the Republic of South Africa without the discovery of any new important kimberlite provinces. Shaft sampling of a kimberlite cluster on the Venetia farm, with bulk sample treatment by a heavy media separation plant, progressed during the year. Sampling for reserve extension of existing mines in Namaqualand continued.

The Namaqualand Div. of De Beers suspended operations in the Tweepad area for the last 7 months of 1981, and production at Annexe Kleinzee and the Koingnaas complex was reduced by 10% for the remainder of the year. Diamond recovery declined 15% to a level of 1.2 million carats with an average grade of 18.6 carats per 110 short tons.

At the Finsch Mine, operation of the new treatment plant for the full year at a high throughput and improved diamond recovery efficiency resulted in a 50% increase of diamond production in 1981 compared with 1980. The open pit mine, presently producing from the 160- to 220-meter levels, was scheduled to change over to underground production in 1988. Vertical shaft sinking to 763 meters was completed in August 1981.[26]

Leichardt Exploration of Australia discovered more diamonds on Farm "C" at the Reads Drift prospect, confirming expectations that higher grades exist at depth.[27]

The Octha diamond group was expanding its investment program to $160 million in South Africa, to create an integrated diamond mining, cutting, marketing, and retailing operation. Included in its operations was a Namaqualand Mine and four mines in the Kimberley area. Production in 1981, about 100,000 carats of 85% gem-quality, was expected to be increased to 1 million carats per year 50% gem-quality, by 1986.[28]

Sweden.—Two diamonds, each about 0.3 millimeter, were found in an area of kimberlite on the Baltic island of Alnon, just off the east coast of Sweden near Sundsvall. Washing of 12 short tons of ore yielded one diamond. This was the first confirmed diamond find ever made in western Europe.[29]

Thailand.—Thailand continued to be one of the most important centers of gem stone cutting and polishing in the world, principally diamonds, rubies, and sapphires. Export value of all precious stones in 1980 was approximately $2.5 billion.[30]

U.S.S.R.—The Siberian platform of the Soviet Union in north-central Asia has emerged as one of the most remarkable kimberlite and diamond areas on earth. Since the pioneering days 25 years ago, over 400 kimberlite pipes have been discovered within an oval belt 300 miles long and 250 miles wide southwest of the Lena River, a kimberlite province comparable with the Diamond Belt of southern Africa. Twelve principal kimberlite and/or diamond regions have been delineated, and the state has concentrated on these for maximum production development. The famous Mir diamond mine is in the Malo Botuoba region and was one of the richest pipes. However, it is questionable whether the full potential of this remote area will ever be realized, because at least 5 of the 12 principal regions are well within the Arctic Circle, where deep permafrost prevails along with long winters and extremely sub-Arctic temperatures. In one case at Mirnyy, construction engineers were fortunate in finding a dolerite sill upon which to build a milling and recovery plant.[31]

A new diamond mine was under develop-

Table 8.—Diamond (natural): World production, by country and type[1]

(Thousand carats)

Country	1977 Gem	1977 Industrial	1977 Total	1978 Gem	1978 Industrial	1978 Total	1979 Gem	1979 Industrial	1979 Total	1980[p] Gem	1980[p] Industrial	1980[p] Total	1981[e] Gem	1981[e] Industrial	1981[e] Total
Africa:															
Angola	265	88	353	[r]488	[r]162	[r]650	630	211	841	1,125	375	1,500	1,050	350	1,400
Botswana	404	2,287	2,691	[r]420	[r]2,379	[r]2,799	659	3,735	4,394	765	4,336	5,101	744	4,217	[2]4,961
Central African Republic	178	119	297	199	85	284	205	110	315	227	123	350	200	100	300
Ghana	230	1,717	1,947	142	1,281	1,423	125	1,128	1,253	126	1,132	1,258	100	900	1,000
Guinea[e]	25	55	80	25	55	80	27	58	85	12	26	38	12	26	38
Ivory Coast	[r]20	[r]19	[2]39	[r]22	[r]23	[r]45	24	24	48	--	--	--	--	--	--
Lesotho	39	3	42	62	5	67	48	4	52	50	4	54	49	4	[2]53
Liberia[3]	163	163	326	128	180	308	170	132	302	123	175	298	117	169	[2]286
Namibia	1,901	100	2,001	1,803	95	1,898	1,570	83	1,653	1,482	78	1,560	1,186	62	[2]1,248
Sierra Leone	423	538	961	353	426	779	419	436	855	317	275	592	320	275	595
South Africa, Republic of:															
Finsch Mine	[r]365	[r]2,061	2,426	[r]403	[r]2,227	2,630	465	2,120	2,585	465	2,442	2,907	1,002	3,463	[2]4,465
Premier Mine	[r]378	[r]1,632	2,010	[r]380	[r]1,603	1,983	468	1,613	2,081	407	1,632	2,039	510	1,530	[2]2,040
Other De Beers properties[4]	[r]1,216	[r]1,441	2,657	[r]1,254	[r]1,395	2,649	1,850	1,370	3,220	1,550	1,489	3,039	1,603	1,069	[2]2,672
Other	[r]372	[r]178	550	[r]320	[r]145	465	403	95	498	391	44	435	314	35	349
Total	[r]2,331	[r]5,312	7,643	[r]2,357	[r]5,370	7,727	3,186	5,198	8,384	2,813	5,607	8,420	3,429	6,097	[2]9,526
Tanzania	204	204	408	[r]141	[r]141	[r]282	157	157	314	137	137	274	140	140	280
Zaire	533	10,681	11,214	640	10,603	11,243	294	8,440	8,734	345	9,890	10,235	260	7,240	7,500
Other areas:															
Australia	--	--	--	--	[r]--	--	--	--	--	--	48	48	[2]21	[2]184	[2]205
Brazil	[r]236	[r]384	[r]620	[r]236	[r]384	[r]620	236	384	620	253	414	667	228	372	600
Guyana	7	10	17	7	10	17	6	10	16	4	6	10	4	6	10
India	15	3	18	14	2	16	14	2	16	[e]12	[e]2	[e]14	12	2	14
Indonesia[e]	3	12	15	3	12	15	3	12	15	3	12	15	3	12	15
U.S.S.R.[e]	2,100	8,200	10,300	2,150	8,400	10,550	2,200	8,500	10,700	2,250	8,600	10,850	2,120	8,480	10,600
Venezuela	204	483	687	[r]271	[r]549	[r]820	247	556	803	238	483	721	[2]102	[2]388	[2]490
Total	[r]9,281	[r]30,378	[r]39,659	[r]9,461	[r]30,162	[r]39,623	10,220	29,180	39,400	10,282	31,723	42,005	10,097	29,024	39,121

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Table includes data available through May 7, 1982. Total diamond output (gem plus industrial) for each country is actually reported except where indicated by a footnote to be estimated. In contrast, the detailed separate production data for gem diamond and industrial diamond are Bureau of Mines estimates in the case of every country except Australia (1980-81), Central African Republic (1977-78), Liberia (1977-78), Sierra Leone (1977-78), and Venezuela (1978-81), for which source publications give details on grade as well as totals. The estimated distribution of total output between gem and industrial diamond is conjectural, and for most countries is based on the best available data at time of publication. China also produces some natural diamond, but output is not reported.

[2]Reported figure.

[3]Total exports.

[4]All company output from the Republic of South Africa, except for that credited to the Finsch and Premier Mines for the years indicated; excludes De Beers Group output from Botswana, Lesotho, and Namibia.

ment near Mirnyy in the Yakutsk Autonomous Soviet Socialist Republic . The mine, which was the first Soviet underground diamond mine, was to go into operation during the period 1983-85. Twin 21-foot shafts will be sunk by freezing techniques in the unconsolidated formation below permafrost—one for ore removal and the other for ventilation. Both shafts will be approximately 3,300 feet deep.[32]

Zaire.—Zaire is the largest producer of industrial diamonds in the world. Production by Société Minière de Bakwanga (Miba) progressively dropped from a record 18 million carats in 1961 to an estimated 7.5 million carats in 1981. Illegal mining and smuggling have been reported to represent 50% of official production by Miba.

Faced with higher operating costs and declining grades, Miba was seeking financing for a new mine, as well as modernization and expansion of current alluvial operations. The plant was to treat primary kimberlite and to purchase two dredges to work deposits in riverbeds and adjoining areas. The Miba deposits at Mbuji-Mayi are about 1,400 kilometers east of Kinshasa in Kasai Oriental Province. The deposits were first worked over 60 years ago; recent exploitation has been equally divided between alluvial deposits and primary kimberlite deposits to depths of 60 meters.[33]

In 1981, Sozacom, the Zairean state marketing agency, announced a break with De Beers' Central Selling Organization, which had exclusive marketing rights for the last 14 years. At yearend, Sozacom announced that they had marketed 10 millions carats for 1981, as demand for industrials and low-grade gems had held up better in a recession year compared with the demand for larger gems.[34]

At yearend, three companies—International Diamond Co. of London, and Caddi Sprl and Glasol NV of Belgium—who had agreed to market Zaire's diamonds in cooperation with Sozacom, also agreed to assist a local diamond cutting and polishing industry by constructing a $2 million plant.

TECHNOLOGY

The labeling of the so-called reconstructed or reconstituted Geneva ruby, produced in the early development of synthetic ruby in 1903-04, has been convincingly proven incorrect. The most popular production technique explanation—that of fusing small pieces of genuine ruby together by flame fusion such as with Verneuil torch—has been discounted by scientific experiments. Genuine reconstructed products from these experiments do not resemble in any way the boules or cut stones of the original reconstructed ruby. The originals can now be attributed to multiple-step boule production under less than ideal conditions.[35]

The quality of synthetic ruby has now so improved that the new synthetic Kashan ruby is so similar to the natural that only professional laboratories can distinguish the difference. Heretofore, a professional with a 10-power hand lens could distinguish between natural rubies with crystal and Saturn-like inclusions, coarse twinning, and wispy fingerprints, and synthetic ruby with bubble inclusions and curved striae, but 45-power microscopic observation by a professional is now necessary.[36]

Zircon-based age-dating of six different Siberian kimberlite pipes have indicated a geological age ranging from 148 to 450 million years. Diamond-bearing eclogite examination presented definite conclusions that the diamonds were formed in a medium close to normal basalt in chemical composition, the only difference being that the formation of diamonds took place at a depth of about 200 kilometers. Isolation and separate examination of diamond-bearing inclusions such as red garnet and chrome diopside indicated that the morphology of the enclosed mineral is a perfect copy of the morphology of the diamond itself, and confirm the age of the diamond.[37]

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Gem Stones

By J. W. Pressler[1]

The value of gem stones and mineral specimens produced in the United States during 1982 was estimated to be $7.2 million, a 5% decrease compared with that of 1981. During the year, turquoise production decreased while tourmaline, sapphire, and opal production increased. Amateur collectors accounted for much of the activity in many States. Commercial operators produced agate, jade, jasper, opal, sapphire, tourmaline, and turquoise, which they sold mainly to wholesale or retail outlets and also to jewelry manufacturers.

Domestic Data Coverage.—Domestic production data for gem stones are developed by the Bureau of Mines from the production of Gem Stones survey, a voluntary survey of U.S. operations. Of the 46 operations to which a survey request was sent, 26% responded, representing an estimated 25% of the total production indicated in the text. Production for the 34 nonrespondents was estimated using reported prior year production levels adjusted by trends in employment and other guidelines.

DOMESTIC PRODUCTION

Mines and collectors in 46 States produced gem materials with an estimated value of $1,000 or more in each State in 1982. Eleven States supplied 91% of the total value as follows: Arizona, $2.8 million; Nevada, $1.2 million; Maine and Oregon, $500,000 each; California and Wyoming, $250,000 each; Montana, $225,000; and Arkansas, New Mexico, Texas, and Washington, $200,000 each. In 1982, estimated production increased 125% in Montana and 20% in Nevada, but decreased 29% in Maine, 17% in California and Oregon, and 14% in Arizona.

Park authorities at the Crater of Diamonds Park in Pike County, Ark., reported that 84,600 people visited the park in 1982 and found 1,382 diamonds with a total weight of 263 carats. This was a slight increase compared with the 1,327 diamonds found in 1981. The largest was a 3.48-carat brown stone of undetermined value. The next four largest diamonds, one brown, two whites, and one yellow, ranged from 2.43 to 3.40 carats. The new concentrating and screening techniques that enabled diggers to recover more of the smaller (1- to 24-point) diamonds contributed substantially to the total diamonds recovered, which averaged 19 points compared with 33 points 2 years ago. The "dig for fee" operations remained popular.

Prospecting and evaluation of kimberlite in Michigan and Kansas continued during 1982. Commercial interest and evaluation of the Murfreesboro diamond-bearing kimberlite was active.

The Geological Survey of Wyoming continued its research and exploration activities in the southern Laramie Range. Cominco American, Inc., and Superior Minerals Co. prospected several regions in the Laramie Range and Medicine Bow Mountains. Cominco American and Superior were committed to testing of kimberlite diatremes for commercial diamond mineralization near the Wyoming-Colorado border, with a pilot plant located in Fort Collins, Colo.

In Pala, San Diego County, Calif., Pala Gem Mines produced tourmaline at its Stewart lithia mine. Other small mines, in the same county, continued to produce fine gem-quality and specimen tourmaline, kunzite, and morganite.

Montana continued to lead the other

States in the production of corundum, particularly gem-quality sapphire. Intergem Inc., of Denver, Colo., was conducting sampling and hydraulic testing in June 1982 on the Yogo Gulch Sapphire Mine in Fergus County, Mont. No sapphire production was reported for the year. Three pay-as-you-dig or fee placer operations were active: Eldorado Bar and Castle's Sapphire Mine near Helena, and Gem Mountain Sapphire near Philipsburg. Gem-quality rubies and sapphires were also found in the Cowee Valley near Franklin, N.C. The Cherokee Mine near Franklin, N.C., was active, with many visitors buying gravel by the bucket, followed by washing and sorting.

The American Gem Co. operated the Rist Emerald Mine near Hiddenite, Alexander County, N.C. The dig-for-fee mine had produced a single-crystal emerald weighing more than 1,000 carats in 1980, with an estimated value of $30,000.

One of the most popular gem-hunting areas in the United States was Emerald Creek in northern Idaho where gem-quality and asteriated garnet continued to be produced. The U.S. Forest Service administered the riverbed and gravel area in Benewah County, Idaho, and charged prospectors and rock hounds a daily fee.

CONSUMPTION

Domestic gem stone output went to amateur and commercial rock, mineral, and gem stone collections, objects of art, and jewelry. Apparent consumption (domestic production plus imports minus exports and reexports) in 1982 was valued at $1,643 million, 10% less than the revised value of $1,816 million for 1981.

PRICES

A sampling of prices that diamond dealers in various U.S. cities charged their customers in January 1983 is shown in table 1.

Table 1.—Prices of U.S. cut diamonds, by size and quality

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Price range per carat[3] 1982	Median price per carat[3] January 1982	Median price per carat[3] Early January 1983
0.04-0.08	G-I	VS_1	$400- $613	$532	$475
.04- .08	G-I	SI_1	365- 520	385	400
.09- .16	G-I	VS_1	450- 700	565	525
.09- .16	G-I	SI_1	400- 585	450	450
.17- .22	G-I	VS_1	600- 1,205	829	750
.17- .22	G-I	SI_1	490- 1,045	700	650
.23- .28	G-I	VS_1	675- 1,375	1,050	940
.23- .28	G-I	SI_1	580- 1,215	850	750
.29- .35	G-I	VS_1	690- 1,600	1,250	1,250
.29- .35	G-I	SI_1	600- 1,210	950	1,000
.46- .55	G-I	VS_1	1,200- 2,125	2,000	1,900
.46- .55	G-I	SI_1	885- 1,740	1,500	1,480
.69- .79	G-I	VS_1	1,500- 3,010	2,300	2,250
.69- .79	G-I	SI_1	1,000- 2,180	2,000	1,750
1.00-1.15[4]	D	FL	12,000-25,000	22,500	19,750
1.00-1.15	E	VVS_1	7,000- 7,500	12,500	7,300
1.00-1.15	G	VS_1	3,500- 4,500	5,350	3,900
1.00-1.15	H	VS_2	2,800- 4,050	4,400	3,200
1.00-1.15	I	SI_1	2,000- 3,000	2,775	2,600

[1]Gemological Institute of America color grades: D—colorless; E—rare white; G-I—traces of color.
[2]Clarity: FL—no blemishes; VVS_1—very, very slightly included; VS_1—very slightly included; VS_2—very slightly included, but more visible; SI_1—slightly included.
[3]Jewelers' Circular-Keystone, v. 154, No. 2, February 1983, p. 86. These figures represent a sampling of net prices that diamond dealers in various U.S. cities charged their customers during the month.
[4]The Diamond Registry Bulletin, v. 13, No. 1, Dec. 31, 1981, and v. 14, No. 1, Dec. 31, 1982.

Yearend domestic sales of commercial-grade gem diamonds and inexpensive commercial-grade stones up to 1 carat, had its traditional Christmas season surge. In 1982, total sales of gold jewelry, in which the value of the precious stone, principally diamond, was over 50% of the total value, decreased 3% compared with that of 1981.

The U.S. price of 1.0-carat, D-flawless, investment-grade diamond fluctuated during 1982 between $12,000 and $25,000 per carat, and at yearend 1982 was $19,750 per carat, a 12% decrease compared with that of 1981. However, investment diamond sales are only a very small percentage of the total diamond market, estimated at $100 million for the world, compared with total world diamond jewelry sales of $18.5 billion.

A sampling of prices that colored-stone dealers in various U.S. cities charged their customers during January 1983 is shown in table 2.

Colored stones languished during the year. Commercial gem materials were more popular although expensive, and fine-quality stones experienced poor sales. Average prices of some medium-quality stones—sapphire, Colombian emerald, and ruby—decreased 20% to 56%. The average price for medium-quality tsavorite garnet increased 27% because of its rarity and beauty.

Table 2.—Prices of U.S. cut colored gem stones, by size[1]

Gem stone	Carat weight	Price range per carat 1982	Median price per carat[1 2] January 1982	Median price per carat[1 2] Early January 1983
Amethyst	10	$10- $35	$18	$17
Aquamarine	5	40- 300	187	150
Citrine	10	6- 45	16	10
Emerald:				
Colombian	1	1,200-4,000	2,500	1,500
Zambian	1	NA	NA	1,400
Garnet, tsavorite	1	300-1,200	625	725
Opal, black	3	200- 900	250	NA
Opal, white	5	40- 130	80	NA
Peridot	5	40- 200	65	NA
Ruby:				
Medium to better	1	1,000-5,000	1,650	1,200
Commercial	1	500-3,000	700	NA
Sapphire:				
Medium to better	1	450-2,500	1,500	700
Commercial	1	225-1,000	750	NA
Star sapphire:				
Sky-blue	5	200-1,000	450	NA
Gray	5	30- 200	102	NA
Tanzanite	5	300-1,200	850	762
Topaz	5	75- 500	237	210
Tourmaline, green	5	40- 200	125	132
Tourmaline, pink	5	40- 250	125	137

NA Not available.
[1]Medium to better quality.
[2]Jewelers' Circular-Keystone, v. 153, No. 2, February 1982, p. 152; v. 154, No. 2, February 1983, p. 87. These figures represent a sampling of net prices that colored stone dealers in various U.S. cities charged their cash customers during the month.

FOREIGN TRADE

The declared customs value of U.S. imports of rough and polished natural diamonds, excluding industrial diamonds, was $1.9 billion in 1982, a 14% decrease compared with that of 1981. Total polished diamond imports, principally from Belgium (35%) and Israel (25%), were valued at $1.6 billion. Imports in the over-0.5-carat category, mostly from Belgium (40%), Israel (15%), and Switzerland (15%), decreased 17% in value to $633 million. Imports in the less-than-0.5-carat group, mostly from Belgium (32%), Israel (31%), and India (27%), decreased 3% in value to $1.01 billion. Imports of rough natural diamond, principally from the Republic of South Africa (65%), the United Kingdom (9%), and Belgium, (9%), decreased 5% in caratage and 32% in value in 1982 compared with that of 1981. The decrease in carat value from $430 in 1981 to $345 in 1982 for South African imports again indicated that De Beers Consolidated Mines Ltd. was withholding the better quality rough stones from the market.

The total value of emerald imports decreased 8% to $121 million in 1982. The total value of rubies and sapphires imported in 1982 decreased 27% to $129 million, compared with $177 million in 1981. Import caratage of ruby and sapphire were reported for the first time in 1982, and indicated an average carat value of $34 for ruby and $24.50 for sapphire.

Export value of all gem materials, other than diamond, amounted to $67.3 million.

Of this total, other precious and semiprecious stones, cut but unset, were valued at $29.6 million; other natural precious and semiprecious stones, not set or cut, $17.2 million; synthetic gem stones and materials for jewelry, cut, $7.7 million; pearls, natural, cultured, or synthetic, not strung or set, $1.3 million; and other, $11.5 million. Reexports of all gem materials, other than diamond, amounted to $43.1 million in value in categories as follows: pearls, $3.0 million; precious and semiprecious stones, cut but unset, $32.5 million; and other, $7.6 million.

Table 3.—U.S. exports and reexports of diamond (exclusive of industrial diamond), by country

Country	1981		1982	
	Quantity (carats)	Value (millions)	Quantity (carats)	Value (millions)
Exports:				
Belgium-Luxembourg	47,781	$49.4	40,655	$33.6
Canada	9,020	7.1	10,193	5.8
France	5,909	23.0	4,990	9.8
Germany, Federal Republic of	3,037	6.8	1,961	3.5
Hong Kong	47,802	134.8	47,395	100.0
Israel	16,253	11.8	20,353	5.6
Japan	31,415	66.8	27,411	52.0
Netherlands	371	4.3	1,052	2.5
Singapore	6,585	12.3	8,528	17.0
Switzerland	16,930	98.4	13,649	48.4
United Kingdom	5,278	18.3	4,180	9.1
Other	6,729	8.3	4,504	5.5
Total	197,110	441.3	184,871	292.8
Reexports:				
Belgium-Luxembourg	[1]1,973,297	142.0	[1]1,368,040	108.0
France	4,315	5.2	4,537	3.3
Hong Kong	55,118	44.9	112,431	54.8
India	323,785	7.2	370,863	7.2
Israel	386,840	79.3	338,034	66.7
Japan	79,813	19.5	77,687	26.8
Netherlands	41,324	3.2	27,824	4.6
Switzerland	28,182	58.5	43,727	39.3
United Kingdom	43,719	39.1	69,113	25.2
Other	81,484	13.9	85,922	9.8
Total	3,017,877	412.8	2,498,178	345.7

[1]Artificially inflated in 1981 by auction of 1,477,365 carats of U.S. Government stockpile industrial diamond stones with subsequent reexport as gem stones to Belgium-Luxembourg. In 1982, approximately 1.2 million carats were similarly auctioned and reexported to Belgium-Luxembourg.

Table 4.—U.S. imports of diamond for consumption, by kind and country

Kind and country	1981		1982	
	Quantity (carats)	Value (millions)	Quantity (carats)	Value (millions)
Rough or uncut, natural:[1]				
Belgium-Luxembourg	[r]28,237	$12.2	77,117	$25.3
Central African Republic	19,869	2.2	7,860	.5
Guinea	--	--	37,168	4.0
Israel	21,609	6.7	25,123	4.9
Liberia	[r]3,798	[r]3.2	4,407	4.7
Netherlands	--	--	6,581	4.4
Sierra Leone	37,872	23.3	1,953	.6
South Africa, Republic of	[r]656,444	282.5	579,815	199.8
Switzerland	[r]7,966	[r]4.2	6,955	6.8
United Kingdom	[r]80,236	56.9	77,818	19.3
Venezuela	67,351	6.0	38,156	2.8
Other	[r]11,726	[r]7.2	27,767	3.5
Total	[r]935,108	[r]404.4	890,720	276.6

See footnotes at end of table.

Table 4.—U.S. imports of diamond for consumption, by kind and country —Continued

Kind and country	1981 Quantity (carats)	1981 Value (millions)	1982 Quantity (carats)	1982 Value (millions)
Cut but unset, not over 0.5 carat:				
Belgium-Luxembourg	777,054	$319.9	954,156	$323.6
Hong Kong	19,370	10.0	27,196	11.0
India	1,120,122	246.0	1,229,187	271.4
Israel	958,153	383.3	832,168	315.4
South Africa, Republic of	45,150	27.9	49,611	24.2
Switzerland	29,660	13.8	44,734	15.4
United Kingdom	17,571	10.8	39,080	16.5
Other	68,851	25.5	87,427	30.4
Total	3,035,931	1,037.2	3,263,559	1,007.9
Cut but unset, over 0.5 carat:				
Belgium-Luxembourg	206,171	319.3	232,263	250.7
Hong Kong	5,899	26.2	9,177	28.4
India	11,409	6.3	27,299	7.6
Israel	138,107	146.7	111,084	95.7
Netherlands	8,288	16.0	12,322	16.5
South Africa, Republic of	26,463	48.2	36,045	51.7
Switzerland	18,688	125.6	14,539	91.8
United Kingdom	11,112	40.1	22,089	46.4
Other	11,927	31.4	15,717	44.3
Total	438,064	759.8	480,535	633.1

[r]Revised.
[1]Includes some natural advanced diamond.

Table 5.—U.S. imports of natural precious and semiprecious gem stones, other than diamond, by kind and country

Kind and country	1981 Quantity (carats)	1981 Value (millions)	1982 Quantity (carats)	1982 Value (millions)
Emerald:				
Belgium-Luxembourg	6,645	$3.2	5,392	$1.5
Brazil	48,977	5.8	328,976	5.7
Canada	18,788	1.2	10,351	.7
Colombia	121,708	40.2	116,272	37.6
France	9,759	2.2	12,963	2.9
Germany, Federal Republic of	41,795	4.6	19,167	2.2
Hong Kong	120,313	12.2	100,955	15.5
India	1,572,510	15.8	1,136,247	11.5
Israel	96,870	22.8	238,543	17.1
Pakistan	4,651	1.2	4,813	1.0
South Africa, Republic of	14,787	1.4	15,702	.4
Switzerland	49,721	1.1	76,377	14.5
Thailand	31,940	2.6	43,246	1.9
United Kingdom	7,097	4.6	18,442	3.9
Other	152,098	12.7	39,404	4.4
Total	2,297,659	131.6	2,166,850	120.8
Ruby:				
Austria	NA	.1	14,267	.2
Germany, Federal Republic of		3.1	35,994	1.3
Hong Kong		[r]9.1	203,379	9.1
India		4.7	303,205	4.7
Israel		.7	25,258	.7
Italy		.1	40,722	.1
Switzerland		12.0	45,876	16.4
Thailand		47.6	1,175,698	25.2
United Kingdom		4.7	47,395	3.6
Other		11.7	41,489	4.5
Total	NA	93.8	1,933,283	65.8

See footnotes at end of table.

Table 5.—U.S. imports of natural precious and semiprecious gem stones, other than diamond, by kind and country —Continued

Kind and country	1981 Quantity (carats)	1981 Value (millions)	1982 Quantity (carats)	1982 Value (millions)
Sapphire:				
Austria	NA	$.1	14,521	$0.2
Belgium		1.4	10,922	1.4
Canada		1.1	12,919	.4
France		2.2	11,036	1.8
Germany, Federal Republic of		2.4	40,381	1.6
Hong Kong		8.4	179,616	8.0
India		3.3	360,810	2.4
Israel		.6	41,597	.6
Sri Lanka		7.5	41,938	4.0
Switzerland		11.1	66,575	13.4
Thailand		34.8	1,749,651	22.3
United Kingdom		5.1	25,800	3.0
Other		5.0	25,184	4.2
Total	NA	83.0	2,580,950	63.3
Other:				
Rough, uncut:				
Australia	NA	1.2	NA	.9
Brazil		3.2		4.4
Colombia		2.2		3.4
South Africa, Republic of		1.6		.9
Switzerland		.7		2.9
Zambia		2.5		.9
Other		6.3		6.3
Total	NA	17.7	NA	19.7
Cut, set and unset:				
Brazil	NA	r37.1	NA	15.7
China		3.6		1.6
Germany, Federal Republic of		r11.6		10.0
Hong Kong		r22.8		19.7
India		r4.0		3.7
Japan		96.6		84.7
Switzerland		r3.7		3.4
Taiwan		r3.5		1.1
Thailand		r2.9		2.2
Other		14.3		16.8
Total	NA	r200.1	NA	158.9

rRevised. NA Not available.

Table 6.—Value of U.S. imports of synthetic and imitation gem stones, by country

(Million dollars)

Country	1981	1982
Synthetic, cut but unset:		
Austria	r1.8	1.0
France	1.2	1.3
Germany, Federal Republic of	r5.9	5.9
Korea, Republic of	8.2	11.1
Switzerland	r3.2	3.0
Other	r3.3	1.9
Total	r23.6	24.2
Imitation:		
Austria	7.7	7.2
Czechoslovakia	r.9	.8
Germany, Federal Republic of	r3.9	3.0
Other	r2.8	2.4
Total	r15.3	13.4

rRevised.

Table 7.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1981 Quantity	1981 Value	1982 Quantity	1982 Value
Diamonds:				
Rough or uncut[1]	935	404,354	891	276,577
Cut but unset	3,474	1,796,908	3,745	1,641,035
Emeralds: Cut but unset	2,298	131,560	2,167	120,809
Coral: Cut but unset, and cameos suitable for use in jewelry	NA	3,630	NA	2,804
Rubies and sapphires: Cut but unset	NA	176,758	4,514	129,794
Marcasites	NA	498	NA	38
Pearls:				
Natural	NA	2,008	NA	3,003
Cultured	NA	105,942	NA	92,741
Imitation	NA	1,966	NA	1,458
Other precious and semiprecious stones:				
Rough, uncut	NA	17,697	NA	19,769
Cut, set and unset	NA	r87,990	NA	58,842
Synthetic:				
Cut but unset[2]	28,846	22,646	26,703	23,238
Other	NA	961	NA	896
Imitation gem stones	NA	13,332	NA	13,448
Total	XX	2,766,250	XX	2,384,452

rRevised. NA Not available. XX Not applicable.

[1]Includes 1,823 carats of other natural diamond, advanced, valued at $1.26 million in 1981, and 4,985 carats valued at $837,000 in 1982.

[2]Quantity in thousands of stones.

WORLD REVIEW

Angola.—In Angola, Companhia de Diamantes de Angola (Diamang) became the operating arm of the state-owned National Diamond Enterprise (Endiama). Endiama has the exclusive right to prospect, explore, and trade in Angolan diamonds. The Diamond Trading Co., owned by Anglo American Corp. of South Africa Ltd. and De Beers of the Republic of South Africa, provided essential managerial, technical, and marketing services, and owned a 2% interest in Diamang. Diamang was making significant progress in revitalizing Angola's diamond industry, the second most important mineral industry, following petroleum.[2]

Australia.—On November 1, 1982, Ashton Joint Venture (AJV) was restructured into two new joint ventures—Argyle Diamond Mines Joint Venture, with responsibility for the development, mining, and management of AJV's diamond interest in the Argyle and Ellendale areas of Western Australia, and Ashton Exploration Joint Venture, covering all exploration and evaluation activities in the remainder of the existing AJV area of diamond exploration in the Kimberley region.

Six small shafts on the kimberlite pipe AK-1 were completed in late 1982 to an average depth of 51 meters. Diamond recovery of 16 carats per metric ton from these shaft samples was much higher than cumulative averages to date. Total cumulative totals of bulk testing of the kimberlite pipe AK-1 gave a recovery of 408,392 carats from 62,846 tons, an average of 6.5 carats per ton. Testing of 120,650 tons of alluvial ore resulted in the recovery of 401,985 carats, an average of 3.33 carats per ton. Based on this information, diamond reserves were estimated to be about 500 million carats.[3]

AJV estimated that the average diamond quality from the AK-1 pipe comprised 5% gem, 25% cheap gem, and 70% industrial, with a total average value of $6.50 per carat. Average diamond quality for the alluvials comprised 10% gem, 35% cheap gem, and 55% industrial, with a total average value of $11.00 per carat.[4]

A 34.5-kilometer water supply pipeline from Lake Argyle was completed in November 1982 for the commercial alluvial operation and the large-scale kimberlite treatment plant. Work was continuing to double the capacity of the Argyle alluvial treatment plant to 4,000 tons per day by early 1983. This project will expand Argyle's diamond production capability to about 5 million carats per year. After the State government of Western Australia approved the mining and marketing proposals on December 21, 1982, commercial production of diamonds from the Upper Smoke Creek alluvial deposit was initiated at yearend.[5]

In the last 15 years, Australian production of opals and sapphires increased to over $66 million in value in 1982, with the principal production coming from small syndicate operations and individual producers. Precious opal mining came from long-established fields at Coober Pedy and Andamooka in South Australia, at Lightning Ridge and White Cliffs in New South Wales, and from smaller fields in Queensland.

Australia has become the major world supplier of rough gem-quality sapphires. The industry is centered in the placer gravels of the Glen Innes-Inverell district and in Queensland in the Anakie district.[6]

Belgium.—Antwerp's diamond industry had increased exports despite major price instability in the last few years, but local employment in diamond cutting had decreased sharply, principally because of increased competition from India and the U.S.S.R. The U.S.S.R. had become the largest source of imports of polished goods for Antwerp dealers, some of which were reexported to the United States. Antwerp was expected to remain a world center for trading, grading, and cutting by virtue of its skilled labor force and favorable business climate. Diamond exports in 1982 increased in value 0.7% to $3.1 billion, with the United States receiving $832 million, or 35%, of the total value.[7]

Botswana.—Botswana's diamond production was rapidly approaching that of the Republic of South Africa, with 7.8 million carats in 1982 compared with South African production of 9.2 million carats, and showed possibilities of becoming the leading producer of gem diamonds in the world. Botswana started its Jwaneng Mine in June, the third major diamond mine developed in recent years. Jwaneng produced about 2.6 million carats of medium-quality diamonds in 1982, and the yield was expected to reach 4.5 million carats by 1985. The other two mines, Orapa with a production of 4.5 million carats per year and Letlhakane with a production of 0.5 million carats per year, were operated by Debswana, a joint venture by De Beers and the Botswana Government. All diamond production was sold to the Central Selling Organization (CSO).[8]

Brazil.—Société d'Enterprise et d'Investissements S.A. (Sibeka), the Belgium-based diamond producer, was prospecting for diamonds in Brazil through its subsidiary, Sibinter, which had an 8.5% interest in Dinamin CA. Dinamin was carrying out an extensive drilling and dredging program over an area south of the Orinoco River.[9]

Central African Republic.—The Central African Republic's only active mining industry was gem diamond. In 1981, the International Development Association approved a $4 million technical assistance project for the Central African Republic, part of which included a study of the diamond sector. Central African diamond production decreased 10% in 1982 to about 277,000 carats, and remained far below the 1972 high of 524,000 carats.[10]

China.—A diamond weighing 96.94 carats was found in 1982 at the Chenjiafu diamond placer mine near Tancheng in Shandong Province. It was the third largest diamond found in the mining area, and followed finds of 159 carats in 1979 and 124 carats in 1981. The diamonds may come from deposits in the nearby Yi-Meg Mountain Range.[11]

Although several diamond mining areas have been reported in China, Changte in north Hunan Province is the only one confirmed. Changte has been known since 1955, and the recovery grade of the mine is about 0.25 carat per ton. Provinces where diamond deposits, individual stones, or kimberlite pipes have been discovered include Liaoning, Shandong, Guangxi, Guizhou, and Xizang. The Changte Mine produced principally industrial stones; production had been initiated in the early 1970's. China's diamond production was estimated to have been 15,000 carats in 1976, and by 1980, output had increased to 1.8 to 2.8 million carats, with about 20% gem-quality.

A diamond cutting industry has operated in Shanghai for about 50 years. A new diamond cutting plant was established in Beijing in 1981, financed by a Federal Republic of Germany company that previously had a marketing outlet for Chinese gold and silver jewelry. The new plant capacity was estimated at 60,000 carats per year of principally small stones. The first Chinese cut gem diamonds were introduced to the London market in 1980, and were pronounced of high-quality cut.[12]

Colombia.—Colombia, previous supplier of 90% of the world's high-quality emeralds, was facing strong competition from stones from Brazil, Zimbabwe, Mozambique, Tanzania, and especially Zambia. At yearend 1982, the median price of Zambian emeralds was almost the same as Colombian emeralds. However, the Bogota prices remained high, and because of their exceptional color and reputation, Colombian emeralds continued to dominate the market for investment gems.[13]

Ghana.—India contracted in 1982 to market Ghana's diamond production of over 800,000 carats per year. The Ghanaian Government had also asked the Indian Government to participate in a joint venture for diamond mining in Ghana.[14]

Guinea.—The Guinean $85 million joint venture, Société Mixte Aredor-Guinea, received at yearend 1982 a 7-year bank credit of $43 million as part of a $60 million financing package to develop and exploit diamond and gold deposits in the Baule Basin. Aredor-Guinea was a joint venture of Guinea, 50%; Bridge Oil Ltd. of Australia, 45%; Industrial Diamond Co., of London, 2.5%; and Simonius Vischer of Basel, Switzerland, 2.5%. The alluvial project was scheduled to come onstream in 1984 and was to mine 400,000 cubic meters of diamond-bearing gravels annually, with reserves sufficient for 15 years of operation. Exploration testing had indicated recovery of 20 carats per 100 tons, 80% gem quality, and average diamond value of $170 per carat. Guinea was the only African nation to sell its diamonds independently of the CSO.[15]

India.—The Geological Survey of India (GSI) explored the Ramkheria alluvial deposit adjacent to the famous Panna diamond district of India, and estimated the diamond reserves to be over 200,000 carats with a grade of 10 carats per 100 tons. GSI was also exploring many other diamond prospects including the famous Golconda Mines in Andhra Pradesh.

Emerald production in India's Rajasthan State was on the decline with only 6,600 carats produced in 1980 compared with 38,000 carats in 1975. Gem-quality garnet, agate, and jasper were also produced in Rajasthan, while Maharashtra State produced 80% of India's corundum and sapphire.[16]

The Indian Government continued to promote its diamond cutting and polishing industry to improve its export earnings, with over 200,000 artisans specializing in cutting small, inexpensive stones. Exports for the 1981-82 year were about $800 million, only a slight improvement over 1978-79. To ensure a long-term source of small gem diamond, India's Metals and Minerals Trading Corp. had offered to play a major role in the marketing of Ashton Joint Venture diamond production from Western Australia.[17]

Israel.—In September and October 1982, Israel's diamond imports increased considerably over the corresponding months in 1981, indicating that dealers were beginning to replenish their inventories that had depleted over the previous 2 years. For January and February 1983, exports of finished goods were $181 million, an 8% increase compared with that of the corresponding period of 1982.[18]

Ivory Coast.—Diamond mining in the Tortiya area had ceased in 1980, and prospecting programs were the major mining activity in the Ivory Coast. A diamond deposit was discovered in 1982 in the Tortiya area, 440 kilometers northwest of Abidjan. A Canadian company was contracted to follow up this initial discovery under the supervision of the state company, Société pour le Development Minier de la Cote d'Ivoire.[19]

Lesotho.—During May 1982, the Lesotho Government and De Beers agreed that the Letseng-la-Terai diamond mine was no longer economic, and the mine was closed. Stockpiled ore was treated through October 1982, and final cleanup operations were finished by yearend. Average recovery for 1982 was 2.95 carats per 100 tons.[20]

Liberia.—Exports of Liberian diamonds were valued at $23 million in 1981. About 75% of these exports were believed to originate from Guinea and Sierra Leone. Liberia exported diamonds to four countries in 1981: The United Kingdom (48%), Belgium (29%), the United States (21%), and Israel (2%).[21]

Namibia.—Production at De Beer's Consolidated Diamond Mines (Pty.) Ltd. beach-placer diamond mine at Oranjemund was reduced early in 1982 to achieve further economies because of the soft diamond market. This resulted in 19% less diamond production for 1982. Ten million tons of ore was treated during the year, with an average recovery of 10.13 carats per 100 tons. Ninety-five percent of the production was of gem quality.[22]

Pakistan.—The Pakistan Investment Promotion Bureau project for cutting, processing, finishing, and polishing diamond and precious stones, to be established in Karachi, was delayed for lack of approval and financing. This plan was reportedly similar to the plan of the Government of

India, which has been so successful.[23]

Three new emerald deposits were discovered by the country's Gemstone Corp., at Charbagh, Makad, and Gujar Killi in Swat.[24]

Sierra Leone.—Diamond production in Sierra Leone had consistently accounted for over one-half of its export earnings in recent years. The National Diamond Mining Co. (DIMINCO) was forced to layoff over 1,800 employees in 1982. The country's diamond production in 1982 was less than 300,000 carats, a decrease of about 5% from 1981 totals. Production had previously peaked at nearly 2 million carats in 1969. Production from the Alluvial Diamond Mining Scheme accounted for most of the shortfall and is expected to diminish further as alluvial deposits are depleted.[25]

DIMINCO had developed a $100 million project for the underground mining of a kimberlite pipe at Kono and negotiated during 1982 for international funding.[26]

South Africa, Republic of.—De Beer's CSO reported that diamond sales were higher in the second half of 1982 compared with the previous two half-years, reflecting a significant improvement in the demand for small sizes and cheaper qualities. Retail sales of diamond jewelry in 1982 was only 3% lower than in 1981, a record year. Despite all of De Beer's economy measures and cutbacks during 1982, its diamond stocks remained high at a value of $1.7 billion.

Operations at the De Beer's Koffiefontein Mine, a producer of high-quality diamonds, was suspended in June 1982, but its Finsch Mine, which produced smaller and lower quality stones, was restored to full capacity. Production at the Premier Mine increased 21% as a result of improved grade and recovery brought about by better mining and metallurgical controls. In Namaqualand, the Tweepad plant closed in mid-1981 and was reopened in September 1982; and the Annex Kleinzee plant was temporarily closed, resulting in an overall reduction of 22% in the Namaqualand Div. output. Active exploration continued during the year, with the sampling of the kimberlite pipes on the farm Venetia, and the testing of gravel along the north bank of the Orange River.[27]

Tanzania.—Diamond production in Tanzania comprised 99% of the country's value of mineral production, and 88% of mineral export revenues. Diamond production came from kimberlite and its associated alluvial deposits in the Shinyanga region. Williamson Diamonds Ltd. and Alamasi Ltd. operated two mines in the area.[28]

Thailand.—Thailand customs estimated that total gem export value in 1981 was over $220 million, principally sapphires and rubies. Over 200,000 miners, cutters, and polishers were employed in the country.[29]

U.S.S.R.—Diamond, after fossil fuels and precious metals, was one of the significant foreign-exchange-earning exports of the Soviet Union. Diamonds were cut in centers at Leningrad, Sverdlovsk, and Smolensk. A principal market was Antwerp, through a Soviet-Belgium diamond export organization, Almazyuvelierexport. Operating mines in Yakutia included the Mirnyy open pit with five concentrators, the Aykhal open pit and concentrator, the Udachnaya placer mine and concentrator, and the Irelyakh placer mine with two dredges. A small production came from the Vishera River region in Perm Oblast', where four dredges and two separation plants were operated at two deposits.[30]

Venezuela.—The Venezuelan Ministry of Energy and Mines enacted a new law during 1982 to improve mining techniques of small miners because an estimated 65% of their diamond production was smuggled out of the country.[31]

Sibeka, through its subsidiary, Sibinter, continued to prospect by drilling and dredging during the year in the large area south of the Orinoco.[32]

Zaire.—Zaire's state-owned Société Minière de Bakwanga (Miba) diamond mine produced about 6 million carats in 1982, valued at about $45 million. About 70% of this output was industrial-quality crushing bort, 25% was for cheap gem or high-quality industrial use such as setting stones, and the remaining 5% was gem stones. An estimated additional 6 million carats was produced by numerous small alluvial operators and illicit miners in the Tshikapa area. This artisanal production was supposed to have been sold to authorized buyers in Kinshasa. Instead, most of it was smuggled into the neighboring Congo and sold in Bujumbura, Brazzaville, and Europe. Congo has no diamond production of its own, but is a sizable exporter of gem-quality goods. Despite efforts of the Zairean Government to set up purchasing offices in several parts of the country in 1982 and to pay for the diamonds at black market exchange rates, the project was only marginally successful and may not continue. At yearend, the Zairean Depart-

Table 8.—Diamond (natural): World production, by country and type[1]

(Thousand carats)

Country	1978			1979			1980			1981[p]			1982[e]		
	Gem	Industrial	Total	Gem	Industrial	Total	Gem	Industrial	Total	Gem	Industrial	Total	Gem	Industrial	Total
Angola	488	162	650	630	211	841	1,110	370	1,480	1,050	350	1,400	1,000	400	1,400
Australia	--	--	--	--	--	--	--	48	48	21	184	205	70	487	[2]557
Botswana	420	2,379	2,799	659	3,735	4,394	765	4,336	5,101	744	4,217	4,961	1,165	6,604	[2]7,769
Brazil[3]	236	384	620	236	384	620	253	414	667	163	926	1,089	175	975	1,150
Central African Republic	199	85	284	205	110	315	227	115	342	209	103	312	186	91	[2]277
China[e]	NA	NA	NA	NA	NA	NA	360	1,440	1,800	380	1,520	1,900	400	1,600	2,000
Ghana	142	1,281	1,423	125	1,128	1,253	126	1,132	1,258	85	751	836	68	612	[2]680
Guinea[e]	25	55	80	27	58	85	12	26	38	12	26	38	13	27	40
Guyana	7	10	17	6	10	16	4	6	10	4	6	10	5	6	[2]11
India	14	2	16	14	2	16	12	2	14	14	2	16	12	2	14
Indonesia[e]	3	12	15	3	12	15	3	12	15	3	12	15	3	12	15
Ivory Coast	22	23	45	24	24	48	--	--	--	--	--	--	--	--	--
Lesotho	62	5	67	48	4	52	50	4	54	49	4	53	39	3	[2]42
Liberia	128	180	308	170	132	302	123	175	298	132	204	336	170	268	[2]438
Namibia	1,803	95	1,898	1,570	83	1,653	1,482	78	1,560	1,186	62	1,248	963	51	[2]1,014
Sierra Leone	353	426	779	[r]434	[r]451	[r]885	317	275	592	208	97	305	[e]203	[e]87	[e]290
South Africa, Republic of:															
Finsch Mine	403	2,227	2,630	465	2,120	2,585	465	2,442	2,907	1,002	3,463	4,465	847	3,003	3,850
Premier Mine	380	1,603	1,983	468	1,613	2,081	407	1,632	2,039	510	1,530	2,040	615	1,845	2,460
Other De Beers properties[4]	1,254	1,395	2,649	1,850	1,370	3,220	1,550	1,489	3,039	1,603	1,069	2,672	1,359	906	2,265
Other	320	145	465	403	95	498	390	145	535	314	35	349	521	58	579
Total	2,357	5,370	7,727	3,186	5,198	8,384	2,812	5,708	8,520	3,429	6,097	9,526	3,342	5,812	[2]9,154
Tanzania	141	141	282	157	157	314	137	137	274	110	107	217	100	120	220
U.S.S.R.[e]	2,150	8,400	10,550	2,200	8,500	10,700	2,250	8,600	10,850	2,100	8,500	10,600	2,100	8,500	10,600
Venezuela	271	549	820	247	556	803	238	483	721	102	388	490	100	400	500
Zaire	640	10,603	11,243	294	8,440	8,734	345	9,890	10,235	450	8,550	9,000	450	8,550	9,000
World total	9,461	30,162	39,623	[r]10,235	[r]29,195	[r]39,430	10,626	33,251	43,877	10,451	32,106	42,557	10,564	34,602	45,166

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.

[1]Table includes data available through June 3, 1983. Total diamond output (gem plus industrial) for each country is actually reported except where indicated by a footnote to be estimated. In contrast, the detailed separate production data for gem diamond and industrial diamond are Bureau of Mines estimates in the case of every country except Australia (1980-82), Central African Republic (1978-81), Liberia (1978-82), Sierra Leone (1978-82), the Republic of South Africa (1978-79), and Venezuela (1978-81), for which source publications give details on grade as well as totals. The estimated distribution of total output between gem and industrial diamond is conjectural, and for most countries, is based on the best available data at time of publication.

[2]Reported figure.

[3]Figures represent officially reported output plus official Brazilian estimates of output by nonreporting mines; officially reported output was as follows, in thousand carats: 1978—86, 1979—83, 1980—158, 1981-136.

[4]Other De Beers Group output from the Republic of South Africa includes Kimberley Pool, Koffiefontein Mine, and the Namaqualand Mines.

ment of Mines and Energy had established a list of approved private buyers of artisanally mined diamonds. These buyers will compete legally with the state marketing agency, Sozacom, which also has a diamond buying and marketing operation.[33] Miba had suffered declining grade and production of its alluvial deposits since 1961 and had been seeking a $40 million loan from the International Finance Corp. for the mining of its Massif I kimberlite pipe near Mbuji Mayi, with no progress at yearend 1982. Despite this, preparations continued for development of the new mine with increased capacity and modernization of its treatment plant.[34] Of the world's 15 largest diamond pipes, Zaire has two: Talala, covering 40 hectares, and Massif I, 18.6 hectares.

Zairean announcements during 1982 indicated satisfaction with its break in 1981 with CSO for the marketing of its Miba diamond production. Five-year contracts were signed with three buying concerns, Caddi Sprl and Glasol NV of Antwerp, Belgium, and Industrial Diamond Co. of London, England. Despite this apparent success, the Zairean Government announced on March 7, 1983, that it was once again returning to the CSO, and gave CSO exclusive purchase rights for Miba's diamond production with a floor price of $8.55 per carat. The prior system of three designated buyers was determined not to be as profitable to the Government as the new CSO arrangement was expected to be with a guaranteed minimum price.[35]

Zambia.—Extensive illegal mining of emerald occurred in Zambia during 1982. Estimated total value of emerald production for the year was $100 million. International Development and Construction Co. of Saudi Arabia and the Reserved Minerals Corp. of Zambia formed a joint venture for mining of emeralds in Zambia.[36]

TECHNOLOGY

Two methods were announced during 1982 to mark valuable gem diamonds with invisible identification marks. General Electric Co. developed an ion implanter to bombard the surface of a stone with a brand or secret pattern for use in positive identification.[37]

The Gemological Institute of America announced the development of a machine to inscribe an identification on the girdle of a stone using a laser device. The inscription will only be visible under 10-power magnification or better.[38]

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Gem Stones

By J. W. Pressler[1]

The value of gem stones and mineral specimens produced in the United States during 1983 was estimated to be $7.4 million, a 3% increase compared with that of 1982. Turquoise and peridot production decreased while tourmaline, sapphire, and opal production increased. Amateur collectors accounted for much of the activity in many States. Small mine operators produced jade, opal, sapphire, tourmaline, and turquoise, which they sold mainly to wholesale and retail outlets, in gem and mineral shops, gem shows, and to jewelry manufacturers.

Domestic Data Coverage.—Domestic production data for gem stones were developed by the Bureau of Mines from the production of Gem Stones survey, a voluntary survey of U.S. operations. Of the 46 operations to which a survey request was sent, 43% responded, representing an estimated 35% of the total production indicated in the text. Production for the 23 nonrespondents was estimated using reported prior year production levels adjusted by trends in employment and other guidelines.

DOMESTIC PRODUCTION

Mines and collectors in 46 States produced gem materials with an estimated value of $1,000 or more in each State. Eleven States supplied 91% of the total value as follows: Arizona, $2.8 million; Nevada, $1.2 million; Oregon, $600,000; Maine, $500,000; California and Montana, $300,000 each; Wyoming, $250,000; Texas, $225,000; and Arkansas, New Mexico, and Washington, $200,000 each. Estimated production increased 33% in Idaho and Montana, 20% in California and Oregon, and 13% in Texas.

Park authorities at the Crater of Diamonds Park in Pike County, AR, reported that 89,500 people visited the park and recovered, by washing, screening and panning, 1,501 diamonds, a 9% increase over that of 1983, with a total weight of 315 carats. The largest was a 6.2-carat white stone of undetermined value. The next four largest diamonds, one white, two yellows, and one brown, ranged from 4.2 to 5.63 carats. The total diamonds recovered averaged 21 points compared with 19 points in 1982. The "dig for fee" operations remained popular.

In Emerald Creek, ID, the U.S. Forest Service issued 867 permits to diggers and panners who found 735 pounds of gem garnet, most of which was asteriated, with the balance faceting grade. The garnet area consisted of three gulches, with one being especially noted for large stones. The 15 largest stones reported during the season ranged from 4 to 18 ounces. Because of the cold weather, the area was opened for about 100 days from May to September during 1983.

About 100 kimberlite pipes, 14 of them yielding diamonds, were discovered in Wyoming since 1960 by private companies and the Wyoming Geological Survey, utilizing heavy mineral stream sediment sampling, detailed geological mapping, and bulk sample testing. In 1983, the University of Wyoming, the Wyoming Geological Survey, and the National Aeronautics and Space Administration were working on an airborne remote-sensing project for detection of kimberlite. Three 100-square-mile plots near the Wyoming-Colorado border had been covered from an altitude of 2,000 feet and the images received were being analyzed by computer. This airborne technique may provide a more efficient and rapid means of exploring for additional kimberlite occurrences.[8] Bulk sampling and testing of about 10,000 short tons from the 14 diamondiferous kimberlites to date had yielded only an average of 0.01 carat per short ton, well below economic viability. The largest stone found weighed about 1 carat, and was of industrial grade.

The Michigan Department of Natural Resources announced that there was evidence that kimberlite had been found in the Crystal Falls area of Iron County, MI. Dow Chemical Co. planned to mine a 30-ton sample for processing at the Michigan Technological University laboratory to determine its diamond content.[9]

Montana continued to be the largest producer of gem-quality sapphire in the United States. Two companies, Intergem Inc. of Denver, CO, and Big Blue Sapphire Co. Inc. of Great Falls, MT, tested their properties on Yogo Gulch, near Lewiston, Fergus County, MT. Some high-quality Kashmiri-blue sapphires were recovered, although the total corundum content of the ore was less than 10 carats per ton.

CONSUMPTION

Domestic gem stones output went to amateur and commercial rock, mineral, and gem stone collections, objects of art, and jewelry. Value of apparent consumption (domestic production plus imports minus exports and reexports) increased 30% to $2,132 million.

Jewelry store sales increased 5% to $8.9 billion, and jewelry containing pearls and diamonds increased almost 10%. The Christmas trade was particularly good. Demand for small, lower quality diamond goods was high, but the demand for larger stones of good quality was restricted.

U.S. consumption of colored stones increased slightly. However, the value of all imported gem stones, other than diamond, increased 24%, with sapphire leading the way. Annual sales of emerald continued to be almost equal to those of ruby and sapphire combined.

PRICES

The U.S. price of 1.0-carat, D-flawless, investment-grade diamond fluctuated between $13,000 and $19,000 per carat, and at yearend was $13,500 per carat, a decrease of 32% for the year. However, only a few hundred of these perfect 1-carat stones have been available each year, and their value may have amounted to less than 0.2% of the total market.

Table 1.—Prices of U.S. cut diamonds, by size and quality

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Price range per carat[3] in 1983	Median price per carat[3] January 1983	Median price per carat[3] December 1983
0.04-0.08	G-I	VS_1	$400- $613	$501	$490
.04- .08	G-I	SI_1	400- 520	400	450
.09- .16	G-I	VS_1	450- 770	525	560
.09- .16	G-I	SI_1	410- 610	450	473
.17- .22	G-I	VS_1	700- 1,260	730	835
.17- .22	G-I	SI_1	500- 1,195	650	690
.23- .28	G-I	VS_1	775- 1,470	940	965
.23- .28	G-I	SI_1	650- 1,350	730	770
.29- .35	G-I	VS_1	875- 1,700	1,250	1,260
.29- .35	G-I	SI_1	735- 1,570	1,000	1,050
.46- .55	G-I	VS_1	1,450- 2,350	1,900	2,000
.46- .55	G-I	SI_1	900- 1,845	1,400	1,545
.69- .79	G-I	VS_1	1,895- 3,010	2,250	2,500
.69- .79	G-I	SI_1	1,400- 2,465	1,750	1,950
1.00-1.15[4]	D	FL	13,000-19,000	19,750	13,500
1.00-1.15	E	VVS_1	6,000- 8,200	7,200	7,500
1.00-1.15	G	VS_1	2,500- 5,200	3,900	4,200
1.00-1.15	H	VS_2	2,400- 4,800	3,200	3,300
1.00-1.15	I	SI_1	2,000- 3,400	2,600	2,600

[1]Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; G-I—traces of color.

[2]Clarity: FL—no blemishes; VVS_1—very, very slightly included; VS_1—very slightly included; VS_2—very slightly included, but more visible; SI_1—slightly included.

[3]Jewelers' Circular-Keystone, v. 155, No. 2, Feb. 1984, p. 134. These figures represent a sampling of net prices that diamond dealers in various U.S. cities charged their customers during the month.

[4]The Diamond Registry Bulletin, v. 14, No. 1, Dec. 31, 1982, and v. 15, No. 1, Jan. 1984.

Prices for colored stones experienced little change during the year.

The unit value of Colombian and Zambian emerald continued at a median price of $1,500 per carat.

Table 2.—Prices of U.S. cut colored gem stones, by size[1]

Gem stone	Carat weight	Price range per carat in 1983	Median price per carat[1 2] January 1983	Median price per carat[1 2] January 1984
Amethyst	10	$8- $24	$17	$17
Aquamarine	5	75- 210	150	150
Citrine	10	8- 18	10	10
Emerald:				
Colombian	1	900-1,800	1,500	1,500
Zambian	1	750-2,200	1,400	1,400
Commercial[3]		550-1,500	NA	550
Garnet, tsavorite	1	350-1,100	725	725
Opal, black			NA	
Opal, white			NA	
Peridot			NA	
Ruby:				
Medium to better	1	500-2,200	1,200	1,200
Commercial[3]	1	330- 660	NA	330
Sapphire:				
Medium to better	1	150-1,500	700	700
Commercial[3]	1	220- 440	NA	220
Tanzanite	5	500- 950	762	762
Topaz	5	85- 400	210	219
Tourmaline, green	5	60- 200	132	132
Tourmaline, pink	5	50- 225	137	187

NA Not available.
[1]Medium to better quality.
[2]Jewelers' Circular-Keystone, v. 153, No. 2, Feb. 1982, p. 154; v. 154, No. 2, Feb. 1983, p. 87. These figures represent a sampling of net prices that colored stone dealers in various U.S. cities charged their cash customers during the month.
[3]The Gemstone Registry Bulletin, v. 11, No. 2, Jan. 1984.

FOREIGN TRADE

The declared customs value of U.S. imports of rough and polished natural diamond, excluding industrial diamond, increased 19% to $2.3 billion. Total polished diamond imports, principally from Belgium-Luxembourg, 32%; Israel, 24%; and India, 23%; were valued at $2.0 billion. Imports in the over-0.5-carat category, mostly from Belgium-Luxembourg, 38%; Israel, 18%; and Switzerland, 15%; increased 17% in value to $741 million. Imports in the less-than-0.5-carat group, mostly from India, 36%; Belgium-Luxembourg, 29%; and Israel, 28%; increased 23% in value to $1.2 billion. Imports of rough natural diamond, 84% from the Republic of South Africa, increased 15% in caratage and 6% in value. A slight decrease in carat value for South African imports, from $345 to $336, was indicated.

The total value of emerald imports increased 11% to $134 million. The total value of ruby imports increased 2% to $67 million, and sapphire imports increased 35% to $85 million. Average carat values increased 14% for emerald to $63, but decreased 30% for ruby to $24, and remained virtually unchanged for sapphire at $25.

Export value of all gem materials other than diamond remained virtually unchanged at $66.8 million. Of this total, other precious and semiprecious stones, cut but unset, were valued at $33.3 million; other natural precious and semiprecious stones, not set or cut, $14.3 million; synthetic gem stones and materials for jewelry, cut, $3.7 million; pearls, natural, cultured, or synthetic, not strung or set, $1.8 million; and other, $13.7 million. Reexports of all gem materials, other than diamond, remained almost unchanged at $42.2 million. Reexport categories were precious and semiprecious stones, cut but unset, $31.1 million; and other, $7.9 million.

Table 3.—U.S. exports and reexports of diamond (exclusive of industrial diamond), by country

Country	1982 Quantity (carats)	1982 Value (millions)	1983 Quantity (carats)	1983 Value (millions)
Exports:				
Belgium-Luxembourg	48,656	$88.6	108,106	$350.5
Canada	10,198	5.8	16,184	10.0
France	4,999	9.8	4,094	9.9
Germany, Federal Republic of	1,961	3.5	3,828	5.0
Hong Kong	47,295	100.0	58,851	87.0
Israel	20,353	5.6	75,092	39.2
Japan	27,411	52.0	90,911	62.2
Singapore	8,028	17.0	5,996	11.5
Sweden	123	.3	1,198	1.1
Switzerland	13,649	48.4	12,473	76.8
Thailand	426	.7	3,564	3.3
United Arab Emirates	879	.5	1,035	.7
United Kingdom	4,180	9.1	5,441	9.5
Other	[r]4,128	[r]6.5	2,912	6.0
Total	184,871	292.8	324,273	372.8
Reexports:				
Belgium-Luxembourg	[1]1,368,049	108.0	[1]1,217,378	84.6
Canada	5,117	1.6	10,145	1.7
China	11,864	.6	10,613	.1
Germany, Federal Republic of	1,781	1.5	25,919	2.2
Hong Kong	112,431	54.8	83,800	28.0
India	279,862	7.2	226,987	6.1
Israel	338,034	66.7	212,557	34.7
Japan	77,697	26.8	92,934	11.0
Netherlands	27,824	4.6	34,407	4.7
Switzerland	42,727	39.3	31,687	43.7
United Kingdom	69,113	25.2	73,474	26.9
Other	[r]71,697	[r]9.4	24,095	5.9
Total	2,498,178	345.7	2,164,176	249.6

[r]Revised.
[1]Artificially inflated in 1982 by auction of approximately 1.2 million carats of U.S. Government stockpile diamond stones with subsequent reexports as gem stones to Belgium-Luxembourg. In 1983, 1 million carats was similarly auctioned and reexported to Belgium-Luxembourg.

Table 4.—U.S. imports for consumption of diamond, by kind and country

Kind and country	1982 Quantity (carats)	1982 Value (millions)	1983 Quantity (carats)	1983 Value (millions)
Rough or uncut, natural:[1]				
Belgium-Luxembourg	77,117	$25.3	111,211	$14.7
Brazil	251	.3	2,290	.7
Cape Verde	23	([2])	3,400	.1
Colombia	--	--	21,413	.1
Congo	3,878	1.1	8,690	2.7
Dominican Republic	--	--	2,331	.1
Guyana	1,768	.1	4,989	.3
Israel	25,122	4.9	9,651	1.6
Netherlands	6,581	4.4	1,565	2.1
South Africa, Republic of	579,815	[r]199.9	729,547	245.2
Switzerland	6,955	4.8	13,035	2.6
United Kingdom	77,818	19.3	41,234	13.4
Venezuela	88,156	2.8	65,908	3.2
Other	[r]73,235	[r]11.7	10,368	5.8
Total	890,720	276.6	1,025,850	292.7
Cut but unset, not over 0.5 carat:				
Belgium-Luxembourg	904,156	222.6	1,126,400	358.7
Hong Kong	27,196	11.6	29,957	8.9
India	1,229,187	271.4	2,153,149	440.8
Israel	832,169	315.4	1,047,471	342.4
South Africa, Republic of	49,611	24.2	45,187	24.3
Switzerland	44,734	15.4	44,864	18.0
United Kingdom	39,080	16.5	31,417	17.2
Other	87,427	30.4	110,438	31.1
Total	3,263,559	1,007.9	4,588,882	1,241.4

See footnotes at end of table.

Table 4.—U.S. imports for consumption of diamond, by kind and country —Continued

Kind and country	1982		1983	
	Quantity (carats)	Value (millions)	Quantity (carats)	Value (millions)
Cut but unset, over 0.5 carat:				
Belgium-Luxembourg	232,363	$350.7	281,064	$394.2
Hong Kong	9,177	28.4	9,135	22.8
India	27,299	7.6	58,871	18.1
Israel	111,084	95.7	165,641	122.1
Netherlands	12,822	16.5	19,841	18.8
South Africa, Republic of	36,045	51.7	33,936	47.4
Switzerland	14,509	91.8	27,364	111.1
United Kingdom	22,069	46.4	29,544	58.8
Other	15,717	44.0	33,501	47.0
Total	480,535	633.1	649,897	741.3

[r]Revised.
[1]Includes some natural advanced diamond.
[2]Less than one-tenth unit.

Table 5.—U.S. imports of natural precious and semiprecious gem stones, other than diamond, by kind and country

Kind and country	1982		1983	
	Quantity (carats)	Value (millions)	Quantity (carats)	Value (millions)
Emerald:				
Belgium-Luxembourg	5,392	$1.5	34,927	$1.6
Brazil	328,976	5.7	174,314	8.0
Colombia	116,272	37.6	203,485	44.1
France	12,963	2.9	7,806	2.2
Germany, Federal Republic of	19,167	2.2	28,290	3.7
Hong Kong	100,955	15.5	44,289	6.1
India	1,136,247	11.5	1,274,765	12.8
Israel	208,543	17.1	87,145	17.9
South Africa, Republic of	15,702	.4	7,979	.3
Switzerland	76,377	14.5	41,518	17.4
Taiwan	61	(1)	78,853	(1)
Thailand	43,246	1.9	64,590	2.2
United Kingdom	18,442	3.9	36,273	11.0
Other	[r]54,507	[r]6.1	33,662	6.9
Total	2,166,850	120.8	2,116,999	134.1
Ruby:				
Austria	14,207	.2	163,361	.2
Colombia	17	(1)	37,070	.2
Germany, Federal Republic of	35,994	1.3	53,343	1.5
Hong Kong	203,379	9.1	125,447	4.9
India	303,265	4.7	230,186	3.3
Israel	26,258	.7	29,376	1.2
Switzerland	45,876	16.4	221,416	8.8
Thailand	1,175,698	25.2	1,840,758	36.0
United Kingdom	47,395	3.6	19,472	4.1
Other	[r]82,194	[r]4.6	47,243	6.6
Total	1,953,283	65.8	2,786,672	66.9
Sapphire:				
Australia	3,819	.3	43,493	.6
Austria	14,521	.2	44,945	.1
Belgium-Luxembourg	10,922	1.4	28,402	1.0
Brazil	4,022	(1)	11,090	(1)
Canada	12,919	.4	15,146	.6
Colombia	800	.3	14,656	.1
France	11,036	1.8	11,026	2.5
Germany, Federal Republic of	40,581	1.6	121,800	2.5
Hong Kong	179,616	8.0	167,305	9.9
India	380,810	2.4	130,481	2.7
Israel	41,087	.6	49,966	.8
Sri Lanka	41,939	4.0	48,277	4.3
Switzerland	66,375	13.4	244,025	11.8
Thailand	1,749,651	22.3	2,456,096	32.7
United Kingdom	25,900	3.6	32,959	8.3
Other	[r]16,543	[r]3.6	50,738	7.3
Total	2,580,950	62.3	3,470,553	95.3

See footnotes at end of table.

Table 5.—U.S. imports of natural precious and semiprecious gem stones, other than diamond, by kind and country —Continued

Kind and country	1982 Quantity (carats)	1982 Value (millions)	1983 Quantity (carats)	1983 Value (millions)
Other:				
Rough, uncut:				
Australia		$0.9		$1.0
Belgium-Luxembourg		.4		.4
Brazil		4.4		11.1
Canada		([1])		1.4
Colombia	NA	3.4	NA	7.3
Hong Kong		1.1		.9
Pakistan		.7		.5
Switzerland		2.9		.7
Zambia		.9		.9
Other		[r]5.0		2.5
Total	NA	19.7	NA	26.7
Cut, set and unset:				
Australia		2.4		2.1
Brazil		15.7		12.5
China		1.6		2.5
Germany, Federal Republic of		10.0		11.8
Hong Kong		19.7		22.6
India	NA	3.7	NA	4.5
Japan		84.7		152.8
Switzerland		3.4		4.5
Taiwan		1.1		4.8
Thailand		2.2		2.6
Other		[r]14.4		6.8
Total	NA	158.9	NA	227.5

[r]Revised. NA Not available.
[1]Less than one-tenth unit.

Table 6.—Value of U.S. imports of synthetic and imitation gem stones, by country

(Million dollars)

Country	1982	1983
Synthetic, cut but unset:		
Austria	1.0	1.3
France	1.3	1.6
Germany, Federal Republic of	5.9	6.1
Japan	.4	1.0
Korea, Republic of	11.1	6.7
Switzerland	3.0	3.2
Other	[r]1.5	1.2
Total	24.2	20.5
Imitation:		
Austria	7.2	10.9
Czechoslovakia	.8	1.2
Germany, Federal Republic of	3.0	4.4
Japan	1.3	2.4
Other	[r]1.1	1.4
Total	13.4	20.3

[r]Revised.

Table 7.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1982 Quantity	1982 Value	1983 Quantity	1983 Value
Diamonds:				
Rough or uncut[1]	891	276,377	1,008	292,687
Cut but unset	3,745	1,641,685	3,239	1,992,686
Emeralds: Cut but unset	2,167	130,809	3,117	194,130
Coral: Cut but unset, and cameos suitable for use in jewelry	NA	2,804	NA	2,584
Rubies and sapphires: Cut but unset	4,514	129,794	4,257	161,951
Marcasites	NA	38	NA	121
Pearls:				
Natural	NA	3,008	NA	3,019
Cultured	NA	92,741	NA	142,838
Imitation	NA	1,458	NA	3,015
Other precious and semiprecious stones:				
Rough, uncut	NA	19,749	NA	26,700
Cut, set and unset	NA	[r]60,300	NA	58,983
Synthetic:				
Cut but unset[2]	26,703	23,239	36,737	18,949
Other	NA	896	NA	1,586
Imitation gem stones	NA	[r]11,990	NA	17,281
Total	XX	2,384,452	XX	2,856,454

[r]Revised. NA Not available. XX Not applicable.

[1]Includes 4,985 carats of other natural diamond, advanced, valued at $837,000 in 1982, and 16,799 carats valued at $759,200 in 1983.

[2]Quantity in thousands of stones.

WORLD REVIEW

Angola.—It was estimated that diamond production by Companhia de Diamantes de Angola (DIAMANG) remained unchanged at 1.2 million carats, with a reduced value because of the depressed state of the international diamond market. DIAMANG had retained over 600 expatriate workers since 1978 in an effort to improve productivity, principally in Lunda-Norte Province, near the Zairean border. Illicit theft and trafficking was reportedly encouraged by the Unita insurgents, who almost certainly derived substantial income from these activities.[4]

DIAMANG's total work force, about 17,000, operated several mines within a 50,000-square-kilometer concession in Lunda-Norte Province, with three mining divisions, at Andrada, Lucapa, and Cuango. Most of the diamonds were recovered from alluvial terrace and riverbed gravels. The average grade was about 0.2 to 0.3 carat per cubic meter, with some rich pockets yielding up to 100 carats per cubic meter. Ample alluvial reserves remained, and there was no haste to work the extensive kimberlite discovered during operations. Limited mining of the weathered kimberlite tops was carried out, and one of the largest pipes in the world—Camofuca Camazombo—was still being explored. Alluvial diamond recovery methods were conventional, with some heavy media separators being employed.[5]

Australia.—The Western Australia State Government approved the Argyle Diamond Mines Joint Venture's mining project commencement of the AK-1 kimberlite pipe, with an estimated $440 million investment. The project involves preparation of the Argyle kimberlite pipe for commercial mining and construction of a 3.3-million-short-ton-per-year treatment plant, together with ancillary infrastructure and services. Expected to be in production in 1986, the project's annual output will eventually reach 25 million carats of diamond per year, with a minimum life of 20 years. Reserves are over 500 million short tons. Argyle was the richest diamond mine in the world in terms of carats per ton of ore.[6]

Shortly after it approved the project, the state purchased Northern Mining Corp. N.L.'s 5% interest in the Argyle project for $38 million, most of which was to be covered by advance royalties on production. Western Australia's Prime Minister stated that the investment was the first step in the creation of the Western Australian Development Corp. designed to hold equity stakes in all natural resource projects.[7]

Commercial production of diamond from Argyle's Upper Smoke Creek alluvial deposit commenced on January 1, 1983, at an expanded rate of 4,400 short tons of ore per day. By yearend, 1.18 million short tons of ore had yielded 6.15 million carats of diamond. It was planned to continue alluvial operations for 3 years, and to phase in with the kimberlite mining operation.[8]

Argyle's diamond quality had been estimated through the testing and exploration phase as 10% gem and 20% to 25% near-gem. However, a yearend report by the Australian Bureau of Mineral Resources reestimated the quality to be 45% gem and cheap-gem, with the balance being industrial stones and grit.[9]

De Beers Central Selling Organisation (CSO) had a purchasing and marketing contract with the Argyle Diamond Sales Ltd. for 95% of the gem and 75% of the cheap-gem and industrial diamond stones covering the period of alluvial production and 5 years of large-scale mining of the AK-1 kimberlite pipe through 1990, which was estimated to have an annual production rate of 25 million carats. It was expected that Australia would be the world's largest producer of natural diamond commencing in 1986.

Two other companies reported diamond production from their exploration activities. The Bow River joint venture of Freeport of Australia Pty. Inc. and Gem Exploration & Minerals Ltd. recovered 2,177 diamonds with a total weight of 367 carats from 2,250 tons of ore at Limestone Creek near the Argyle deposit. Afro-West Mining Ltd. also reported recovery of diamonds from claims along Smoke Creek, downstream from the Argyle project.[10]

Botswana.—Botswana not only became the world's second largest producer of natural diamond, but the world's second largest producer of gem diamond. Three mines—Jwaneng, Letlhakane, and Orapa—reported production of 10.73 million carats, valued at $491 million, of which 4.3 million carats was of gem quality. The new Debswana's (De Beers-Government of Botswana joint venture) Jwaneng diamond mine west of Gabarone exceeded its nameplate capacity, and because of improved recovery processes, greatly increased its production ratio of small gem diamonds. Jwaneng produced almost 5.9 million carats of diamond, and another increase of up to 6.5 million carats was predicted for 1984, after which production would level off. In 1983, the Government of Botswana was forced to stockpile about one-third of its gem production, and the total value of its cumulative stockpile at yearend was about $600 million. This was principally because the world market for larger stones was weak, while the small gem and near-gem material was very strong. Botswana's diamond exports constituted about two-thirds of its total foreign exchange earnings.[11]

New diamond sorting and evaluation facilities were established for all of Botswana's production, and Mabrodium of Belgium was granted permission to establish a small diamond cutting and polishing factory. The first polished stone was produced in 1981 by the company's subsidiary, Diamond Manufacturing Co., in Gabarone.[12]

Evaluation of the DK7 kimberlite pipe near Jwaneng was near final evaluation at yearend 1983, and an agreement by De Beers and Falconbridge Explorations Botswana resulted in continuing examination and evaluation of other licensed areas.

Central African Republic.—The principal mining industry of the Central African Republic was diamond. State revenues from this production continued to erode. Illicit mining and trafficking was substantial. Reported production has been as high as 524,000 carats in 1974, but in 1982, this had fallen to 277,000 carats. This decrease had encouraged the Government to attract foreign investment. The major marketing cooperative consisting of nine companies produced 264,900 carats in 1983, and five other companies produced 30,500 carats. A 1981 World Bank International Development Association's $4 million technical assistance project loan had included a portion for diamond exploration and a feasibility study. The final report, submitted in 1983 by a Canadian contractor, was confidential.[13]

China.—A new diamond cutting and polishing plant was installed in Beijing in 1981, financed by the Dresdner Bank of the Federal Republic of Germany. The joint venture consisted of the China National Arts and Crafts Import and Export Corp. and the export firm F. K. Narasimham from Frankfurt Main, and Franz Amann of Brucken Pfalz. The plant consisted of several hundred cutting and polishing machines from Franz Amann and included a training school for several hundred students. It was estimated that the indigenous supply of rough diamond consisted of 20% gem and near-gem quality, thus making approximately 500,000 carats available for cutting. There was no domestic demand for cut diamond or diamond jewelry.

China had an ambitious plan for development of modern cutting and polishing plants using low-cost labor for an export-oriented industry. The plan also included manufacture of diamond machinery and tools.[14]

Colombia.—Smuggling of valuable emeralds from Colombia continued to make true production and revenues difficult to assess. Export revenues from all precious stones, principally emeralds, declined in 1982 by 17% to $43 million.[15]

Gabon.—The Government of Gabon reported that 25,913 carats of diamond had been produced in 1979 with a unit value of $16.53 per carat. No diamond production has been reported in recent years.[16]

Ghana.—Ghana Consolidated Diamonds Ltd., a Government corporation that operated a diamond placer deposit at Akwatia, reported that production of primarily industrial diamond decreased to an estimated 300,000 carats from 836,000 carats in 1981. The original Akwatia Valley placer gravel deposits were essentially depleted. Mining in 1983 was within a thin Akwatia terrace gravel pay zone. Current reserves were expected to be mined out within 10 years. Additional lower grade placer resources averaging 1 to 1.4 carats per cubic meter were known to occur in the Birim Valley. A United Nations Development Program team investigated these resources and found that development would require substantial new foreign investment.

Guinea.—Aredor-Guinea S.A. was expected to begin commercial production of its $80 million alluvial diamond project in the first quarter of 1984. The Aredor-Guinea alluvial gravel mining was to be accomplished by three 7-cubic-yard draglines with 140-foot booms, and loaded into 40-ton articulated vehicles for delivery to the nearby recovery plant. The plant consisted of a main recovery facility containing a heavy media separator, a washing section, a feed section, and a separator house.

Fifty percent of the Aredor-Guinea was owned by the Government of Guinea, and 50% by Aredor Holdings Ltd. of Australia. Aredor Holdings in turn was owned 79.2% by Bridge Oil Ltd., 11.3% by the World Bank's International Finance Corp., 5% by Industrial Diamond Co. of the United Kingdom, 3.5% by Bankers Trust Australia (UK) Ltd., and 1% by Simonius Vischer of Basel, Switzerland. With a production rate of 250,000 carats per year from 440,000 short tons of gravel, Aredor-Guinea had sufficient reserves for 14 years of operations. The alluvial deposit is located in the Kissidougou area in southeast Guinea near the Sierra Leone border. Initial prospecting and exploration indicated that average expected size of stone was 0.8 to 1 carat with an estimated value of $185 to $200 per carat. Marketing of the stones was to be done by Aredor Sales Pty. Ltd. of Basel, Switzerland, and managed by Industrial Diamond of London.[17]

The U.S. Overseas Private Investment Corp., after a detailed feasibility survey, was providing political risk insurance to Bridge Oil's investment.[18]

India.—The flourishing diamond cutting and polishing industry exported 5.4 million carats of finished stones valued at $1.1 billion, which required 27 million carats of imported rough stones as the raw material. This indicated an approximate recovery of 20% from rough to finished stone. The number of Indian gem skilled workers had increased to 350,000, most of whom reside in the Palanpur-Bombay area. The trade and industry was dominated by 250 related families, also from the Palanpur area.[19] India was the leading importer and exporter of diamonds in the world. Both private and governmental buyers were searching the world to establish continuous supplies of rough. India's Minerals and Metals Trading Corp. (MMTC) continued its attempts to conclude agreements with African diamond producing countries to bypass the hold De Beers' Diamond Trading Corp. and CSO have on the world market. However, little progress had been achieved. Recent reports from Australia showed similar failure of the MMTC for direct buying.

Despite efforts by the Indian Government to increase diamond mining, annual production had averaged only about 14,700 carats during the 1981-83 period. The largest single diamond found during the period was a 29-carat gem quality from Majhgawan.[20]

Indonesia.—The Anaconda Co. was exploring for diamond in central Kalimantan. Indonesia had produced about 15,000 carats of principally gem diamond from the alluvial gravels in recent years, and had been a producer of diamond since the 17th century.[21]

Israel.—Imports of rough diamond in Israel increased 37% to $782 million. Exports of cut and polished diamond goods increased 11% to 1.0 billion. However, about $100 million of the commodity trade deficit increase could be traced to the diamond trade.[22]

Ivory Coast.—The Government of Ivory Coast reported that 48,000 carats of diamond had been produced in 1979. No apparent production has been reported in recent years.

Liberia.—Two alluvial diamond mining areas were in operation, at Takpormah on the Lofa River 130 kilometers northwest of Monrovia and at Gbapa south of Nimba. Most gravels were screened, washed, and jigged or panned by hand. In 1982, 780 diamond mining licensees produced 433,000 carats valued at $26 million. Gem-quality, 2-carat diamonds were produced from Takpormah and up to 6 carats from Gbapa. Reported production decreased 24% in 1983 compared with that of 1982.

Mali.—The Malian Ministry of Energy and Mines and the French Office for Geological and Mining Exploration signed an agreement in Bamako to conduct diamond exploration and extraction in the Kenieba area.[23]

Namibia.—Despite the De Beers' CDM (Pty.) Ltd.'s temporary cutback near Oranjemund, 10.6 million short tons of gravel and conglomerate were processed to produce 963,000 carats of diamond, a reduction of 5%. The No. 4 plant foreshore mining face was maintained in operation throughout the year and extended about 130 meters seawards of the high water mark, and mining operations were starting to extend the seawall further westward into the sea. Operational bedrock depth was 15 meters below mean sea level. The ratio of gem to industrial quality was maintained at 95%.[24]

Pakistan.—In the previous few years, Pakistan had emerged as an important world producer of precious gem stones. In 1981, exports were $6.2 million of principally aquamarine, emerald, ruby, and topaz. The Gemstone Corp. of Pakistan, a Government corporation, had been set up in 1979 to promote the production of gem materials. Most of the gem stones were found in the northern areas of the country close to the Himalayas.[25]

Sierra Leone.—Sierra Leone's diamond production decreased from about 800,000 carats annually in 1978-79 to an estimated 275,000 carats in 1983. Estimated to be 70% gem quality, illicit mining and trafficking in Yengema and Tonge was reported to be uncontrollable. A new Kono kimberlite mining project was organized in 1983 by Sierra Leone Selection Trust and the Government of Guinea, which was projected to cost in excess of $100 million. The project was to be handled by the Guinean National Diamond Mining Co., which was 60% owned by the Government, and 40% owned by Sierra Leone Selection Trust (a subsidiary of British Petroleum Minerals Co.). Financing was to be obtained from European banking institutions, with loan guarantees by U.S. Overseas Private Investment. The feasibility of sinking a cheaper inclined shaft, rather than a vertical shaft, was being investigated.[26]

South Africa, Republic of.—Substantial increases in diamond production at the largest mine of De Beers, the Finsch, resulted in a 13% increase in South African diamond production to 10.3 million carats. Higher throughput and grade improvements resulted in recovery of more small gem diamond for the improving world market. However, De Beers' rough diamond stocks increased 10% to a total of $1.85 million. The farm Letitia kimberlite exploration was terminated at yearend by De Beers, but exploration of the farm Venetia continued. De Beers was also a successful bidder in two deepwater marine diamond prospecting concessions situated off the Namaqualand coast. Preliminary investigation was to require profiling of the coastal shore for location of gravel beds or heavy mineral concentrations.[27] A 471-carat flawless white diamond was found in a crusher at De Beers' Premier Mine near Pretoria. A 72-carat flawless white diamond had been found earlier in the year.[28]

There was spirited bidding on the shallow, mid-, and deepwater concessions on the Namaqualand coastline offered and awarded by the South African Government during the year. Bid awards were made to large companies and small independents such as De Beers, Newmont Mining Corp., O'Okiep Copper Co. Ltd., Rio Tinto Zinc Corp. Ltd., Terra Marina Mining Co. Ltd., and Oceaneering International Ltd.

Mafikeng Diamonds Ltd. was test mining an alluvial diamond deposit near Mafikeng, Bophuthatswana. Rio Tinto's subsidiary, Rio Tinto South Africa, was managing the daily throughput of 1,400 short tons of gravel. The test duration was to be a full year. The 2,300-hectare lease contained about 27 million short tons of gravel.[29]

Two kimberlite pipes, previously abandoned by De Beers as uneconomic, were being retested by Trans Hex Group Ltd. of Cape Town. The Swaziland Government issued a license to Trans Hex for the mining of the Ehlane and Dokolwayo pipes.[30]

Sri Lanka.—Sri Lanka, previously Ceylon, has been a world-class producer of gem stones since ancient times. Most important are sapphire, ruby, chrysoberyl, beryl, and spinel. Other gem stones include aquamarine, garnet, moonstone, topaz, tourmaline, and zircon. These precious stones are found in the layers of older alluvium and river gravels of Quaternary age in the valleys of the Ratnapura district in southwest Sri Lanka. The operations are a mixture of Government corporations, overseas joint ventures, and private entrepreneurs. Some priority has been given to the areas to be inundated by the Majaweli and Samanala Wewa irrigation projects. Regular gem auctions have been held since 1980.[31] The State Gem Corp. is significantly involved in the industry, but most of the production comes from the small miners. Simple hand washing processes are employed. Estimated 1981 exports and tourist sales were $91 million, an increase of 31% compared with that of 1980.[32]

In 1983, a large deposit of high-quality blue sapphires was discovered near the village of Aluth Nuwara in southern Sri Lanka. It was reported that many millionaires were created overnight, and as many as 10,000 people became rich. As much as 90% of the gems were smuggled out of the country.[33]

U.S.S.R.—Soviet diamond output increased 1% to 10.7 million carats, with no indication of any new diamond mining development. The Soviet method of diamond marketing had not changed for 20 years, with both polished diamonds and rough gems sold via Geneva and Antwerp. The Antwerp Diamond Association reported that rough diamond supplies from the U.S.S.R. were larger in 1983 than those from De Beers. Shipments of packets of Soviet cut stones in Antwerp indicated a somewhat lower quality, which may be a market phenomenon because of the higher demand for lower quality goods.[34]

A 95-carat gem diamond was found in Yakutsk, Siberia.[35]

Zaire.—Zaire was the world's largest producer of natural and industrial diamond. Société Minière de Bakwanga's (MIBA) diamond mine was at Mbuji Mayi on the river of the same name. MIBA continued its program to develop kimberlite deposits, because of the declining alluvial reserves. A new $8 million dredge, put into operation on the river, was expected to extend MIBA's life for alluvial mining by allowing the mining of adjacent river flats and terraces. The new dredge had an annual capacity of 1 million cubic meters and an operating depth of 28 feet.[36]

MIBA, 20% owned by Sibeka of Belgium and 80% by the Zairean Government, mined 1.4 million cubic meters of alluvials for a production of 5.5 million carats of diamond. Fourteen private offices purchased 5.9 million carats of artisanal diamonds worth over $71 million. In previous years, most of these diamonds had been smuggled out of Zaire. The quality of the combined diamond production of MIBA and 14 private offices was estimated to be 71% industrial stones and bort and the balance gem and cheap-gem. The Société Zairoise de Commercialisation de Minerais (Sozacom), Zaire's diamond marketing organization, which had taken over the independent marketing companies in Kinshasa and Tshikapa, reported a 58% decrease in diamond sales for a total of 423,000 carats of diamond, 60% gem quality. Despite the Government's efforts, illicit mining and trafficking of gem diamonds continued to be substantial.[37] Sozacom moved the sorting and grading of diamond from the Centre National d'Expertise office in Kinshasa to the Miba Mine Headquarters in Mbuji Mayi.[38]

Zambia.—Since 1974, emerald production from the Kafubu area of the Copperbelt had increased significantly, with about 18 known deposits being mined in 1983. The estimated value of emerald production was $100 million, with only 10% of the output reaching the official market. The bulk of the emerald was reportedly being mined illegally and smuggled out of the country.[39]

Table 8.—Diamond (natural): World production, by country and type[1]

(Thousand carats)

Country	1979 Gem	1979 Industrial	1979 Total	1980 Gem	1980 Industrial	1980 Total	1981 Gem	1981 Industrial	1981 Total	1982[p] Gem	1982[p] Industrial	1982[p] Total	1983[e] Gem[2]	1983[e] Industrial	1983[e] Total
Angola	630	211	841	1,110	370	1,480	1,050	350	1,400	915	310	1,225	900	300	1,200
Australia	--	--	--	--	48	48	21	184	205	70	487	557	2,170	4,030	[3]6,200
Botswana	659	3,735	4,394	765	4,336	5,101	744	4,217	4,961	1,165	6,604	7,769	4,300	6,431	[3]10,731
Brazil[e] [4]	236	384	620	253	414	667	163	926	1,089	80	450	530	80	450	530
Central African Republic	205	110	315	227	115	342	209	103	312	186	91	277	[3]230	[3]65	[3]295
China[e]	NA	NA	NA	360	1,440	1,800	380	1,520	1,900	400	1,600	2,000	400	1,600	2,000
Ghana	125	1,128	1,253	126	1,132	1,258	85	751	836	68	616	684	30	270	300
Guinea[e]	27	58	85	12	26	38	12	26	38	13	27	40	15	30	45
Guyana	6	10	16	4	6	10	4	6	10	[e]5	[e]6	[e]11	4	5	9
India	14	2	16	12	2	14	14	2	16	11	2	13	13	2	15
Indonesia[e]	3	12	15	3	12	15	3	12	15	3	12	15	5	22	27
Ivory Coast	24	24	48	--	--	--	--	--	--	--	--	--	--	--	--
Lesotho	48	4	52	50	4	54	49	4	53	39	3	42	--	--	--
Liberia	170	132	302	123	175	298	132	204	336	170	263	433	132	198	[3]330
Namibia	1,570	83	1,653	1,482	78	1,560	1,186	62	1,248	963	51	1,014	915	48	[3]963
Sierra Leone	434	451	885	317	275	592	208	97	305	203	87	290	192	83	275
South Africa, Republic of:															
Finsch Mine	465	2,120	2,585	465	2,442	2,907	1,002	3,463	4,465	847	3,003	3,850	1,765	3,278	[3]5,043
Premier Mine	468	1,613	2,081	407	1,632	2,039	510	1,530	2,040	615	1,845	2,460	800	1,844	[3]2,644
Other De Beers properties[5]	1,850	1,370	3,220	1,550	1,489	3,039	1,603	1,069	2,672	1,359	906	2,265	1,400	589	[3]1,989
Other	403	95	498	390	145	535	314	35	349	521	58	579	589	66	[3]655
Total	3,186	5,198	8,384	2,812	5,708	8,520	3,429	6,097	9,526	3,342	5,812	9,154	4,554	5,757	[3]10,311
Tanzania	157	157	314	137	137	274	110	107	217	[e]100	[e]120	[e]220	125	125	250
U.S.S.R.[e]	2,200	8,500	10,700	2,250	8,600	10,850	2,100	8,500	10,600	2,100	8,500	10,600	3,700	7,000	10,700
Venezuela	247	556	803	238	483	721	102	388	490	[r] [3]99	[r] [3]394	[r] [3]493	100	400	500
Zaire	294	8,440	8,734	345	9,890	10,235	450	8,550	9,000	[e]450	[e]8,550	[e]9,000	3,172	8,266	[3]11,438
World total	10,235	29,195	39,430	10,626	33,251	43,877	10,451	32,106	42,557	10,382	33,985	44,367	21,037	35,082	56,119

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.

[1]Table includes data available through May 16, 1984. Total diamond output (gem plus industrial) for each country is actually reported except where indicated by a footnote to be estimated. In contrast, the detailed separate production data for gem diamond and industrial diamond are Bureau of Mines estimates in the case of every country except Australia (1980-83), the Central African Republic (1979-81), Liberia (1979-81), Sierra Leone (1979-81), the Republic of South Africa (1979), and Venezuela (1979-81), for which source publications give details on grade as well as totals. The estimated distribution of total output between gem and industrial diamond is conjectural, and for most countries, is based on the best available data at time of publication.

[2]Includes near-gem and cheap-gem qualities.

[3]Reported figure.

[4]Figures represent officially reported output plus official Brazilian estimates of output by nonreporting mines; officially reported output was as follows, in thousand carats: 1979—88; 1980—158; 1981—136; 1982—212; and 1983—not available.

[5]Other De Beers Group output from the Republic of South Africa includes Kimberley Pool, Koffiefontein Mine, and the Namaqualand mines.

TECHNOLOGY

Heat treatment was one of the first methods people used to alter the appearance of gem stones. The Romans soaked ordinary agate in honey and heated it to produce black stone capable of taking a high polish. Throughout history, low levels of heat have been used to alter or improve the color of aquamarine, quartz, sapphire, topaz, and zircon. High technology has now improved this technique so that much more dramatic changes can be effected. It is likely that most modern-colored gem stones are treated by heat, or other means, and that detection can only be done by professional gemologists. A tabulation of all gem stones and their reaction to heat treatment and/or radiation, including detection methods, was published. Ethical practices of the industry were discussed in light of the knowledge that the general public is not aware of this color enhancement as compared with a natural gem stone.[40]

The Confederation Internationale de la Bijouterie, Dimants, Perles et Pierres (CIBJO) is composed of jewelry trade associations from 23 countries. The American Gem Trade Association, the largest association of colored stone dealers in the United States, voted to adopt the CIBJO definitions and rules of application. One of the definitions was article 7 prohibiting use of the term "semiprecious," indicating that the term "semiprecious" is unauthorized and false and must never be used.[41]

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Gem Stones

By J. W. Pressler[1]

The value of gem stones and mineral specimens produced in the United States during 1984 was estimated to be $7.5 million, virtually the same as that of 1983. Turquoise and peridot production decreased while tourmaline, sapphire, and opal production increased. Amateur collectors accounted for much of the activity in many States. Small mine operators produced jade, opal, sapphire, tourmaline, and turquoise, which they sold mainly to wholesale and retail outlets, in gem and mineral shops, gem shows, and to jewelry manufacturers.

Domestic Data Coverage.—Domestic production data for gem stones are developed by the Bureau of Mines from the "Gem Stones" survey, a voluntary survey of U.S. operations. Of the 52 operations to which a survey request was sent, 44% responded, representing an estimated 60% of the total production indicated in the text. Production for the 29 nonrespondents was estimated using reported prior year production levels adjusted by trends in employment and other guidelines.

DOMESTIC PRODUCTION

Mines and collectors in 46 States produced gem materials with an estimated value of $1,000 or more in each State. Ten States supplied 88% of the total value as follows: Arizona, $2.7 million; Nevada, $1.3 million; California, $500,000; Montana, $450,000; Maine and Oregon, $400,000 each; Wyoming, $225,000; and Arkansas, New Mexico, and Washington, $200,000 each. Estimated production increased 67% in California, 50% in Idaho and Montana, and 8% in Nevada, but decreased 33% in Oregon, 20% in Maine, 10% in Wyoming, and 4% in Arizona.

Park authorities at the Crater of Diamonds Park in Pike County, AR, reported that 85,000 people visited the park and recovered, by washing, screening, and panning, 1,339 diamonds, an 11% decrease from that of 1983, with a total weight of 202 carats. The largest was a 5.58-carat brown stone of good quality. The total diamonds recovered averaged 15 points (100 points equals 1 carat) compared with 21 points in 1983. More small stones were found because of improvements in panning and screening equipment, especially the hemispherical "suruka" screen. The "dig for fee" operations remained popular.

In Emerald Creek, ID, the U.S. Forest Service issued 753 permits to diggers and panners who found 1,800 kilograms of gem garnet, most of which was asteriated, with the balance faceting grade. The garnet area consisted of three gulches, with one being especially noted for large stones. The 15 largest stones reported during the season varied from 50 to 500 grams. Because of the cold weather, the area was opened for about 100 days from May to September.

Exploration for diamondiferous kimberlite in Wyoming was continued by Cominco American Incorporated and Superior Minerals Co., working independently with the Geological Survey of Wyoming and the University of Wyoming, using remote sensing techniques. The Geological Survey of Wyoming also discovered a new kimberlite district in the Pole Mountain region of the Laramie Range. Bulk sampling and testing of properties in the Colorado-Wyoming State line district indicated grades of 0.01 and 0.2 carat per short ton, with stones as large as 1 carat.

In upper Michigan and northwest Wisconsin, Dow Chemical Co., Exmin Corp., Anaconda Mining Co., and others conducted investigations and sampled kimberlites in Dickinson and Iron Counties, MI, and Florence, Forest, and Pierce Counties, WI. Three small diamonds were found by a prospector in the Antigo area, Langlade County, WI, in glacial deposits.

Alaska's first confirmed find of diamond occurred near Circle, AK, in 1982, while working a gold placer deposit.

Montana continued to be the largest producer of gem-quality corundum in the United States. Intergem Inc. of Denver, CO, produced over 100,000 carats of corundum in 1984 from test operations of its properties on Yogo Gulch, near Lewiston, Fergus County, MT. Some high-quality colored stones were recovered, including blue and alexandrite-like purple. Recoverable corundum content of the ore was less than 10 carats per ton. After cutting, some of the larger sapphires were as much as 4 carats, but average cut stones, done in Bangkok, were only 20 points. Intergem was vertically integrated with its Yogo Mine, cutting and polishing of stones, and marketing of jewelry. In addition to Intergem, three other pay-as-you-dig or fee placer operations were active in Montana: Eldorado Bar and Castle's Sapphire Mine near Helena, and Gem Mountain Sapphire Mine near Philipsburg.

CONSUMPTION

Domestic gem stone output went to amateur and commercial rock, mineral, and gem stone collections, objects of art, and jewelry. Value of apparent consumption (domestic production plus imports minus exports and reexports) increased 40% to $2,978 million.

The sales value of jewelry containing pearls and diamonds increased 19%, with the Christmas trade being particularly good. Demand for small, lower quality goods was high, and the demand for larger stones of good quality was better than that in 1983.

U.S. consumption of colored stones, led by emerald, ruby, and sapphire, increased significantly. Annual sales of emerald continued to be almost equal to those of ruby and sapphire combined. The value of all imported gem stones, other than diamond, increased 28%, with other cut, set, and unset, principally cultured pearls, increasing 48%, followed by emerald with a 15% increase.

PRICES

The U.S. price of 1.0-carat, D-flawless, investment-grade diamond fluctuated between $11,000 and $14,000 per carat, and at yearend was $12,750 per carat, a decrease of 6% for the year. However, only a few hundred of these perfect 1-carat stones have been available each year, and their value may have amounted to less than 0.2% of the total market.

Prices for colored stones experienced little change during the year.

The unit value of Colombian and Zambian emeralds continued at a median price of $1,400 to $1,500 per carat.

Table 1.—Prices of U.S. cut diamonds, by size and quality

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Price range per carat[3] in 1984	Median price per carat[3] December 1983	Median price per carat[3] November 1984
0.04-0.08	G-I	VS_1	$400- $613	$490	$490
.04- .08	G-I	SI_1	400- 520	450	450
.09- .16	G-I	VS_1	450- 770	560	560
.09- .16	G-I	SI_1	410- 610	475	475
.17- .22	G-I	VS_1	700- 1,300	835	835
.17- .22	G-I	SI_1	500- 1,195	690	690
.23- .28	G-I	VS_1	775- 1,470	965	965
.23- .28	G-I	SI_1	650- 1,350	770	770
.29- .35	G-I	VS_1	875- 1,700	1,260	1,260
.29- .35	G-I	SI_1	735- 1,570	1,050	1,050
.46- .55	G-I	VS_1	1,450- 2,350	2,000	2,000
.46- .55	G-I	SI_1	900- 1,845	1,545	1,545
.69- .79	G-I	VS_1	1,800- 3,010	2,500	2,500
.69- .79	G-I	SI_1	1,400- 2,465	1,950	1,950
1.00-1.15[4]	D	FL	11,000-14,000	13,500	12,750
1.00-1.15	E	VVS_1	6,800- 8,200	7,500	7,500
1.00-1.15	G	VS_1	3,500- 5,200	4,200	4,200
1.00-1.15	H	VS_2	2,400- 4,800	3,300	3,300
1.00-1.15	I	SI_1	2,000- 3,800	2,600	2,600

[1]Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; and G-I—traces of color.
[2]Clarity: FL—no blemishes; VVS_1—very, very slightly included; VS_1—very slightly included; VS_2—very slightly included, but more visible; and SI_1—slightly included.
[3]Jewelers' Circular-Keystone. V. 155, No. 2, Feb. 1984, p. 124, and v. 155, No. 12, Dec. 1984, p. 42. These figures represent a sampling of net prices that diamond dealers in various U.S. cities charged their customers during the month.
[4]The Diamond Registry Bulletin. V. 15, No. 1, Jan. 1984.

Table 2.—Prices of U.S. cut colored gem stones

Gem stone	Carat weight	Price range per carat in 1984	Median price per carat[1] [2] January 1984	Median price per carat[1] [2] November 1984
Amethyst	10	$8- $24	$17	$17
Aquamarine	5	75- 210	150	150
Citrine	10	8- 18	10	10
Emerald:				
Colombian	1	900-1,800	1,500	1,500
Zambian	1	750-2,200	1,400	1,400
Commercial, 2d quality[3]		550-1,500	550	550
Garnet, tsavorite	1	350-1,100	725	725
Ruby:				
Medium to better	1	500-2,200	1,200	1,200
Commercial, 2d quality[3]	1	330- 660	330	330
Sapphire:				
Medium to better	1	150-1,500	700	700
Commercial, 2d quality[3]	1	220- 440	220	220
Tanzanite	5	500- 950	762	762
Topaz	5	80- 400	210	210
Tourmaline, green	5	60- 200	132	132
Tourmaline, pink	5	50- 225	137	137

[1]Medium to better quality.
[2]Jewelers' Circular-Keystone. V. 154, No. 2, Feb. 1983, p. 87, and v. 155, No. 12, Dec. 1984, p. 44. These figures represent a sampling of net prices that colored stone dealers in various U.S. cities charged their cash customers during the month.
[3]The Gemstone Registry Bulletin. V. 2, No. 2, Jan. 1984, and v. 3, No. 1, Jan. 1985, p. 8.

FOREIGN TRADE

The declared customs value of U.S. imports of rough and polished natural diamond, excluding industrial diamond, increased 28% to $2.9 billion. Total polished diamond imports, principally from Belgium, 32%; Israel, 26%; and India, 22%; were valued at $2.6 billion. Imports in the over-0.5-carat category, mostly from Belgium, 36%; Israel, 24%; and Switzerland, 13%; increased 43% in value to $1.1 billion. Imports in the less-than-0.5-carat group, mostly from India, 36%; Belgium, 29%; and

Israel, 26%; increased 22% in value to $1.5 billion. Imports of rough natural diamond, 79% from the Republic of South Africa, increased 6% in caratage and 11% in value. A 3% decrease in South African carat value, from $336 to $325, was indicated.

The total value of emerald imports increased 15% to $155 million. The total value of ruby imports increased 19% to $80 million, and sapphire imports decreased 3% to $83 million. Average carat value decreased 45% for emerald to $35, influenced by large imports of cheap cut emeralds from India. Average carat values decreased 31% for ruby to $16 and 8% for sapphire to $23, both impacted principally by imports of cheap goods from Thailand.

Export value of all gem materials other than diamond decreased 20% to $53.6 million. Of this total, other precious and semiprecious stones, cut but unset, were valued at $27.7 million; other natural precious and semiprecious stones, not set or cut, $12.8 million; synthetic gem stones and materials for jewelry, cut, $4.7 million; pearls, natural, cultured, and imitation, not strung or set, $2.6 million; and other, $5.8 million. Reexports of all gem materials, other than diamond, increased 25% to $52.8 million. Reexport categories were precious and semiprecious stones, cut but unset, $33.3 million, and other, $19.5 million.

Table 3.—U.S. exports and reexports of diamond (exclusive of industrial diamond), by country

Country	1983 Quantity (carats)	1983 Value (millions)	1984 Quantity (carats)	1984 Value (millions)
Exports:				
Belgium-Luxembourg	103,106	$50.5	128,521	$65.0
Canada	16,134	10.0	19,043	11.0
France	4,094	9.9	2,153	7.1
Germany, Federal Republic of	3,626	5.0	3,677	3.7
Hong Kong	58,851	87.0	63,320	64.8
Israel	75,092	39.2	101,532	53.0
Japan	30,911	62.3	29,043	54.2
Singapore	5,996	11.5	3,734	9.2
Sweden	1,198	1.1	9	(1)
Switzerland	12,478	76.8	20,113	73.9
Thailand	3,504	3.3	3,813	2.4
United Arab Emirates	1,035	.7	29	(1)
United Kingdom	5,441	9.5	5,707	14.2
Other	2,912	6.0	4,468	4.4
Total	324,378	372.8	385,162	362.9
Reexports:				
Belgium-Luxembourg	[2]1,317,578	84.6	[2]1,072,640	57.4
Canada	10,145	1.7	7,834	.6
China	10,613	.1	17,784	.7
Germany, Federal Republic of	25,919	2.2	32,530	1.5
Hong Kong	83,800	28.0	27,244	17.6
India	226,987	6.1	228,205	6.5
Israel	212,557	34.7	126,400	26.3
Japan	92,934	11.0	98,398	8.5
Netherlands	54,407	4.7	21,793	3.4
Switzerland	31,667	43.7	110,486	46.3
United Kingdom	73,474	26.9	93,442	32.6
Other	24,095	5.9	50,592	10.3
Total	2,164,176	249.6	1,887,348	211.7

[1]Less than 1/10 unit.
[2]Artificially inflated in 1983 by auction of approximately 1 million carats of U.S. Government stockpile diamond stones with subsequent reexports as gem stones to Belgium-Luxembourg. In 1984, 1 million carats was similarly auctioned and reexported to Belgium-Luxembourg and India.

Table 4.—U.S. imports for consumption of diamond, by kind and country

Kind and country	1983 Quantity (carats)	1983 Value (millions)	1984 Quantity (carats)	1984 Value (millions)
Rough or uncut, natural:[1]				
Belgium-Luxembourg	111,211	$14.7	160,100	$32.8
Brazil	2,290	.7	1,431	.3
Cape Verde	3,400	.1	--	--
Colombia	21,413	.1	216	.2
Congo	8,690	2.7	12,977	4.4
Dominican Republic	2,331	.1	--	--
Guyana	4,989	.3	2,475	.1
Israel	9,651	1.6	14,880	4.7
Netherlands	1,585	2.1	4,675	4.1
South Africa, Republic of	729,547	245.3	794,912	258.3
Switzerland	13,035	2.6	7,748	7.2
United Kingdom	41,234	13.4	22,125	4.6
Venezuela	65,908	3.2	34,811	2.3
Other	10,366	5.8	28,163	6.9
Total	1,025,650	292.7	1,084,513	325.9
Cut but unset, not over 0.5 carat:				
Belgium-Luxembourg	1,126,400	358.7	1,424,655	433.6
Brazil	5,530	.8	20,567	6.0
Canada	9,832	2.5	38,567	5.2
Hong Kong	29,957	8.9	100,017	20.3
India	2,153,148	440.8	3,107,794	544.8
Israel	1,047,471	342.4	1,113,127	399.5
Malaysia	5,215	1.8	21,949	7.8
Netherlands	19,802	8.6	56,924	23.5
South Africa, Republic of	45,187	24.3	38,301	23.8
Switzerland	44,864	18.0	56,670	23.8
United Kingdom	31,417	17.2	33,332	15.3
Other	[r]70,059	[r]17.4	44,030	16.0
Total	4,588,882	1,241.4	6,055,933	1,519.6
Cut but unset, over 0.5 carat:				
Belgium-Luxembourg	281,064	284.2	410,638	379.8
Hong Kong	9,135	23.8	13,697	22.5
India	58,871	18.1	83,415	23.2
Israel	165,641	132.1	342,221	259.5
Netherlands	10,841	18.8	32,846	33.6
South Africa, Republic of	33,936	47.4	61,595	89.8
Switzerland	27,364	111.1	56,618	134.0
United Kingdom	29,544	58.8	34,643	68.9
Other	33,501	47.0	51,200	48.6
Total	649,897	741.3	1,086,873	1,059.9

[r]Revised.
[1]Includes some natural advanced diamond.

Table 5.—U.S. imports for consumption of natural precious and semiprecious gem stones, other than diamond, by kind and country

Kind and country	1983 Quantity (carats)	1983 Value (millions)	1984 Quantity (carats)	1984 Value (millions)
Emerald:				
Argentina	550	([1])	12,474	$1.3
Belgium-Luxembourg	34,027	$1.6	10,092	2.8
Brazil	174,314	8.0	197,367	13.8
Colombia	203,485	44.1	271,559	48.9
France	7,806	2.2	11,456	2.5
Germany, Federal Republic of	28,293	3.7	52,883	2.4
Hong Kong	44,289	6.1	114,630	11.3
India	1,274,765	12.8	3,220,565	16.7
Israel	87,145	17.9	162,559	19.6
Japan	8,415	2.0	28,516	1.4
Paraguay	--	--	25,790	([1])
South Africa, Republic of	7,979	.3	3,118	.1
Switzerland	41,518	17.4	103,859	20.8
Taiwan	78,853	([1])	2,758	([1])
Thailand	64,590	2.2	116,812	4.5
United Kingdom	36,273	11.0	20,008	4.6
Other	[r]24,697	[r]4.8	55,709	3.9
Total	2,116,999	134.1	4,410,155	154.6

See footnotes at end of table.

Table 5.—U.S. imports for consumption of natural precious and semiprecious gem stones, other than diamond, by kind and country —Continued

Kind and country	1983 Quantity (carats)	1983 Value (millions)	1984 Quantity (carats)	1984 Value (millions)
Ruby:				
Austria	163,361	$.2	75,977	$.1
Belgium-Luxembourg	6,930	.9	14,246	1.9
Brazil	6,594	.2	10,712	.1
Colombia	37,070	.2	948	.2
France	4,393	1.6	11,277	1.4
Germany, Federal Republic of	53,843	1.5	65,703	1.6
Hong Kong	125,447	4.9	71,857	5.5
India	230,186	3.3	226,782	1.8
Israel	28,376	1.2	99,663	2.1
Japan	4,168	.1	33,146	.6
Switzerland	221,416	8.8	81,943	12.6
Thailand	1,840,758	36.0	4,107,406	43.0
United Kingdom	19,472	4.1	21,208	6.1
Other	r45,158	r3.8	32,977	2.7
Total	2,786,672	66.8	4,853,845	79.7
Sapphire:				
Australia	43,493	.6	13,415	.4
Austria	44,945	.1	1,186	(1)
Belgium-Luxembourg	28,462	1.0	20,436	1.8
Brazil	11,080	(1)	13,209	.1
Canada	15,146	.6	9,260	.6
Colombia	14,656	.1	1,647	(1)
France	11,026	2.5	11,185	2.5
Germany, Federal Republic of	121,800	2.5	67,298	1.8
Hong Kong	167,305	9.9	98,180	3.8
India	130,481	2.7	175,855	1.7
Israel	48,966	.8	71,286	1.6
Japan	8,317	.3	45,737	1.3
Korea, Republic of	5,245	.1	22,478	.1
Singapore	12,106	.1	22,955	.8
Sri Lanka	48,377	4.3	28,999	2.7
Switzerland	244,025	11.8	87,879	15.7
Thailand	2,456,096	32.7	2,917,584	39.2
United Kingdom	33,959	8.3	36,973	6.6
Other	r25,068	r6.8	32,816	2.3
Total	3,470,553	85.2	3,678,378	83.0
Other:				
Rough, uncut:				
Australia		1.0		1.9
Belgium-Luxembourg		.4		.4
Brazil		11.1		14.0
Canada		1.4		.1
Colombia		7.3		10.3
Hong Kong		.9		.6
Nigeria	NA	--	NA	2.6
Pakistan		.5		.5
South Africa, Republic of		.3		1.6
Switzerland		.7		.5
United Kingdom		.2		.6
Zambia		.9		.4
Other		r2.0		2.3
Total	NA	26.7	NA	35.8
Cut, set and unset:				
Australia		2.1		2.8
Brazil		12.5		32.7
Canada		.1		1.3
China		2.5		5.0
Germany, Federal Republic of		11.8		12.0
Hong Kong		22.6		20.4
India	NA	4.5	NA	6.1
Japan		152.8		240.7
Switzerland		4.5		.7
Taiwan		4.8		5.4
Thailand		2.6		2.8
United Kingdom		.8		1.5
Other		r5.9		5.6
Total	NA	227.5	NA	337.0

rRevised. NA Not available.
[1]Less than 1/10 unit.

Table 6.—Value of U.S. imports of synthetic and imitation gem stones, including pearls, by country

(Million dollars)

Country	1983	1984
Synthetic, cut but unset:		
Austria	1.3	0.8
France	1.0	1.4
Germany, Federal Republic of	6.1	5.5
Japan	1.0	1.4
Korea, Republic of	6.7	9.4
Switzerland	3.2	3.6
Other	1.2	1.7
Total	20.5	23.8
Imitation:		
Austria	10.9	17.4
Czechoslovakia	1.2	1.8
Germany, Federal Republic of	4.4	6.0
Japan	2.4	4.5
Other	1.4	2.7
Total	20.3	32.4

Table 7.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1983		1984	
	Quantity	Value	Quantity	Value
Diamonds:				
Rough or uncut[1]	1,026	292,687	1,085	325,851
Cut but unset	5,239	1,982,686	7,143	2,579,466
Emeralds: Cut but unset	2,117	134,130	4,410	154,644
Coral: Cut but unset, and cameos suitable for use in jewelry	NA	2,584	NA	3,120
Rubies and sapphires: Cut but unset	6,257	151,931	8,532	162,677
Marcasites	NA	121	NA	152
Pearls:				
Natural	NA	3,019	NA	2,823
Cultured	NA	162,833	NA	240,439
Imitation	NA	3,015	NA	6,171
Other precious and semiprecious stones:				
Rough, uncut	NA	26,700	NA	35,792
Cut, set and unset	NA	58,983	NA	90,421
Synthetic:				
Cut but unset[2]	36,787	18,948	52,484	21,368
Other	NA	1,536	NA	2,410
Imitation gem stones	NA	17,281	NA	26,182
Total	XX	2,856,454	XX	3,651,516

NA Not available. XX Not applicable.

[1]Includes 16,799 carats of other natural diamond, advanced, valued at $759,200 in 1983, and 2,084 carats valued at $700,100 in 1984.

[2]Quantity in thousands of stones.

WORLD REVIEW

De Beers Consolidated Mines Ltd.'s sales of rough diamond through the Central Selling Organization was $1.6 billion, virtually the same as that of 1983. The value of De Beers' stocks of rough diamond has increased from $936 million in 1980 to $2.0 billion in 1984, even though world retail jewelry sales had set new records every year. The 1983 retail value of world diamond jewelry sales increased 9% to $21.6 billion, representing 45 million pieces containing 9.2 million carats of gem diamond. The largest consuming markets were the United States, 36%, and Japan, 19%, with 50% of their diamond needs imported from India, the world's largest processor of small diamonds.

Angola.—Angola, whose diamonds are considered by the market to be "nice goods," is ranked among the top three countries in the world in terms of quality.

Although diamonds have been found over much of Angola in alluvial and eluvial deposits, Companhia de Diamantes de Angola (DIAMANG), 77% owned by the Angolan Government, has concentrated its prospecting and exploitation in a 50,000-square-kilometer concession in Lunda Norte Province in northeast Angola near the Zairian border. A labor force of 17,000 workers and dozens of mining and treatment sites, complicated by smuggling and illicit operations, continued to present major problems at the mining headquarters at Dundo. Diamond production was estimated at over 1 million carats in 1984, 97% of which was gem or near-gem quality. In 1983, the three mining divisions' production was Lucapa, 443,000 carats; Andrada, 295,000 carats; and Cuango, 296,000 carats. In late 1984, the Angolan Press Agency said that 124 people were on trial for smuggling, which caused the loss of about $140 million to DIAMANG. Of these, 1 person was sentenced to death, and 122 others were jailed. The trials were a major attempt by the Angolan Government to curb the smuggling.[2]

Australia.—Argyle Diamond Mines Joint Venture produced 5.7 million carats of diamond in its second year of alluvial mining operations, an 8% decline compared with 1983 production, reflecting the expected depletion of the higher grade alluvial material. The 1985 production was projected by Argyle to decline as the remaining alluvial material is mined out. Although much of the Argyle infrastructure was already in, construction was initiated at the beginning of 1984 for the $400 million mine and treatment plant on the AK-1 kimberlite project. The primary crushing plant was delivered in September with planned test operations of the mine and concentrator in mid-1986. Design capacity called for the treatment of 3 million metric tons of ore annually to produce over 20 million carats of diamond, 45% of which will be gem and near-gem quality, with the balance industrial quality. The AK-1 pipe is estimated to contain 150 million tons of kimberlite with a grade of 6.5 carats per ton.[3]

CRA Ltd. and Ashton Mining Ltd. established a diamond marketing organization in Antwerp, Belgium. It was to be run by Argyle Diamond Sales Ltd. (ADS), and was owned 60% by CRA and 40% by Ashton. The organization will eventually handle some 6 million carats of diamond per year. From June 1984, ADS was responsible for marketing 25% of the cheap-gem and industrial diamonds, which will increase to a level of 6 million carats per year when the AK-1 project comes on-stream in 1986. Northern Mining Corp. NL, the other partner in Argyle, had been previously purchased by the Western Australian government and in 1984 was selling its 5% share of production through a Belgian agent. A $65 million public offering of the Western Australian government share was made through the Western Australian Development Corp.[4]

The Bow River joint venture, 20 kilometers from the Argyle project, composed of Freeport of Australia Pty. Inc. and Gem Exploration and Minerals Ltd., recovered 0.35 carat per ton and 0.56 carat per ton from two of the four terraces sampled during 1983-84.[5]

Three equal joint venture members, Ashton, AOG Minerals Ltd., and Aberfoyle Ltd. have delineated a potentially major new diamond province in the Coanjula area of the Northern Territory of Australia near the border of Queensland. Diamonds were discovered in 15 of the 22 first priority geophysical targets.[6]

Stockdale Prospecting Ltd. and United Nickel Ltd. were drilling the Jubilee diamond prospect near Kalgoorlie, Western Australia.[7]

Australia produced over 80% of the world's opal, and over 70% of the world's uncut sapphire. In the last 15 years, production has increased to a total value in 1984 of over $50 million. Small syndicates and individuals operated opal mines at Coober Pedy and Andamooka in South Australia, at Lightning Ridge and White Cliffs in New South Wales, and in Queensland. Sapphire production in 1984 was from the alluvial gravels of the Glen Innes-Inverell district in New South Wales and from the Anakie district in Queensland. The heat treatment of the steel-blue stones, as a method of enhancement, has greatly improved the quality in the international market.[8]

Belgium.—The World Diamond Congress held in Antwerp reported through the Diamond High Council that diamond prices were stronger, and that exports to the principal consuming countries, the United States, Switzerland, and Japan, were up substantially compared with those of 1983. Sales of Belgian, Israeli, and Soviet diamonds have benefitted from the movement in demand toward higher priced stones at the expense of the cheaper Indian goods.[9]

Botswana.—Botswana was the world's second largest producer of diamonds with a total of 12.9 million carats, a 20% increase compared with that of 1983. This included 5.8 million carats of gem diamond. The richness of the Jwaneng Mine, with over 149 carats recovered from 100 metric tons of ore, far surpassed any of De Beers' operations or joint ventures. In Botswana, 15.2 million tons of diamondiferous kimberlite was processed to produce 12.9 million carats of diamonds. The Jwaneng Mine produced 7.5 million carats, Orapa produced 4.7 million carats, and the Letlhakane, 0.7 million carats.[10]

Brazil.—Extratifera de Diamantes Brasil S.A. Exportacao de Comercio was investing $6.9 million in an alluvial diamond deposit in Romaria, Minas Gerais. Capacity was to be 240 cubic meters per hour of gravel with a recoverable content of 200 carats of diamond per day. When fully operational in 1985, the mine will produce 72,000 carats of diamond per year, 76% gem quality and 24% industrial.[11]

According to the Brazilian Department of Trade and Industry, Brazilian production of diamond almost doubled in 1983 to more than 1 million carats. About 60% of the diamond came from mines in the States of Minas Gerais, Matto Grosso, Para, Bahia, and the territory of Roraima.[12]

Minerção Tejucana S.A. was expanding its operations in Minas Gerais in 1984, with a fifth dredge on an alluvial diamond deposit with a capacity of 84,000 carats of diamond per year. Morro Vermelho Ltda. was developing its reserves and had a pilot plant in operation on its alluvial diamond deposit in Cuiaba, Matta Grosso. Design production was 60,000 carats per year.[13]

Brazil is a major world producer of gem stones, other than diamond. Exports in 1982 included over 1.1 million kilograms of crude and worked agate, 197,000 kilograms of crude and worked amethyst, 42,000 kilograms of crude and worked emerald, 32,000 kilograms of citrine, 26,000 kilograms of crude and worked aquamarine, and 400,000 kilograms of other crude and worked gem stones.[14]

Canada.—Two companies, Monopros Ltd. and BP Resources (Canada) Ltd., were actively prospecting for diamond in northeastern Ontario. Kimberlite has been found, not only as boulders in gravel, but as outcrops in the Kirkland Lake area of Ontario. In British Columbia, kimberlite has been found on two properties, and one gem-quality diamond measuring 0.43 millimeter was identified.[15]

Central African Republic.—Diamond production, the principal mining industry of the Central African Republic, improved in 1984. Although smuggling and illicit mining continued to be a problem, the High Commissioner of Mines and Geology announced a plan of stricter controls of the 40,000 workers, 200 collectors, and 12 purchasing offices. Production increased 19% to 350,000 carats, and it was planned to reach 530,000 carats in 1985.[16]

China.—The China Nonmetallic Minerals Industry Corp. estimated that China's annual production of diamond was less than 1 million carats, of which 17% was of gem quality. Mines were located in three Provinces: Liaoning, Hunan, and Shandong. Liaoning's Binhai Mines in Fu County was the best source of larger high-quality gem stones. Shandong has one principal placer mine, Chengjiafu near Tancheng, where stones of 96, 124, and 159 carats have been found since 1979. A number of smaller placer mines also were operated. The Changde Mine in Changde County, Hunan, began production in the early 1970's of principally industrial stones, with a recovery of 0.25 carat per metric ton. Kimberlite deposits were also identified in Guangxi and Guizhou.[17]

Colombia.—Empresa Colombiana de Minas and the United Nations Development Fund announced in 1983 a $2.5 million, 30-month exploration program for emeralds and improvement of mining techniques. Improved reserves at the Muzo Mine, 90 miles northwest of Bogota, and at the Coscuez and Peeas Blancas Mines, was to be attempted.[18]

Ghana.—Ghana Consolidated Diamonds Ltd. produced 340,000 carats of diamond in 1983, of which 10% was gem quality and the balance industrial quality. Reserves at Akwatia are nearing exhaustion, and production has declined progressively. The company will initiate production at its $12 million Birim River placer project in early 1985, in which diamond reserves were estimated at 20 million carats. Design capacity was based on an annual extraction rate of 800,000 cubic meters of gravel, with a recovery of 1 million carats of diamond.[19]

Guinea.—The $86.6 million Société Mixte Aredor-Guinea alluvial diamond mine initiated operations in April 1984. The mine is at Banankoro near Kissidougou in southeast Guinea near the Sierra Leone border.

Proven diamond reserves are 2.5 million carats, 90% of which is of gem quality having an average size of 0.53 carat. The average net selling price for the first production consignment was higher than expected, $248 per carat compared with an estimated price of $225 per carat. Diamond production was less than expected in the first 8 months of operation through December 1984, with 70,000 carats produced. Dragline operation encountered large boulders, clay beds, and undulating bedrock, which impeded operations. The latter problem required an increase in washing plant capacity from 400,000 cubic meters per year to 750,000 cubic meters per year. The target production level of 200,000 carats per year was to be achieved by July 1985.[20]

In 1984, diamond prospecting rights were awarded to several other companies in Guinea as follows: Brady Nixon, 10,000 square kilometers in Kindia-Telemele; ADG, 39,000 square kilometers in Faranah-Kouroussa; and Gulf African Enterprises, 9,000 square kilometers in Nzerekore-Yomou.[21]

India.—India has the world's leading diamond cutting and polishing industry. Centered in Surat, Navsari, and Bombay, approximately 300,000 workers operate in the cottage industry. Low wages enabled India to compete very favorably on the world market. In 1984, 28 million carats of rough cheap-gem material, commonly called "Indian goods," was processed as cuttables. India apparently is consuming more than the estimated 26 million carats in the world supply, and is using a substantial portion of the natural industrial stones; 38 million carats in 1984. The Indian Ministry of Commerce and the Hindustan Diamond Co., Ltd. have agreed to develop a sawn-goods industry to provide more cutting material for the cottage industry. Sawn goods are being processed mainly by Belgium and Israel, and their excess supply could be made available to India, especially for the cheaper and small sizes. India's exports of cut and polished diamonds were 5 million carats with a value of $584 million.[22]

Israel.—Imports of rough diamond were $881 million, a 13% increase compared with that of 1983. Exports of cut and polished diamonds were $1,035 million, a 3.5% decrease compared with that of 1983. Israel produced more small stones and larger stones than in the recent past, and its traditional medium range was less in demand. It also had firmly established itself as the main source of fancy cuts, especially marquises. The trend toward movement of manufacturing activities to smaller plants continued. Sales to the United States represented about one-half of Tel Aviv's diamond exports.[23]

Ivory Coast.—The Ivory Coast Syndicate (ICS) recently completed a second field program on its 1,800-square-kilometer concession in the Sanwi region in the southwest. ICS consisted of three Canadian companies, Eden Roc Mineral Corp., Golden Rule Resources Inc., and Dibi Resources Inc., which together held a 49% interest, with the state-owned Société pour le Développement Minière de La Cote d'Ivoire holding the balance. Eden Roc recommended diamond drilling in the Afema sector, pilot plant processing of Asupiri River alluvials, and bulk sampling of alluvials where a diamond occurrence was located. Further ground work over the anomalies also was recommended.[24]

Liberia.—Liberia's diamond production declined 27% to 240,000 carats, 45% of which was gem quality, and the balance industrial quality. Total value was $11 million, a 36% decrease compared with the $17.2 million in 1983.[25]

More than one-half of the diamonds exported from Liberia were believed to have originated in Sierra Leone and Guinea, because of the availability of hard currency in Liberia. Exporters must have a Government license.[26]

Namibia.—DeBeers' CDM (Pty.) Ltd. continued mining operations at a reduced rate and produced 930,200 carats of diamond from the beach placers, a 3% decrease compared with that of 1983. However, overburden stripped increased to 19.3 million tons, a 12% increase compared with that of 1983. A bedrock vacuum cleaning unit was commissioned with encouraging results. Seawall construction had advanced the high-water mark to 260 meters seaward, and mining was taking place 200 meters beyond the original high-water mark. The Namibian Government increased the tax on diamond mining to 55%, and CDM pointed out that its tax burden in 1984 will climb to 75% of profits.[27]

Sierra Leone.—British Petroleum Co. Ltd. sold its 49% interest in Sierra Leone's National Diamond Mining Co. (DIMINCO) for $8.5 million. DIMINCO is now virtually state-owned. Negotiations for the financing of the $100 million Kono kimberlite project collapsed at yearend. An estimated 70% of Sierra Leone's diamond production is gem quality, and smuggling and illicit mining has intensified.[28]

South Africa, Republic of.—De Beers' Consolidated Mines represented 94% of South African diamond production, and mined 22.1 million tons of ore with a recovery of 9.5 million carats of diamond. The Finsch diamond mine, the Republic of South Africa's largest and richest source of diamond, treated 5.1 million metric tons of ore and produced 4.9 million carats, 65% gem quality, and the balance industrial quality. The Finsch ore grade of 95 carats of diamond per 100 metric tons of ore was the highest of all other South African diamond mines. Finsch underground mine development has progressed to the 680-meter level. As the mine shifted from open pit to underground mining, the last phases of open pit mining produced a lower grade material, and resulted in an ore grade of 95 carats per 100 metric tons in 1984, compared with 100 carats per 100 metric tons in 1983.[29]

De Beers' Namaqualand Div. recovered high-quality gem diamonds from marine alluvial deposits along the Namaqualand coast similar to those produced by CDM north of the Orange River in Namibia. Production was from farm concessions Tweepad, Karreedoornvlei, Koingnass, and Langhoogte. The Annex Kleinzee plant has been temporarily suspended since 1982. De Beers was awarded several prospecting leases off the Namaqualand coast, totaling over 9,000 square kilometers in 1984.

Ocean Diamond Mining Ltd. initiated a beach mining project off the coast of Namibia near CDM operations. An air-lift suction dredge will excavate diamondiferous gravels to a washing plant. The company expected to produce about 3,000 carats per month of over 95% gem-quality stones.[30]

Tanzania.—The famous Mwadui diamondiferous kimberlite mine in Tanzania is one of the largest kimberlites ever found in the world. Production of diamond, 70% gem quality, decreased to 262,000 carats in 1984. Results from a completed $30 million mineralogical survey performed by Geosurvey Ltd. of Nairobi, Kenya, indicated the presence of new diamond-bearing deposits. The Dar Madine al-Umma Ltd., a private Egyptian-Arab mineral resource development company, was considering the development of the newly found diamond resources.[31]

U.S.S.R.—Soviet annual diamond production in recent years has been constant at a level of 10.7 million carats, 40% of which was gem quality and cheap Indian goods, with the balance industrial stones. A major diamond mining complex on the Lena River had been temporarily closed for modernization for some time and was reopened in 1984. The new Anabar diamond placer mine on the Ebelyakh River, long delayed because of the severe weather conditions and permafrost, was commissioned in 1983.[32]

A large diamond weighing 291.6 carats was found at the Udachnaya Mine in the Yakutsk A.S.S.R. This was the second largest stone ever found in the U.S.S.R., and it was likely to remain in the country.[33]

The U.S.S.R. heavily sold cut diamonds, especially good-quality rounds in medium sizes, mainly in the Antwerp market, during two periods in May and October 1984. This caused considerable disruption in the cutting industries of Belgium and Israel, which produced comparable goods, because Soviet prices were 10% to 15% below market levels. A conservatively estimated $300 million in cut stones entered Europe, $200 million of which came through Antwerp, and generated badly needed foreign exchange for the U.S.S.R.[34]

Zaire.—Zaire became the world's largest producer of diamonds with a total of 18.5 million carats, a 54% increase compared with that of 1983. This included 5.2 million carats of gem and cheap gem quality. Artisanal mining almost doubled its production from 5.9 to 10.7 million carats. Production from the Bakwanga deposits has enabled Zaire to be the world's largest producer of industrial diamond (Congo boart) since the alluvial deposits were discovered in 1918. Société Minière de Bakwanga's (MIBA) new 100,000-cubic-meter-per-month bucket dredge was in production, and had the capacity to produce 1 million carats of diamond per year. MIBA's 1983 production was 5.5 million carats and was sold to Britmond-Zaire, a De Beers' affiliate, for $48 million. Only 3.5% of this production was classified as gem quality, but it sold for $21 million, 44% of MIBA's revenue.

Table 8.—Diamond (natural): World production, by country[1]

(Thousand carats)

Country	1980 Gem	1980 Industrial	1980 Total	1981 Gem	1981 Industrial	1981 Total	1982 Gem	1982 Industrial	1982 Total	1983[p] Gem[2]	1983[p] Industrial	1983[p] Total	1984[e] Gem[2]	1984[e] Industrial	1984[e] Total
Angola	1,110	370	1,480	1,050	350	1,400	915	310	1,225	1,003	31	1,034	970	30	1,000
Australia		48	48	21	184	205	251	306	557	2,770	3,385	6,155	2,560	3,130	[3]5,690
Botswana	765	4,336	5,101	744	4,217	4,961	1,165	6,604	7,769	4,829	5,902	10,731	5,810	7,104	[3]12,914
Brazil[4]	253	414	667	163	926	1,089	80	450	530	200	800	1,000	220	880	1,100
Central African Republic	227	115	342	209	103	312	186	91	277	230	65	295	[3]270	[3]80	[3]350
China[e]	[r]180	[r]720	[r]900	[r]190	[r]760	[r]950	[r]200	[r]800	[r]1,000	[r]200	[r]800	[r]1,000	200	800	1,000
Ghana	126	1,132	1,258	85	751	836	68	616	684	34	306	340	35	315	350
Guinea[e]	12	26	38	12	26	38	13	27	40	[r]23	[r]17	[r]40	[3]34	[3]14	[3]48
Guyana	4	6	10	4	6	10	[e]5	[e]6	[e]11	5	7	12	5	5	10
India	12	2	14	14	2	16	11	2	13	12	2	14	12	2	14
Indonesia[e]	3	12	15	3	12	15	3	12	15	5	22	27	5	22	27
Lesotho	50	4	54	49	4	53	39	3	42						
Liberia	123	175	298	132	204	336	170	263	433	132	198	330	[3]108	[3]132	[3]240
Namibia	1,482	78	1,560	1,186	62	1,248	963	51	1,014	915	48	963	884	46	[3]930
Sierra Leone	317	275	592	208	97	305	203	87	290	242	103	345	240	105	345
South Africa, Republic of:															
Finsch Mine	465	2,442	2,907	1,002	3,463	4,465	847	3,003	3,850	1,765	3,278	5,043	1,714	3,184	[3]4,898
Premier Mine	407	1,632	2,039	510	1,530	2,040	615	1,845	2,460	800	1,844	2,644	765	1,785	[3]2,550
Other De Beers' properties[5]	1,550	1,489	3,039	1,603	1,069	2,672	1,359	906	2,265	1,400	569	1,969	1,452	593	[3]2,045
Other	390	145	536	314	35	349	521	58	579	589	66	655	585	65	650
Total	2,812	5,708	8,520	3,429	6,097	9,526	3,342	5,812	9,154	4,554	5,757	10,311	4,516	5,627	10,143
Tanzania	137	137	274	110	107	217	[e]100	[e]120	[e]220	183	78	261	182	78	260
U.S.S.R.[e]	2,250	8,600	10,850	2,100	8,500	10,600	2,100	8,500	10,600	3,700	7,000	10,700	4,300	6,400	10,700
Venezuela	238	483	721	102	388	490	[e]99	[e]394	[e]493	45	234	279	75	175	250
Zaire	345	9,890	10,235	450	8,550	9,000	[e]450	[e]8,550	[e]9,000	3,355	8,627	11,982	5,169	13,290	[3]18,459
World total	[r]10,446	[r]32,531	[r]42,977	[r]10,261	[r]31,346	[r]41,607	10,363	33,004	43,367	22,437	33,382	55,819	25,595	38,235	63,830

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Table includes data available through July 8, 1985. Total diamond output (gem plus industrial) for each country is actually reported except where indicated by a footnote to be estimated. In contrast, the detailed separate production data for gem and industrial diamond are Bureau of Mines estimates in the case of every country except Australia (1980-84), Central African Republic (1980-84), Guinea (1984), Liberia (1980, 1981, 1984), Sierra Leone (1980-81), and Venezuela (1980-81), for which source publications give details on grade as well as totals. The estimated distribution of total output between gem and industrial diamond is conjectural, and for most countries, is based on the best available data at time of publication.

[2]Includes near-gem and cheap-gem qualities.

[3]Reported figure.

[4]Series changed from estimated data to reported data to conform with official Brazilian Government published data.

[5]Other De Beers Group output from the Republic of South Africa includes Kimberley Pool, Koffiefontein Mine, and the Namaqualand Mines.

The Zairian Government's 1982 decree liberalizing diamond production and marketing by private Zairians, resulted in some abatement of illegal mining and smuggling. Total diamond exports increased from $72 million in 1982 to $139 million in 1983. The Société Zairoise de Commercialisation de Minerais was abolished by Presidential decree in 1984, and as a result, both MIBA and La Générale des Carrières et des Mines du Zaire were to be responsible for their own marketing. Britmond is the sole buyer of MIBA diamonds with a floor price of $8.55 per carat. Britmond stated that in the first half of 1984 the market value of the diamonds was below the floor price, attributing the decline to the theft of the more valuable stones, a continuing problem.[35]

TECHNOLOGY

Geological research of the West Kimberley Province in Western Australia indicated that diamonds are found in lamproites as well as kimberlites. Seventy new discoveries of lamproite on the southwest border of the Kimberley craton have been made. This was the first recognition of a primary terrestrial source of diamond other than kimberlite. Different properties and tectonic settings for these two diamond-bearing rocks has given a new and expanding geologic horizon, with different major elements, trace elements, indicator minerals, and geophysical responses.[36]

A research team at Cornell University has used a Q-switched YAG laser beam to melt a diamond surface at high pressure. This experiment was the first phase in investigations to determine whether molten carbon can exist in the earth's interior.[37]

Microscopic diamonds, the largest of which was about 30 micrometers, have been formed during the gas-phase decomposition of a mixture of methane and hydrogen in a microwave plasma, by the Hitachi Research Laboratory, Ibaraki, Japan. Diamond, a very good electrical insulator and heat conductor, could be a very important substrate for integrated circuits.[38]

The General Electric Research and Development Center in Schenectady, New York, produced gem-quality synthetic jadeite with a diamond-making press in samples large enough to be cut into gems.[39]

Soviet scientists at Kharkov University, developed a geobotannical prospecting method for location of diamondiferous kimberlites. Some well-known deposits in the Yakut A.S.S.R. were tested and showed excellent geological delineation.[40]

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Gem Stones

By Staff, Bureau of Mines

The value of gem stones and mineral specimens produced in the United States during 1985 was estimated to be $7.4 million, virtually the same as that of 1984. Amateur collectors accounted for much of the activity in many States. Small mine operators produced jade, opal, sapphire, tourmaline, and turquoise, which they sold mainly to wholesale and retail outlets, in gem and mineral shops, gem shows, and to jewelry manufacturers.

Domestic Data Coverage.—Domestic production data for gem stones are developed by the Bureau of Mines from the "Gem Stones" survey, a voluntary survey of U.S. operations. Of the 43 operations to which a survey request was sent, 33% responded. Production for the 29 nonrespondents was estimated using reported prior year production levels adjusted by trends in employment and other guidelines.

DOMESTIC PRODUCTION

Mines and collectors in 46 States produced gem materials with an estimated value of $1,000 or more in each State. Ten States supplied 88% of the total value as follows: Arizona, $2.7 million; Nevada, $1.3 million; California, $550,000; Montana and Maine, $400,000 each; Oregon, $350,000; Wyoming, $225,000; and Arkansas, New Mexico, and Washington, $200,000 each. Estimated production increased 10% in California, 17% in Idaho, but decreased 11% in Montana and 13% in Oregon.

Lac Minerals Ltd. entered a joint venture with Superior Oil Co. in the continuing exploration of the Wyoming-Colorado border area near Tie Siding, WY, for diamond. The land holdings involve 63 unpatented claims and rights on an additional 2,500 acres leased from a Union Pacific subsidiary. Exploration revealed the existence of kimberlite pipes and dikes. A 3,000-short-ton bulk sample was processed through Superior's pilot plant at Fort Collins, CO, and found to be diamondiferous. A 500-carat sample of gem and industrial-quality diamonds was offered for sale by the parties, as part of the characterization studies, to determine the economic value.

A major new deposit of pink tourmaline (rubellite) associated with purple apatite was discovered at the Mount Rubellite Quarry near Hebron, ME. Purple and lavender apatite crystals also were found. The discovery could be the most significant gem stone find in Maine since the tourmaline discovery at Newry in 1972.

Exmin Corp. leased some lands in Minnesota's Morrison, Todd, and Wadena Counties to explore for diamonds. Some diamonds and kimberlite have been reported in Michigan and Wisconsin, and exploration continued in these two States in 1985.

A Texas partnership, Hanvey-Boulle Ltd., expressed a willingness to spend up to $2 million to take a core sample at the Crater of Diamonds State Park, Murfreesboro, AR, to determine if diamond mining is feasible. The State of Arkansas has final right of approval, and the Arkansas State Parks, Recreation, and Travel Commission appointed a special committee to examine any plans for commercial operations. A detailed proposal was requested from the firm by the committee. The firm indicated that the core sampling would involve drilling to a depth of 500 feet to determine the number of diamonds per hundred tons of soil. The firm also leased 3,000 acres of land surrounding the park, including several hundred acres leased from Anaconda Mining Co.[1]

CONSUMPTION

Domestic gem stone output went to amateur and commercial rock, mineral, and gem stone collections, objects of art, and jewelry. Value of apparent consumption increased slightly to $3,008 million from that of 1984.

U.S. consumption of colored stones, led by emerald, ruby, and sapphire, decreased. Annual sales of emerald continued to be almost equal to those of ruby and sapphire combined. The value of all imported gem stones, other than diamond, decreased 10%, with other cut, set and unset, principally cultured pearls, decreasing 12%, followed by emerald with a 10% decrease.

According to data reported by the U.S. Department of Commerce, the sales value of merchandise sold by jewelry stores in 1985 increased 9%, to $11.1 billion, over that of the previous year. Jewelers of America Inc. data indicated a substantial gain in colored gem stones sales, compared with diamond sales, for the Nation, and even more strongly for the Southwest.

PRICES

The U.S. price of 1.0-carat, D-flawless, investment-grade diamond fluctuated between $10,500 and $13,500 per carat, and at yearend was $12,750 per carat. However, only a few hundred of these perfect 1-carat stones have been available each year, and their value may have amounted to less than 0.2% of the total market.

Prices for colored stones experienced little change during the year.

Table 1.—Prices of U.S. cut diamonds, by size and quality

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Price range per carat[3] in 1985	Median price per carat[3] November 1984	Median price per carat[3] August 1985
0.04-0.08	G-I	VS_1	$400- $590	$490	$482
.04- .08	G-I	SI_1	400- 500	450	440
.09- .16	G-I	VS_1	440- 750	560	550
.09- .16	G-I	SI_1	410- 600	475	460
.17- .22	G-I	VS_1	670- 1,200	835	810
.17- .22	G-I	SI_1	490- 1,150	690	675
.23- .28	G-I	VS_1	720- 1,400	965	950
.23- .28	G-I	SI_1	650- 1,300	770	755
.29- .35	G-I	VS_1	860- 1,300	1,260	1,235
.29- .35	G-I	SI_1	720- 1,500	1,050	1,010
.46- .55	G-I	VS_1	1,400- 2,300	2,000	1,950
.46- .55	G-I	SI_1	850- 1,845	1,545	1,500
.69- .79	G-I	VS_1	1,700- 2,900	2,500	2,460
.69- .79	G-I	SI_1	1,400- 2,450	1,950	1,910
1.00-1.15[4]	D	FL	10,500-13,500	12,750	12,750
1.00-1.15	E	VVS_1	6,600- 7,900	7,500	7,200
1.00-1.15	G	VS_1	3,400- 5,200	4,200	4,120
1.00-1.15	H	VS_2	2,400- 4,800	3,300	3,300
1.00-1.15	I	SI_1	2,000- 3,800	2,600	2,600

[1]Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; and G-I—traces of color.
[2]Clarity: FL—no blemishes; VVS_1—very, very slightly included; VS_1—very slightly included; VS_2—very slightly included, but more visible; and SI_1—slightly included.
[3]Jewelers' Circular-Keystone. V. 156, No. 14, Dec. 1985, p. 42; and v. 156, No. 12, Oct. 1985, p. 276. These figures represent a sampling of net prices that diamond dealers in various U.S. cities charged their customers during the month.
[4]The Diamond Registry Bulletin. V. 15, No. 1, Jan. 1985.

Table 2.—Prices of U.S. cut colored gem stones, by size[1]

Gem stone	Carat weight	Price range per carat in 1985[2]	Median price per carat,[1 2] November 1984
Amethyst	10	$6.50- $25	$17
Aquamarine	5	50 - 200	150
Citrine	10	5 - 20	10
Emerald:			
Colombian	1	250 -5,000	1,500
Zambian	1	250 -4,000	1,400
Commercial, 2d quality[3]		300 -1,600	550
Garnet, tsavorite	1	175 - 500	725
Ruby:			
Medium to better	1	460 -2,000	1,200
Commercial, 2d quality[3]	1	220 - 700	330
Sapphire:			
Medium to better	1	50 -1,500	700
Commercial, 2d quality[3]	1	165 - 480	220
Tanzanite	5	50 - 750	762
Topaz	5	10 - 500	210
Tourmaline, green[4]	5	50 - 250	132
Tourmaline, pink[4]	5	40 - 200	137

[1]Medium to better quality.
[2]Jewelers' Circular-Keystone. V. 155, No. 12, Dec. 1984, p. 44; and v. 156, No. 1, Jan. 1985, p. 52. These figures represent a sampling of net prices that colored stone dealers in various U.S. cities charged their cash customers during the month.
[3]The Gemstone Registry Bulletin. V. 2, No. 2, Jan. 1984, and v. 3, No. 1, Jan. 1985, p. 8.
[4]The Gemstone Registry Bulletin. V. 17, No. 3, Feb. 28, 1986, p. 8.

FOREIGN TRADE

The declared customs value of U.S. imports of rough and polished natural diamond, excluding industrial diamond, was up slightly to $3.0 billion. Total polished diamond imports, principally from Israel, 29%; India, 19%; and Belgium, 13%; were valued at $2.7 billion. Imports in the over-0.5-carat category, mostly from Israel, 30%; Belgium, 28%; and Switzerland, 13%; increased 7% in value to $1.1 billion. The value of imports in the less-than-0.5-carat group, mostly from India, 31%; Belgium, 29%; and Israel, 29%; increased slightly to $1.6 billion. Imports of rough natural diamond, 53% from the Republic of South Africa, decreased 4% in caratage and slightly in value. A 5% increase in South African carat value, from $325 to $341, was indicated.

The total value of emerald imports decreased 10% to $139 million. The total value of ruby imports decreased 13% to $70 million, and sapphire imports decreased 15% to $71 million. Average carat values increased 45% for emerald to $51. Average carat values increased 15% for ruby to $19 and decreased 18% for sapphire to $19.

Export value of all gem materials other than diamond increased 12% to $60.1 million. Of this total, other precious and semiprecious stones, cut but unset, were valued at $35.4 million; other natural precious and semiprecious stones, not set or cut, $12.2 million; synthetic gem stones and materials for jewelry, cut, $4.1 million; pearls, natural, cultured, and imitation, not strung or set, $3.6 million; and other, $4.2 million. Reexports of all gem materials, other than diamond, decreased 24% to $39.9 million. Reexport categories were precious and semiprecious stones, cut but unset, $22.9 million; and other, $16.9 million.

Table 3.—U.S. exports and reexports of diamond (exclusive of industrial diamond), by country

Country	1984 Quantity (carats)	1984 Value (millions)	1985 Quantity (carats)	1985 Value (millions)
Exports:				
Belgium-Luxembourg	128,521	$65.0	179,829	$82.3
Canada	19,043	11.0	23,012	12.2
France	2,153	7.1	1,763	8.3
Germany, Federal Republic of	3,677	3.7	2,937	2.5
Hong Kong	63,320	64.8	42,302	61.7
Israel	101,532	53.0	109,842	56.7
Japan	29,043	54.2	31,218	46.5
Singapore	3,734	9.2	2,039	4.4
Sweden	9	(1)	21	(1)
Switzerland	20,113	73.9	29,025	95.6
Thailand	3,813	2.4	5,226	2.8
United Arab Emirates	29	(1)	--	--
United Kingdom	5,707	14.2	3,966	4.0
Other	4,468	4.4	6,865	8.3
Total	385,162	362.9	438,045	385.3
Reexports:				
Belgium-Luxembourg	[2]1,072,640	57.4	839,257	56.7
Canada	7,834	.6	4,243	.3
China	17,784	.7	8,120	.4
Germany, Federal Republic of	32,530	1.5	53,318	1.6
Hong Kong	27,244	17.6	42,021	14.0
India	228,205	6.5	153,323	3.9
Israel	126,400	26.3	196,743	31.4
Japan	98,398	8.5	114,713	8.5
Netherlands	21,793	3.4	106,819	5.2
Switzerland	110,486	46.3	41,953	41.2
United Kingdom	93,442	32.6	297,044	12.2
Other	50,592	10.3	82,324	10.6
Total	1,887,348	211.7	1,939,878	186.0

[1]Less than 1/10 unit.
[2]Artificially inflated in 1984 by auction of approximately 1 million carats of U.S. Government stockpile industrial diamond stones with subsequent reexports as gem stones to Belgium-Luxembourg and India.

Source: Bureau of the Census.

Table 4.—U.S. imports for consumption of diamond, by kind, weight, and country

Kind, weight, and country of origin	1984 Quantity (carats)	1984 Value[1] (millions)	1985 Quantity (carats)	1985 Value[1] (millions)
Rough or uncut, natural:[2]				
Belgium-Luxembourg	160,100	$32.8	130,996	$32.9
Brazil	1,431	.3	90,280	6.6
Cape Verde	--	--	21	(3)
Colombia	216	.2	--	--
Congo	12,977	4.4	80	.2
Guyana	2,475	.1	636	(3)
Israel	14,880	4.7	27,198	8.3
Netherlands	4,675	4.1	9,643	8.0
South Africa, Republic of	794,912	258.3	555,907	189.4
Switzerland	7,748	7.2	15,106	10.4
United Kingdom	22,125	4.6	116,601	52.0
Venezuela	34,811	2.3	21,036	.8
Other	28,163	6.9	75,309	8.9
Total	1,084,513	325.9	1,042,813	317.5
Cut but unset, not over 0.5 carat:				
Belgium-Luxembourg	1,424,655	433.6	1,466,325	444.8
Brazil	20,567	6.0	22,790	2.5
Canada	38,567	5.2	19,607	6.6
Hong Kong	100,017	20.3	146,416	39.4
India	3,107,794	544.8	2,667,906	486.8
Israel	1,113,127	399.5	1,237,123	448.2
Malaysia	21,949	7.8	17,772	6.0
Netherlands	56,924	23.5	85,811	26.9
South Africa, Republic of	38,301	23.8	48,074	16.9
Switzerland	56,670	23.8	153,329	38.7
United Kingdom	33,332	15.3	35,138	13.4

See footnotes at end of table.

Table 4.—U.S. imports for consumption of diamond, by kind, weight, and country —Continued

Kind, weight, and country of origin	1984 Quantity (carats)	1984 Value[1] (millions)	1985 Quantity (carats)	1985 Value[1] (millions)
Cut but unset, not over 0.5 carat —Continued				
Other	44,030	$16.0	68,754	$22.2
Total	6,055,933	1,519.6	5,969,045	1,552.4
Cut but unset, over 0.5 carat:				
Belgium-Luxembourg	410,638	379.8	369,838	314.7
Hong Kong	13,697	22.5	24,259	37.0
India	83,415	23.2	47,709	16.1
Israel	342,221	259.5	439,038	340.9
Netherlands	32,846	33.6	34,951	35.5
South Africa, Republic of	61,595	89.8	76,025	77.4
Switzerland	56,618	134.0	46,098	148.5
United Kingdom	34,643	68.9	46,832	75.1
Other	51,200	48.6	54,397	91.5
Total	1,086,873	1,059.9	1,139,147	1,136.7

[1]Customs value.
[2]Includes some natural advanced diamond.
[3]Less than 1/2 unit.

Source: Bureau of the Census.

Table 5.—U.S. imports for consumption of natural precious and semiprecious gem stones, other than diamond, by kind and country

Kind and country	1984 Quantity (carats)	1984 Value (millions)	1985 Quantity (carats)	1985 Value (millions)
Emerald:				
Argentina	12,474	$1.3	122	([1])
Belgium-Luxembourg	10,092	2.8	106,895	$3.4
Brazil	197,367	13.8	219,068	6.0
Colombia	271,559	48.9	197,249	56.1
France	11,456	2.5	20,928	3.8
Germany, Federal Republic of	52,883	2.4	26,176	1.7
Hong Kong	114,630	11.3	317,142	10.8
India	3,220,565	16.7	1,413,167	11.0
Israel	162,559	19.6	101,683	11.5
Japan	28,516	1.4	12,661	1.4
Paraguay	25,790	([1])	--	--
South Africa, Republic of	3,118	.1	2,436	.4
Switzerland	103,859	20.8	163,048	23.9
Taiwan	2,758	([1])	1	([1])
Thailand	116,812	4.5	74,418	1.1
United Kingdom	20,008	4.6	20,403	2.8
Other	55,709	3.9	65,916	5.1
Total	4,410,155	154.6	2,741,313	139.0
Ruby:				
Austria	75,977	.1	99	([1])
Belgium-Luxembourg	14,246	1.9	11,381	1.7
Brazil	10,712	.1	18,993	([1])
Colombia	948	.2	4,701	.1
France	11,277	1.4	9,712	1.9
Germany, Federal Republic of	65,703	1.6	35,204	1.6
Hong Kong	71,857	5.5	110,033	3.7
India	226,782	1.8	221,923	1.3
Israel	99,663	2.1	42,921	1.2
Japan	33,146	.6	21,242	.5
Switzerland	81,943	12.6	296,877	15.6
Thailand	4,107,406	43.0	2,770,136	31.2
United Kingdom	21,208	6.1	33,713	6.4
Other	32,977	2.7	103,762	4.5
Total	4,853,845	79.7	3,680,697	69.7

See footnotes at end of table.

Table 5.—U.S. imports for consumption of natural precious and semiprecious gem stones, other than diamond, by kind and country —Continued

Kind and country	1984 Quantity (carats)	1984 Value (millions)	1985 Quantity (carats)	1985 Value (millions)
Sapphire:				
Australia	13,415	$0.4	1,070	(1)
Austria	1,186	(1)	122	(1)
Belgium-Luxembourg	20,436	1.8	32,047	$0.9
Brazil	13,209	.1	1,424	(1)
Canada	9,260	.6	2,717	.5
Colombia	1,647	(1)	2,057	.1
France	11,185	2.5	18,973	1.9
Germany, Federal Republic of	67,298	1.8	32,028	1.2
Hong Kong	98,180	3.8	166,329	4.8
India	175,855	1.7	92,456	1.0
Israel	71,286	1.6	56,909	1.2
Japan	45,737	1.3	50,770	.8
Korea, Republic of	22,478	.1	2,664	(1)
Singapore	22,955	.8	5,910	.4
Sri Lanka	28,999	2.7	32,464	1.5
Switzerland	87,879	15.7	431,909	17.0
Thailand	2,917,584	39.2	2,765,371	32.4
United Kingdom	36,973	6.6	60,549	6.1
Other	32,816	2.3	72,000	1.0
Total	3,678,378	83.0	3,827,769	70.8
Other:				
Rough, uncut:				
Australia		1.9		1.5
Belgium-Luxembourg		.4		(1)
Brazil		14.0		14.0
Canada		.1		(1)
Colombia		10.3		9.8
Hong Kong		.6		.9
Nigeria	NA	2.6	NA	.3
Pakistan		.5		.4
South Africa, Republic of		1.6		.2
Switzerland		.5		.1
United Kingdom		.6		.8
Zambia		.4		.3
Other		2.3		4.8
Total	NA	35.8	NA	33.1
Cut, set and unset:				
Australia		2.8		4.1
Brazil		32.7		10.5
Canada		1.3		1.0
China		5.0		4.5
Germany, Federal Republic of		12.0		12.3
Hong Kong		20.4		29.5
India	NA	6.1	NA	5.2
Japan		240.7		200.9
Switzerland		.7		4.7
Taiwan		5.4		6.2
Thailand		2.8		3.4
United Kingdom		1.5		1.7
Other		5.6		12.6
Total	NA	337.0	NA	296.6

NA Not available.
[1]Less than 1/10 unit.

Source: Bureau of the Census.

Table 6.—Value of U.S. imports of synthetic and imitation gem stones, including pearls, by country

(Million dollars)

Country	1984	1985
Synthetic, cut but unset:		
Austria	0.8	0.4
France	1.4	.9
Germany, Federal Republic of	5.5	5.5
Japan	1.4	.1
Korea, Republic of	9.4	7.1
Switzerland	3.6	2.2
Other	1.7	1.4
Total	23.8	17.6
Imitation:		
Austria	17.4	23.0
Czechoslovakia	1.8	1.7
Germany, Federal Republic of	6.0	8.9
Japan	4.5	6.3
Other	2.7	3.6
Total	32.4	43.5

Source: Bureau of the Census.

Table 7.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1984		1985	
	Quantity	Value	Quantity	Value
Diamonds:				
Rough or uncut[1]	1,085	325,851	1,043	317,584
Cut but unset	7,143	2,579,466	7,108	2,689,178
Emeralds: Cut but unset	4,410	154,644	2,741	139,045
Coral: Cut but unset, and cameos suitable for use in jewelry	NA	3,120	NA	2,224
Rubies and sapphires: Cut but unset	8,532	162,677	7,509	140,618
Marcasites	NA	152	NA	256
Pearls:				
Natural	NA	2,823	NA	2,997
Cultured	NA	240,439	NA	228,004
Imitation	NA	6,171	NA	8,396
Other precious and semiprecious stones:				
Rough, uncut	NA	35,792	NA	33,168
Cut, set and unset	NA	90,421	NA	63,070
Synthetic:				
Cut but unset[2]	52,484	21,368	52,164	17,590
Other	NA	2,410	NA	2,457
Imitation gem stones	NA	26,182	NA	35,333
Total	XX	3,651,516	XX	3,679,920

NA Not available. XX Not applicable.

[1]Includes 2,084 carats of other natural diamond, advanced, valued at $700,100 in 1984, and 630 carats valued at $1,062,100 in 1985.

[2]Quantity in thousands of stones.

Source: Bureau of the Census.

WORLD REVIEW

De Beers Consolidated Mines Ltd.'s sales in 1985 through the Central Selling Organization were estimated to be $1.8 billion compared with $1.61 billion in 1984. Second half 1985 sales were unusually strong. Sales of colored gems also did very well.

Emeralds were produced in Australia, Colombia, Mozambique, Pakistan, the Republic of South Africa, the U.S.S.R., Zambia, and Zimbabwe. Sapphires were produced in Australia and Sri Lanka. Aquamarines were produced in Brazil and in very minor amounts in several other countries.

Australia.—Argyle Diamond Mines Joint Venture produced a total of about 17 million carats from its alluvial operation before the operation was closed in October. The second phase, production from the AK-1 kimberlite pipe, commenced on schedule in December. The firm estimated that the

AK-1 deposit would produce about 25 million carats per year for about 20 years.[2]

Botswana.—The new Jwaneng Mine expanded its diamond production. While mining was centered in the middle lobe, stripping proceeded on the northeastern lobe. The ore grade increased by 23% at the Jwaneng Mine, by 30% at the Letlhakane Mine, and by 8% at the Orapa Mine.

Burma.—The Ministry of Mines carried out exploration for diamonds by test pitting and drilling. It discovered 68 diamonds with a total weight of 65.31 carats in the period April 1, 1984, to December 31, 1984. Most of these were industrial diamonds.

Demand for Burmese rubies, particularly the bright red, continued to be strong. Very little material of comparable quality was available from other producers, such as Kenya, Tanzania, and Pakistan, in 1985. Rubies from Afghanistan were comparable but their availability was limited.

Guinea.—Diamonds from the Aredor project reached the New York market in midyear after some delay caused by adverse mining conditions. Société Mixte Aredor-Guinea was granted the sole right to explore and mine within its concession. Prior to this, private Guinean citizens could also mine in the concession. The private sector partners will market all the diamonds until the loans are paid off, after which the Government of Guinea will have the right to sell 30% of the rough gem diamonds and 50% of the rough industrial diamonds. The project was scheduled to produce from 250,000 to 500,000 carats per year.[3]

India.—The Indian diamond industry was almost exclusively dependent on imports of rough diamonds because domestic production usually totals under 15,000 carats. Imports of rough diamonds for Indian fiscal year 1983-84 totaled 28.4 million carats, the bulk of which came from De Beers. India's efforts to import diamonds directly from producers was of limited success. Some direct imports from Botswana, Ghana, and Sierra Leone were arranged. Indian exports of cut and polished diamonds for Indian fiscal year 1983-84 totaled 5.65 million carats, making India the world's leading diamond exporter, and diamonds India's largest single export item. Nearly 45% of the diamonds was exported to the United States. Japan was the second largest buyer, accounting for 11%, much less than that of the United States.

In response to foreign competition, the Indian industry announced plans to introduce foreign technology and machinery into what had been a cottage industry and was considering the production of sawn diamonds. The Government of India reduced duties on diamond cutting machinery and tools. Plans for a public-private joint venture to build a 1,300-acre self-contained diamond industrial park in Surat were announced.

India opened its first diamond exchange in Bombay on February 25. Titled the Bharat Diamond Bourse, it enrolled 150 members and provided them with customs clearance facilities and a vault for storing consignments.

The Government of India staged a series of income tax raids on diamond traders to seize records and diamond stocks as a part of its overall campaign against Government corruption and the underground economy. The industry responded by stopping all rough diamond imports and closing down operations. After a month of negotiations between the Government and the industry, activity resumed.[4]

Israel.—Imports of rough diamonds in the period January-October 1985 were $919 million, up 28.4% over the same period in 1984. Exports of cut and polished diamonds in the period January-October 1985 were $1,034 million, up 20.4% over the same period in 1984.

Namibia.—The Government-established Thirion commission of inquiry that had been investigating allegations of corruption and misappropriation of funds in the diamond industry for several years obtained evidence that the Diamond Board had not been exercising its regulatory powers over diamond mining as was originally intended. Interest centered on the alleged serious undervaluation of taxable diamond exports and on the excessive depletion of reserves in the diamond deposits. The Thirion commission's major purpose was to recommend ways of obtaining a greater degree of governmental control over the mining industry.

Pakistan.—The Pakistani Federal Bureau of Statistics reported that $1.5 million worth of gem stones was exported in the latest period, the fiscal year 1983-84, mainly to Hong Kong, the Federal Republic of Germany, the United States, and the United Kingdom. The exports, by type, included 130,282 kilograms of rough emeralds and 326 kilograms of cut emeralds, 6,062 kilograms of rough rubies and 3,912 kilograms of cut rubies, and 430 kilograms of rough sapphires and 865 kilograms of cut sapphires.

Table 8.—Diamond (natural): World production, by country[1]

(Thousand carats)

Country	1981 Gem	1981 Industrial	1981 Total	1982 Gem	1982 Industrial	1982 Total	1983 Gem[2]	1983 Industrial	1983 Total	1984[p] Gem[2]	1984[p] Industrial	1984[p] Total	1985[e] Gem[2]	1985[e] Industrial	1985[e] Total
Angola	1,050	350	1,400	915	310	1,225	775	259	1,034	760	250	[e]1,000	375	250	625
Australia	21	184	206	[r]274	[r]183	[r]457	3,720	2,480	6,200	3,414	2,276	5,690	[3]4,235	[3]2,824	[3]7,059
Botswana	744	4,217	4,961	1,165	6,604	7,769	4,829	5,902	10,731	5,810	7,104	12,914	5,800	7,100	12,900
Brazil	163	926	1,089	80	450	530	80	450	530	200	550	750	200	800	1,000
Central African Republic	209	103	312	186	91	277	230	65	295	236	101	337	236	101	337
China[e]	190	760	950	200	800	1,000	200	800	1,000	200	800	1,000	200	800	1,000
Ghana	85	751	836	68	616	684	34	306	340	35	315	[e]350	65	585	650
Guinea[e]	12	26	38	13	27	40	23	17	40	[3]34	[3]14	[3]48	105	7	[3]112
Guyana[e]	4	6	10	[r]4	[r]7	11	5	[r]5	[r]10	[r]6	[r]8	[r]14	4	7	11
India	14	2	16	11	2	13	12	2	14	[r]13	2	15	14	2	16
Indonesia[e]	3	12	15	3	12	15	5	22	27	5	22	27	5	22	27
Lesotho	49	4	53	39	3	42	--	--	--	--	--	--			
Liberia	132	204	336	170	263	433	132	198	330	108	132	240	108	132	240
Namibia	1,186	62	1,248	963	51	1,014	915	48	963	884	46	930	894	47	941
Sierra Leone	208	97	305	203	87	290	242	103	345	240	105	[e]345	240	105	345
South Africa, Republic of:															
Finsch Mine	1,002	3,463	4,465	847	3,003	3,850	1,765	3,278	5,043	1,714	3,184	4,898	1,770	3,184	[3]4,954
Premier Mine	510	1,530	2,040	615	1,845	2,460	800	1,844	2,644	765	1,785	2,550	820	1,864	[3]2,684
Other De Beers' properties[4]	1,603	1,069	2,672	1,359	906	2,265	1,400	569	1,969	1,452	593	2,045	1,500	569	[3]2,069
Other	314	35	349	521	58	579	589	66	655	585	65	650	460	35	495
Total	3,429	6,097	9,526	3,342	5,812	9,154	4,554	5,757	10,311	4,516	5,627	10,143	4,550	5,652	[3]10,202
Swaziland	--	--	--	--	--	--	--	--	--	7	10	17	10	15	25
Tanzania	110	107	217	100	120	[e]220	183	78	261	186	80	266	186	80	266
U.S.S.R	2,100	8,500	10,600	2,100	8,500	10,600	3,700	7,000	10,700	4,300	6,400	10,700	4,400	6,400	10,800
Venezuela	102	388	490	99	394	[e]493	45	234	279	40	232	272	35	163	198
Zaire	[r]360	[r]6,801	[r]7,161	[r]308	[r]5,856	[r]6,164	3,356	8,627	11,982	5,169	13,290	18,459	5,493	14,124	19,617
World total	[r]10,171	[r]29,597	[r]39,768	[r]10,243	[r]30,188	[r]40,431	23,039	32,353	55,392	26,153	37,364	63,517	27,155	39,216	66,371

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Table includes data available through June 3, 1986. Total diamond output (gem plus industrial) for each country is actually reported except where indicated by a footnote to be estimated. In contrast, the detailed separate production data for gem and industrial diamond are Bureau of Mines estimates in the case of every country except Australia (1981-85), Central African Republic (1981, 1983-85), Guinea (1984), Liberia (1981, 1984), Sierra Leone (1981), and Venezuela (1981), for which source publications give details on grade as well as totals. The estimated distribution of total output between gem and industrial diamond is conjectural, and for most countries, is based on the best available data at time of publication.

[2]Includes near-gem and cheap-gem qualities.

[3]Reported figure.

[4]Other De Beers Group output from the Republic of South Africa includes Kimberley Pool, Koffiefontein Mine, and the Namaqualand Mines.

South Africa, Republic of.—The Minister of Finance announced a special temporary surcharge of 5% over and above the 20% surcharge already in effect on taxes paid by all domestic diamond and gold mines. The new surcharge was added in view of mining profits obtained owing to the favorable rand-dollar exchange rate in 1984. The Chamber of Mines, a mining trade association, responded by saying that any additional profits had been absorbed by increased capital expenditure.

De Beers reported about 95% of 1985 South African diamond production, or about 9.7 million carats. Its Finsch Mine, the largest diamond mine in the Republic of South Africa, produced 4.9 million carats, and its Premier Mine produced 2.7 million carats. Other sources indicate that in 1984, 73% of South African production was from Cape Province, 26% from Transvaal, and the balance from the Orange Free State.

The Finsch Mine worked slightly lower grade ore, in accordance with management's plan. The Premier Mine experienced no further collapse of the gabbro sill. Investigations indicated that retreatment of the mine's tailings pile appeared to be feasible, and the work was scheduled to begin during 1985.

Swaziland.—Trans Hex Co. was involved with its joint venture partner, the Swaziland Government, in a $5 million expansion of mining activity at its kimberlite pipe. The open pit extraction of industrial and low-quality gem diamonds, plus smaller amounts of good-quality gems, was expected to last at least 8 years. The expansion in capacity was expected to go on-stream in October 1985.

Zaire.—Société Minière de Bakwanga (MIBA) produced 6,896,000 carats in 1984 and exported 6,902,000 carats worth $57.9 million. MIBA invested $9.7 million in a new hydroelectric power station plus substantial sums on geological exploration and research, modernization of workers' housing, and improving the security of the operations.

Zambia.—The Government instituted new regulations on emerald mining in 1984, which were implemented in 1985. Prospecting and mining licenses must be obtained from the Ministry of Mines. Any company seeking a license must form a joint venture with the Government-owned Reserved Mineral Corp. holding a 55% majority of the shares. Several dozen local cooperatives have obtained licenses. The army and police have removed and will continue to remove illegal diggers from the emerald area until Reserved Mineral's new security service can take over completely.

TECHNOLOGY

Sumitomo Electric Co. perfected a technique for the mass production of large industrial diamonds from graphite. The graphite was subjected to ultrahigh pressure in the range of 50,000 to 60,000 atmospheres at a temperature of 1,400° C to 1,600° C for 100 hours. Attaining this critical temperature and pressure on a consistent basis was difficult, but was achieved. Heretofore, only small-sized diamonds could be mass produced. The firm planned to underprice natural diamond slightly and make its sales mainly to the semiconductor and precision toolmaking industries. Although the firm had no immediate plans for the production of gem diamonds, this breakthrough could clearly result in the production of gem diamonds in the near future.[5]

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[1]Arkansas Gazette. Texas Firm Willing To Spend $2 Million on Tests at Crater of Diamonds. Oct. 12, 1985, p. 2.

[2]Industrial Minerals (London). World of Minerals. No. 220, Jan. 1986, p. 8.

[3]Jewelers' Circular-Keystone. Upfront. V. 156, No. 6, Apr. 1985, p. G.

[4]Shor, R. What if India Offers Quality Diamonds at Bargain Rates? Jewelers' Circ.-Keystone, v. 155, No. 8, June 1985, pp. 187-201.

[5]Industrial Minerals (London). Synthetic Diamond Breakthrough. No. 213, June 1985, p. 10.

Gem Stones

By Gordon T. Austin[1]

The value of natural gem stones, mineral specimens, and freshwater pearls, natural and cultured, produced in the United States was estimated to be $9.3 million, an increase of 26% over that of 1985. Small mine owners and amateur collectors accounted for most of the production. Small mines produced tourmaline, jade, opal, sapphire, turquoise, agates, lapis lazuli, garnet, beryl, and quartz.

The combined value of synthetic and simulant gem stones was reported to be $10.3 million. This was the first year that the domestic production of synthetic and simulant gem stones was reported by the Bureau of Mines. Synthetic gem stones are manmade and have the same optical, physical, and chemical properties and the same appearance as the natural gem stone. Synthetic gem stones produced in the United States include ruby, sapphire, garnet, spinel, alexandrite, quartz, emerald, and diamond. Simulants are manmade gem stones that have an appearance similar to that of a natural gem stone but have different optical, chemical, and physical properties. The major gem stone simulant produced in the United States was cubic zirconia.

The gem stone materials are sold to wholesale and retail outlets, in gem and mineral shops, at gem and mineral shows, and to jewelry manufacturers.

Domestic Data Coverage.—Domestic production statistics for gem stones were developed by the Bureau of Mines from the "Gem Stones" survey, a voluntary survey of U.S. operations, and from Bureau estimates of amateur collectors' production. Of the 105 operations to which a survey request was sent, 93% responded, accounting for 78% of the total production.

The 105 operations surveyed in 1986 were an increase of about 144% compared with operations surveyed in 1985, and the response rate represents an increase of 182%. Production by the nonresponding operations and by amateur collectors was estimated based on information from published data, gem and mineral dealers, gem and mineral shows, and collectors.

DOMESTIC PRODUCTION

Mines and collectors in all 50 States produced natural gem stones and/or freshwater pearls with an estimated value of $1,000 or more in each State. Ten States supplied 84% of the total value of the natural gem material. The States, in order of declining value of production, were Arizona, Tennessee, North Carolina, Arkansas, Montana, California, Oregon, Idaho, Texas, and Wyoming. Production of synthetic and simulant gem stone materials was valued at $10.3 million. Seven firms, four in California and one each in three other States, accounted for the production. The States, in order of declining value of production, were California, Massachusetts, New Jersey, and Michigan.

Vortex Mining Co. of Utica, MT, completed construction of a sapphire washing plant situated on the continuation of the Yogo sapphire dike in central Montana. Most of the sapphires found by Vortex were the highly prized cornflower-blue color and less than 1 carat in size. The sapphires found to date have been cut either by Vortex or in Thailand. No rough material was offered for sale.[2]

The Dow Chemical Co.; Amselco Exploration Inc., a subsidiary of British Petroleum Co. of Canada; and Exmin Corp., a subsidiary of the Belgian company Sibeka (Société d'Entreprises et d'Investissements S.A.); conducted exploration for diamond on approximately 60,000 acres of land in Iron and Dickinson Counties, MI. The same three firms continued to explore for diamond in Wisconsin, and Exmin leased land for diamond exploration in Minnesota.

The joint venture between Lac Minerals Ltd. and Mobil Oil Co. for diamond exploration has not discovered any economically recoverable diamond deposits. However, exploration continued during 1986 in the State line district on the Colorado-Wyoming border. One kimberlite project was explored and evaluated to the extent that it was determined that the grade of the deposit, diamonds per ton of kimberlite, was sufficient to be of interest. However, it was determined that the quality of the diamonds recovered would not make the project profitable. Hanvey-Boulle Ltd., a mining company from Dallas, TX, submitted a plan to the State of Arkansas in October 1985 to sample the Crater of Diamonds State Park at Murfreesboro to determine the feasibility of constructing a diamond mining operation. A special committee, appointed by the Governor, completed a study of the proposed plan in late 1986. The committee recommended that the Governor appoint an "expert" committee of engineers and other mining experts to study the technical aspects of the proposed project. A committee of experts was appointed at yearend.[3] In June, a milestone was reached at the Crater of Diamonds State Park, when the 10,000th diamond was found since the park was established in 1972.[4]

In 1986, the world's largest diamond gem stone was cut and polished in the United States. The stone, known as the Zales Diamond and owned by Zales Corp., is a 535-carat, nontraditional shaped stone, which was cut from an 890-carat rough. In addition, 22 satellite stones, some as large as 20 carats, were cut from the same piece of rough, the origin of which was unclear. The world's largest star sapphire, 1,154 carats, was cut in the United States from a 1,905-carat rough reportedly found in the State of Idaho.[5] The world's largest cut gem stone, a smoky quartz that measures 10.0 by 5.6 by 4.0 inches, was cut in the United States from Brazilian rough. The stone was named the "Eye of the Idol" after the cut of the same name. The finished gem stone was valued at approximately $20,000. The world's largest gem stone by weight is the Brazilian Princess, a blue topaz, 5.7 by 5.7 by 4.7 inches, that weighs 21,005 carats. It was cut in the United States in 1976. A Miami Beach, FL, resident discovered an apple-sized pink sapphire at a dig-for-fee gem mine in North Carolina.

CONSUMPTION

Domestic gem and gem stone production was consumed in commercial and amateur gem and mineral collections, the production of objects of art, and the manufacture of jewelry. Value of U.S. apparent consumption increased 10% to $3,296 million.

U.S. imports for consumption of colored gem stones, led by emerald, ruby, and sapphire, increased 16% over those of 1985. The value of annual imports of emerald continued as the largest of any single colored gem stone. However, the combined value of imported ruby and sapphire exceeded that of emerald by 17%. The value of pearls imported into the United States continued to decline, decreasing 15% compared with that of 1985. The value of all imported gem stones, other than diamond, increased 7%.

According to data reported by the U.S. Department of Commerce, the sales value of all jewelry, costume jewelry, gold, and precious and semiprecious stones was about $24 billion, an increase of 11% over that of 1985. The same source reported that sales in jewelry stores increased 12% over that of 1985 to $12.4 billion.

PRICES

The U.S. price of a 1-carat, D-flawless diamond fluctuated between $9,500 and $16,500, and at yearend was $16,000. However, only a few hundred of these high-quality, 1-carat stones have been available each year, and their value has accounted for less than 0.2% of the total U.S. market. Prices of ruby, blue sapphire, and emerald experienced slight increases, while other colored stones experienced little change during the year. The average price of choker-length strands of 6.0- to 6.5-millimeter imported pearls increased approximately 10% compared with that of 1985. The price of American freshwater pearls increased 15% over that of 1985.

Table 1.—Prices of U.S. cut diamonds, by size and quality

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Price range per carat[3] in 1986	Average price per carat[4] June 1985	Average price per carat[4] June 1986
0.04-0.07	H-I	VS	$440- $420	$420	$420
.04- .07	H-I	SI_1	420- 380	380	380
.08- .14	H-I	VS	470- 460	460	460
.08- .14	H-I	SI_1	440- 420	420	420
.18- .22	H-I	VS	850- 680	750	750
.18- .22	H-I	SI_1	700- 600	700	700
.23- .29	H-I	VS	1,200- 900	900	11,750
.23- .29	H-I	SI_1	900- 750	750	900
.30- .37	H-I	VS	1,400- 1,000	1,175	1,475
.30- .37	H-I	SI_1	1,000- 800	900	1,250
.46- .49	H-I	VS	1,700- 1,300	1,475	--
.46- .49	H-I	SI_1	1,400- 1,100	1,250	--
.70- .89	H-I	VS	2,200- 1,800	2,000	2,175
.70- .89	H-I	SI_1	2,000- 1,400	1,600	1,800
1.00[5]	D	IF	16,500- 9,500	[6]11,500	[6]12,000
1.00	E	VVS_1	9,450- 4,100	[6]4,550	[6]5,000
1.00	G	VS	3,700- 2,500	[6]3,000	[6]3,150
1.00	H	VS_2	3,100- 2,000	[6]2,400	[6]2,525

[1]Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; and HG-I—traces of color.
[2]Clarity: IF—no blemishes; VVS_1—very, very slightly included; VS—very slightly included; VS_2—very slightly included, but more visible; and SI_1—slightly included.
[3]Rapaport Diamond Report. V. 9, No. 1, Jan. 10, 1986; and v. 9, No. 45, Dec. 26, 1986. These figures represent Rapaport Diamond Report opinion of New York wholesale asking price.
[4]Rapaport Diamond Report. V. 8, No. 26, July 12, 1985; and v. 9, No. 22, July 11, 1986.
[5]The Diamond Registry Bulletin. V. 17, No. 1, Dec. 1985, p. 8; and v. 17, No. 11, Dec. 1986, p. 8.
[6]The Diamond Registry Bulletin. V. 16, No. 7, July 1985, p. 8; and v. 17, No. 7, July 1986, p. 8.

Table 2.—Prices of U.S. cut colored gem stones, by size[1]

Gem stone	Carat weight	Price range per carat in 1986[2]	Average price per carat,[3] June 1986
Amethyst	1	$6- $10	$8
Aquamarine	1	100- 250	175
Emerald	1	1,350-3,000	1,775
Garnet, tsavorite	1	700-1,200	950
Ruby	1	1,800-3,300	2,150
Sapphire	1	450-1,300	725
Tanzanite	1	275- 450	354
Topaz	1	6- 9	7.50
Tourmaline, green[4]	1	40- 250	145
Tourmaline, pink[4]	1	50- 300	175

[1]Fine quality.
[2]Jewelers' Circular-Keystone. V. 157, No. 5, May 1986, p. 166; and v. 158, No. 2, Feb. 1987, p. 340. These figures represent a sampling of net prices that wholesale colored stone dealers in various U.S. cities charged their cash customers during the month.
[3]Jewelers' Circular-Keystone. V. 157, No. 8, Aug. 1986, p. 430.
[4]The Gemstone Registry Bulletin. V. 3, No. 11, Dec. 30, 1985, p. 8; and v. 4, No. 11, Dec. 31, 1986, p. 8.

FOREIGN TRADE

Export value of all gem materials was $584.9 million. Export value of all gem materials other than diamond decreased slightly to $59.3 million. Of this total, other precious and semiprecious stones, cut but unset, were valued at $31.5 million; other precious and semiprecious stones, not set or cut, $16.5 million; synthetic gem stones and materials for jewelry, cut, $4.7 million; pearls, natural, cultured, and imitation, not strung or set, $2.6 million; and other, $3.9 million. Reexports of all gem materials was $317.1 million. Reexports of all gem materials other than diamond increased 38% to

$55 million. Reexport categories were synthetic gem stones and materials for jewelry, cut, $0.5 million; precious and semiprecious stones, cut but not set, $44.5 million; and other precious and semiprecious stones, natural, not cut or set, $10 million.

The customs value of U.S. imports of rough and polished natural diamond, excluding industrial diamond, was up 15% to about $3.5 billion. Total imports of polished diamond, principally from Israel, 32%; Belgium, 28%; and India, 21%; were valued at $3.0 billion, an 11% increase over those of 1985. Imports of diamond greater than 0.5 carat, mostly from Israel, 34%; Belgium, 30%; and Switzerland, 14%; increased 10% in value to $1.3 billion. The value of imports in the less-than-0.5-carat category, mostly from India, 35%; Israel, 31%; and Belgium, 27%; increased 15% to $1.8 billion. The imports of rough diamond, 52% in value from the Republic of South Africa, decreased 19% in caratage and increased 19% in value. A 46% increase in South African carat value, from $341 to $499, was indicated by custom values.

The total customs value of imported emerald increased 10% to $152.4 million. The total value of ruby imports increased 20% to $83.5 million, and sapphire imports increased 34% to $95.1 million. Average carat values increased 8% for emerald to $55, 16% for ruby to $22, and 16% for sapphire to $22.

Table 3.—U.S. exports and reexports of diamond (exclusive of industrial diamond), by country

Country	1985 Quantity (carats)	1985 Value[1] (millions)	1986 Quantity (carats)	1986 Value[1] (millions)
Exports:				
Belgium-Luxembourg	179,829	$82.8	205,565	$108.9
Canada	23,012	12.2	19,176	13.7
France	1,763	8.3	3,148	6.9
Germany, Federal Republic of	2,937	2.5	2,286	3.1
Hong Kong	42,302	61.7	67,393	97.1
Israel	109,842	56.7	156,819	87.2
Japan	31,218	46.5	48,266	93.6
Singapore	2,039	4.4	5,810	7.5
Sweden	21	(2)	--	--
Switzerland	29,025	95.6	19,318	85.4
Thailand	5,226	2.8	16,958	6.4
United Kingdom	3,966	4.0	6,405	7.8
Other	6,865	8.3	9,915	8.0
Total	438,045	385.3	561,059	525.6
Reexports:[3]				
Belgium-Luxembourg	839,257	56.7	806,945	89.5
Canada	4,243	.3	6,516	.5
China	8,120	.4	10,392	.6
Germany, Federal Republic of	53,318	1.6	39,479	2.7
Hong Kong	42,021	14.0	59,969	20.3
India	153,323	3.9	127,221	3.3
Israel	196,743	31.4	210,333	59.2
Japan	114,713	8.5	105,827	8.8
Netherlands	106,819	5.2	68,079	5.1
Switzerland	41,953	41.2	30,797	35.1
United Kingdom	297,044	12.2	398,044	27.6
Other	82,324	10.6	102,348	9.4
Total	1,939,878	186.0	1,965,950	262.1

[1]Customs value.
[2]Less than 1/10 unit.
[3]Artificially inflated in 1985 and 1986 by auction of approximately 1 million carats of U.S. Government stockpile industrial diamond stones with subsequent reexports as gem stones to Belgium-Luxembourg and India.

Source: Bureau of the Census.

Table 4.—U.S. imports for consumption of diamond, by kind, weight, and country

Kind, weight, and country of origin	1985 Quantity (carats)	1985 Value[1] (millions)	1986 Quantity (carats)	1986 Value[1] (millions)
Rough or uncut, natural:[2]				
Belgium-Luxembourg	130,996	$32.9	418,782	$73.8
Brazil	90,280	6.6	29,444	3.4
Cape Verde	21	(3)	940	1.0
Congo	80	.2	--	--
Guyana	636	(3)	2,122	.3
Israel	27,198	8.3	45,240	12.2
Netherlands	9,643	8.0	7,318	3.7
South Africa, Republic of	555,907	189.4	452,973	225.9
Switzerland	15,106	10.4	22,629	8.1
United Kingdom	116,601	52.0	135,099	66.0
Venezuela	21,036	.8	37,096	1.0
Other	75,309	8.9	155,618	39.7
Total	1,042,813	317.5	1,307,261	435.1
Cut but unset, not over 0.5 carat:				
Belgium-Luxembourg	1,466,325	444.8	1,540,601	471.9
Brazil	22,790	2.5	23,013	7.5
Canada	19,607	6.6	30,485	4.0
Hong Kong	146,416	39.4	181,717	25.0
India	2,667,906	486.8	2,886,722	629.0
Israel	1,237,123	448.2	1,555,742	542.7
Malaysia	17,772	6.0	2,151	.7
Netherlands	85,811	26.9	28,296	11.0
South Africa, Republic of	48,074	16.9	139,692	19.1
Switzerland	153,329	38.7	75,629	28.7
United Kingdom	35,138	13.4	36,714	17.9
Other	68,754	22.2	172,873	21.9
Total	5,969,045	1,552.4	6,623,635	1,779.4
Cut but unset, over 0.5 carat:				
Belgium-Luxembourg	369,838	314.7	412,645	371.1
Hong Kong	24,259	37.0	34,236	45.4
India	47,709	16.1	50,098	13.2
Israel	439,038	340.9	529,226	429.0
Netherlands	34,951	35.5	24,673	23.8
South Africa, Republic of	76,025	77.4	65,180	73.7
Switzerland	46,098	148.5	48,898	169.6
United Kingdom	46,832	75.1	35,303	63.8
Other	54,397	91.5	60,871	55.9
Total	1,139,147	1,136.7	1,261,130	1,245.5

[1]Customs value.
[2]Includes some natural advanced diamond.
[3]Less than 1/10 unit.

Table 5.—U.S. imports for consumption of natural precious and semiprecious gem stones, other than diamond, by kind and country

Kind and country	1985 Quantity (carats)	1985 Value[1] (millions)	1986 Quantity (carats)	1986 Value[1] (millions)
Emerald:				
Argentina	122	(2)	437	(2)
Belgium-Luxembourg	106,895	$3.4	16,262	$3.1
Brazil	219,068	6.0	144,899	6.4
Colombia	197,249	56.1	199,935	52.3
France	20,928	3.8	10,674	3.0
Germany, Federal Republic of	26,176	1.7	60,471	3.2
Hong Kong	317,142	10.8	187,525	12.0
India	1,413,167	11.0	1,267,481	14.5
Israel	101,683	11.5	59,724	14.1
Japan	12,661	1.4	3,816	.8
South Africa, Republic of	2,436	.4	37,795	1.8
Switzerland	163,048	23.9	448,580	27.4
Taiwan	1	(2)	5,056	.3
Thailand	74,418	1.1	138,284	2.6
United Kingdom	20,403	2.8	20,461	6.1
Other	65,916	5.1	155,735	4.8
Total	2,741,313	139.0	2,757,135	152.4

See footnotes at end of table.

Table 5.—U.S. imports for consumption of natural precious and semiprecious gem stones, other than diamond, by kind and country —Continued

Kind and country	1985 Quantity (carats)	1985 Value[1] (millions)	1986 Quantity (carats)	1986 Value[1] (millions)
Ruby:				
Belgium-Luxembourg	11,381	$1.7	16,528	$4.3
Brazil	18,993	([2])	579	([2])
Colombia	4,701	.1	1,558	.1
France	9,712	1.9	4,563	1.9
Germany, Federal Republic of	35,204	1.6	14,412	.9
Hong Kong	110,033	3.7	85,954	3.4
India	221,923	1.3	247,687	2.1
Israel	42,921	1.2	35,433	1.3
Japan	21,242	.5	82,786	.4
Switzerland	296,877	15.6	256,921	16.5
Thailand	2,770,136	31.2	3,020,440	44.4
United Kingdom	33,713	6.4	19,496	5.8
Other	[r]103,861	4.5	82,677	2.4
Total	3,680,697	69.7	3,869,034	83.5
Sapphire:				
Australia	1,070	([2])	2,219	.2
Austria	122	([2])		
Belgium-Luxembourg	32,047	.9	19,152	3.0
Brazil	1,424	([2])	28,604	([2])
Canada	2,717	.5	4,643	.7
Colombia	2,057	.1	1,769	([2])
France	18,973	1.9	26,764	1.9
Germany, Federal Republic of	32,028	1.2	20,699	1.2
Hong Kong	166,329	4.8	132,201	4.9
India	92,456	1.0	127,121	1.0
Israel	56,909	1.2	40,322	1.2
Japan	50,770	.8	29,157	.5
Korea, Republic of	2,664	([2])	7,527	.1
Singapore	5,910	.4	946	([2])
Sri Lanka	32,464	1.5	22,149	2.2
Switzerland	431,909	17.0	370,520	21.0
Thailand	2,765,371	32.4	3,394,602	50.3
United Kingdom	60,549	6.1	60,736	5.5
Other	72,000	1.0	71,587	1.4
Total	3,827,769	70.8	4,360,718	95.1
Other:				
Rough, uncut:				
Australia		1.5		.6
Brazil		14.0		15.9
Colombia		9.8		7.5
Hong Kong		.9		1.1
Nigeria		.3		.3
Pakistan	NA	.4	NA	.6
South Africa, Republic of		.2		.7
Switzerland		.1		.4
United Kingdom		.8		.4
Zambia		.3		.7
Other		4.8		3.0
Total	NA	33.1	NA	31.2
Cut, set and unset:				
Australia		4.1		4.6
Brazil		10.5		11.0
Canada		1.0		.8
China		4.5		5.1
Germany, Federal Republic of		12.3		11.4
Hong Kong		29.5		29.3
India	NA	5.2	NA	4.8
Japan		200.9		161.9
Switzerland		4.7		2.9
Taiwan		6.2		12.1
Thailand		3.4		6.1
United Kingdom		1.7		2.5
Other		12.6		19.3
Total	NA	296.6	NA	271.8

[r]Revised. NA Not available.
[1]Customs value.
[2]Less than 1/10 unit.

Source: Bureau of the Census.

Table 6.—Value of U.S. imports of synthetic and imitation gem stones, including pearls, by country

(Million dollars[1])

Country	1985	1986
Synthetic, cut but unset:		
Austria	0.4	0.5
France	.9	.9
Germany, Federal Republic of	5.5	6.4
Korea, Republic of	7.1	9.0
Switzerland	2.2	2.8
Thailand	.8	1.5
Other	[r].7	1.0
Total	17.6	22.1
Imitation:		
Austria	23.0	34.4
Czechoslovakia	1.7	2.0
Germany, Federal Republic of	8.9	12.0
Japan	6.3	7.2
Other	3.6	7.0
Total	43.5	62.6

[r]Revised.
[1]Customs value.

Source: Bureau of the Census.

Table 7.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1985 Quantity	1985 Value[1]	1986 Quantity	1986 Value[1]
Diamonds:				
Rough or uncut[2]	1,043	317,584	1,307	435,029
Cut but unset	7,108	2,689,178	7,885	3,024,902
Emeralds: Cut but unset	2,741	139,045	2,757	152,396
Coral: Cut but unset, and cameos suitable for use in jewelry	NA	2,224	NA	2,291
Rubies and sapphires: Cut but unset	7,509	140,618	8,230	178,655
Marcasites	NA	256	NA	139
Pearls:				
Natural	NA	2,997	NA	3,406
Cultured	NA	228,004	NA	190,497
Imitation	NA	8,396	NA	9,655
Other precious and semiprecious stones:				
Rough, uncut	NA	33,168	NA	30,589
Cut, set and unset	NA	63,070	NA	65,392
Other	NA	NA	NA	8,102
Synthetic:				
Cut but unset[3]	52,164	17,590	63,532	22,074
Other	NA	2,457	NA	2,586
Imitation gem stones	NA	35,333	NA	52,939
Total	XX	3,679,920	XX	4,178,652

NA Not available. XX Not applicable.
[1]Customs value.
[2]Includes 630 carats of other natural diamond, advanced, valued at $1,062,100 in 1985, and 19,243 carats valued at $675,326 in 1986.
[3]Quantity in thousands of stones.

Source: Bureau of the Census.

WORLD REVIEW

De Beers Consolidated Mines Ltd.'s sales of uncut diamonds through the Central Selling Organization in 1986 were reported to be $2.56 billion compared with $1.83 billion in 1985, an increase of 40%. Sales of colored gem stones also increased.

Emerald was mined in Australia, Brazil, Colombia, Mozambique, Pakistan, the Republic of South Africa, the U.S.S.R., Zambia, and Zimbabwe. Sapphire was produced in Australia, Kenya, Sri Lanka, Tanzania, Thailand, and the United States. Aquamarine was produced in Afghanistan, Brazil, China, India, Nigeria, Pakistan, Tanzania, and the United States.

Angola.—The Government of Angola liquidated Companhia de Diamantes de Angola, the state-owned diamond mining company, and stopped mining diamonds. The Government formed a new corporation called Empresa Nacional de Diamantes de Angola to oversee Angolan diamond operations. Under the new system, Angola's diamond-bearing areas would be parceled into concessions and allocated to foreign companies. The Angolan Civil War totally disrupted the production of diamonds. Production fell from 1.5 million carats in 1979 to approximately 0.3 million carats in 1986. The average price fell from $158 per carat in 1980 to $45 per carat in 1986. Production costs increased greatly because the mining areas were not secured, and all equipment, supplies, and personnel had to be airlifted to the mines.[6]

Australia.—Argyle Diamond Mines Joint Venture completed the first year of production from the AK-1 lamproite pipe. The production of 29.2 million carats exceeded the planned production of 25 million carats. Argyle Diamond Sales Ltd. held the first sale of the rare pink diamond. The 56 cut stones sold for $1.54 million.[7]

Freeport Bow River Properties Inc. and Gem Exploration and Minerals Ltd. completed trial mining and feasibility studies on the Bow River alluvial diamond deposit. Plans were announced for construction of a mine and processing plant.

Australian Ores & Minerals Ltd. Div. and De Beers, Afro West Mining Ltd. and Aracca Petroleum Corp., and Ashton Mining Ltd. all continued exploration and testing of their diamond projects.

Australia accounted for about 70% of world sapphire production and 80% of the world opal production.[8]

China.—The Chinese Corp. of the People's Republic of China opened overseas offices of the China National Arts and Crafts Import and Export Corp. in the Federal Republic of Germany and the United States. The offices were established to improve the marketing of freshwater pearls.

Exports of rough and polished diamonds greatly increased the first half of 1986. Diamond exports from China were valued at $12 million during the period of January through June 1986, compared with $10 million for all of 1985.[9]

Ruby and sapphire deposits of record size were discovered in Wemchange County on Hainan Island off the southern coast of China. The largest find was an oriental sapphire deposit with reserves calculated at over 820 kilograms (4.1 million carats).

The Government of China and Chicester Diamonds Services, a firm associated with De Beers, signed a diamond prospecting agreement to explore for diamond in Shandong Province.

China also produced aquamarine, rock crystal, citrine, turquoise, peridot, sapphire, jet, and jade.

Ghana.—Ghana Consolidated Diamonds Ltd. began mining operations in January in the Birim Valley. The operations were established as the main source of gravel for milling, replacing the almost depleted Akwatia deposits. The continued use of obsolete, inefficient machinery resulted in a decrease in the number of carats produced. Gold was recovered as a byproduct of the diamond production.

The Government of Ghana published the Minerals and Mining Law of 1986, modifying existing laws. It ruled that all minerals in Ghana in their natural state would be vested in the Provisions National Defense Council for and on behalf of the people of Ghana. The Government shall also have the right of preemption of all minerals recovered in Ghana or any waters controlled by Ghana.

Guinea.—Bridge Oil Ltd. reported that Aredor diamond production was 203,788 carats, an increase of 54% compared with 1985 production. A single 100.2-carat, high-quality gem diamond from the project was sold for $3.62 million.[10] This was the most valuable diamond mined from Aredor to date. A second stone of 121.1 carats also was found but was not sold. Feasibility studies and design work were completed for a system to recover gold from the diamondiferous gravel.

Indonesia.—Australian-based Pelsart Resources NL, part of the Parry Corp., negotiated a joint venture with Ashton Mining NL to explore for diamond in the Pujon area of central Kalimantan. Alluvial diamonds have been found in this area for many years. The source of the diamonds and the delineation of the extent of the diamond-bearing alluvials are the primary objectives of the exploration.

Acorn Securities Ltd. of Australia reported that the joint venture of Acorn, 65%; P.T. Aneka Tambang, 20%; and Keymead Ltd. of London, 15%, the Indonesian state-owned mining company, was exploring allu-

Table 8.—Diamond (natural): World production, by country[1]

(Thousand carats)

Country	1982 Gem	1982 Industrial	1982 Total	1983 Gem	1983 Industrial	1983 Total	1984 Gem[2]	1984 Industrial	1984 Total	1985[p] Gem[2]	1985[p] Industrial	1985[p] Total	1986[e] Gem[2]	1986[e] Industrial	1986[e] Total
Angola	915	310	1,225	775	259	1,034	652	250	902	464	250	714	240	10	250
Australia	274	183	457	3,720	2,480	6,200	3,415	2,277	5,692	4,242	2,828	7,070	[3]13,145	[3]16,066	[3]29,211
Botswana	1,165	6,604	7,769	4,829	5,902	10,731	5,810	7,104	12,914	6,318	6,317	12,635	[3]9,610	3,500	13,110
Brazil	80	450	530	80	450	530	200	550	750	233	217	450	300	250	550
Central African Republic	186	91	277	230	65	295	236	101	337	245	105	350	245	105	350
China[e]	200	800	1,000	200	800	1,000	200	800	1,000	200	800	1,000	200	800	1,000
Ghana	68	616	684	34	306	340	35	311	346	65	585	650	60	540	600
Guinea	13	27	[e]40	23	17	[e]40	44	3	47	123	9	132	[3]190	[3]14	[3]204
Guyana[e]	4	7	11	5	5	10	6	8	14	4	7	11	3	6	[3]9
India	11	2	13	12	2	14	13	2	15	14	2	16	14	2	16
Indonesia[e]	3	12	15	5	22	27	5	22	27	5	22	27	5	22	27
Ivory Coast	--	--	--	--	--	--	--	--	--	--	--	--	4	6	10
Lesotho	39	3	42	--	--	--	--	--	--	--	--	--	--	--	--
Liberia	170	263	433	132	198	330	108	132	240	66	72	138	[3]63	[3]189	[3]252
Namibia	963	51	1,014	915	48	963	884	46	930	865	45	910	900	50	950
Sierra Leone	203	87	290	242	103	345	240	105	[e]345	243	106	349	215	100	315
South Africa, Republic of:															
Finsch Mine	847	3,003	3,850	1,765	3,278	5,043	1,714	3,184	4,898	1,770	3,184	4,954	1,800	3,172	4,972
Premier Mine	615	1,845	2,460	800	1,844	2,644	765	1,785	2,550	820	1,864	2,684	834	1,869	2,703
Other De Beers' properties[4]	1,359	906	2,265	1,400	569	1,969	1,452	593	2,045	1,500	569	2,069	1,529	567	2,096
Other	521	58	579	589	66	655	585	65	650	460	35	495	472	57	529
Total	3,342	5,812	9,154	4,554	5,757	10,311	4,516	5,627	10,143	4,550	5,652	10,202	4,635	5,665	10,300
Swaziland	--	--	--	--	--	--	7	10	17	9	12	21	17	23	40
Tanzania	100	120	[e]220	183	78	261	193	84	277	207	89	[r e]296	210	90	300
U.S.S.R.[e]	2,100	8,500	10,600	3,700	7,000	10,700	4,300	6,400	10,700	4,400	6,400	10,800	4,400	6,400	10,800
Venezuela	99	394	[e]493	45	234	279	40	232	272	35	180	215	40	195	235
Zaire	308	5,856	6,164	3,355	8,627	11,982	5,169	13,290	18,459	5,493	14,124	19,617	4,661	18,643	[3]23,304
World total	10,243	30,188	40,431	23,039	32,353	55,392	26,073	37,354	63,427	27,781	37,822	65,603	39,157	52,676	91,833

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Table includes data available through June 2, 1987. Total diamond output (gem plus industrial) for each country is actually reported except where indicated by a footnote to be estimated. In contrast, the detailed separate production data for gem and industrial diamond are Bureau of Mines estimates in the case of every country except Australia (1982-86), Central African Republic (1983-85), Guinea (1984-86), and Liberia (1984-86), for which source publications give details on grade as well as totals. The estimated distribution of total output between gem and industrial diamond is conjectural, and for most countries, is based on the best available data at time of publication.

[2]Includes near-gem and cheap-gem qualities.

[3]Reported figure.

[4]Other De Beers Group output from the Republic of South Africa includes Kimberley Pool, Koffiefontein Mine, and the Namaqualand Mines.

vial diamond claims in the Danan Seran area of southern Kalimantan and had completed a successful sampling program. Results to date yielded 992 stones weighing 144.76 carats. The stones ranged in size from 0.01 to 2.31 carats, and 19 of the stones exceeded 1.0 carat. The stones appeared to be 95% gem quality.

South Africa, Republic of.—De Beers made the decision to deepen its operations and switch from the long-established block-caving system to sublevel caving in the Dutoitspan and Bultfontein Mines. The project would extend the economic life of both mines and would reduce labor costs. The two mines share a common shaft system. Both mines were developed about 100 years ago.

The Gravelotte emerald mine continued to produce a limited number of very-high-quality emeralds in 1986. The mine accumulated an inventory of 1.5 million carats because of the weakness of the market. The Republic of South Africa also produced aquamarine and tourmaline.

Syria.—The Ministry of Syrian Oil and Minerals Resources confirmed the existence of a project to exploit diamond deposits discovered in the Homs area.[11]

Zaire.—Diamond production set a record high for the second consecutive year. Production was reported to be 23,303,739 carats, an increase of about 19%. The average price per carat was $8.26, well above the $7.90-per-carat floor price established by the agreement entered into with De Beers in 1985.

TECHNOLOGY

The Gemological Institute of America perfected a new set of testing procedures to determine whether an amethyst is natural or synthetic. Polarized light is used to determine if Brazil law twinning is present. If Brazil law twinning is present, the stone is natural amethyst. In the absence of any twinning, a synthetic origin is probable, but further testing is needed to correctly identify the stone as synthetic. Angular or straight color zoning with colorless or violetish zones next to purple areas identify natural amethyst. The presence of only light and dark purple zoning or the complete absence of zoning indicates a synthetic stone. These procedures have made it possible for the first time for the average dealer to determine if stones represented as natural amethyst are truly natural.[12]

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[1]Physical scientist, Division of Industrial Minerals.

[2]Jewelers' Circular-Keystone. Gemstones. V. 158, No. 2, Feb. 1987, p. 337.

[3]Arkansas Gazette. Gem of a Plan Awaits Study. Feb. 8, 1987, p. 2.

[4]Murfreesboro Diamond. Nashville Man Finds Crater's 10,000th Gem. June 18, 1986, p. 1.

[5]Jewelers' Circular-Keystone. Gemstones. V. 157, No. 11, Nov. 1986, p. 159.

[6]———. V. 157, No. 9, Sept. 1986, p. 118.

[7]Where necessary, values have been converted from Australian dollars ($A) to U.S. dollars at the Dec. 3, 1986, rate of $A1.00=US$1.54.

[8]Australian Bureau of Mineral Resources. Australian Mineral Industry Annual Review. Preliminary Summary 1986. Gemstones, Feb. 1987.

[9]Page 158 of work cited in footnote 5.

[10]Where necessary, values have been converted from Australian dollars ($A) to U.S. dollars at the Dec. 3, 1986, rate of $A1.00=US$1.54.

[11]Mining Journal (London). Development. V. 308, No. 7903, Feb. 6, 1987, p. 95.

[12]Crowningshield, R., H. Cornelius, and C. W. Fryer. A Simple Procedure To Separate Natural From Synthetic Amethyst on the Basis of Twinning. Gems & Gemology, v. 22, No. 3, 1986, pp. 130-139.

Gem Stones

By Gordon T. Austin[1]

The value of natural gem materials, gem mineral specimens, and natural and cultured freshwater pearls produced in the United States was estimated to be $21.4 million, an increase of 130% over that of 1986. The significant increase reflects both a true increase in production and an increase in the number of producers surveyed. Small mine owners and professional and amateur collectors accounted for most of the production. Small mines produced tourmaline, jade, opal, sapphire, turquoise, agate, lapis lazuli, garnet, beryl, and quartz.

The combined value of synthetic and simulant gem stones was reported to be $15.3 million, an increase of 49% over that of 1986. The increase reflects an actual increase in production. Synthetic gem stones are manmade and have the same optical, physical, and chemical properties and the same appearance as the natural gem stone. Synthetic gem materials produced in the United States include ruby, sapphire, garnet, spinel, alexandrite, quartz, emerald, turquoise, lapis lazuli, coral, and diamond. Simulants are manmade gem materials that have an appearance similar to that of a natural gem material but have different optical, physical, and chemical properties. The gem simulants produced in the United States include turquoise, coral, lapis lazuli, malachite, and cubic zirconia. Cubic zirconia is the major simulant and is produced in colored and colorless varieties.

The gem stone materials are sold to wholesale and retail outlets, in gem and mineral shops, at gem and mineral shows, to cutting factories, and to jewelry manufacturers.

Domestic Data Coverage.—Domestic production statistics for gem materials were developed by the Bureau of Mines from the "Gems and Gem Stones Survey," a voluntary survey of U.S. operations, and from Bureau estimates of unreported production. Of the 267 operations to which a survey request was sent, 91% responded, accounting for 95% of the total production, 92% of the natural production, and 100% of the synthetic and simulant production.

The 267 operations surveyed in 1987 were an increase of about 154% compared with the number of operations surveyed in 1986. The response rate was essentially unchanged. Production by nonresponding operations and by professional and amateur collectors was based on information from published data, gem and mineral dealers, gem and mineral shows, and collectors.

DOMESTIC PRODUCTION

Production of natural gem materials in all 50 states exceeded a value of $1,000. Ten States supplied 82% of the total value of natural gem material produced. The States, in order of declining value of production, were Tennessee, California, Arizona, Montana, Maine, North Carolina, Idaho, Oregon, and New Hampshire. Production of synthetic and simulant gem materials was valued at $15.3 million. Twelve firms, five in California, four in Arizona, and one each in Massachusetts, Michigan, and New Jersey, produced synthetic and simulant gem material. The States, in order of declining value of production, were Massachusetts, California, New Jersey, Michigan, and Arizona.

Dia Em Resources Ltd. and LKA International Inc. continued to evaluate the emerald occurrences on their Rist and Ellis Mines at Hiddenite, NC. LKA designed and built a beryllometer to assist in sorting emeralds from waste materials. The beryllometer contains a nuclear source material that allows the emerald to be located by induced radiation. The emerald is not permanently affected by the radiation.

The largest diamond ever reported from California was recovered in northern California during 1987. The 14.33 carat alluvial diamond was recovered while panning for gold in Trinity County. The diamond is a knotted grayish-green semitranslucent industrial-grade stone with adamantine luster.

The Dow Chemical Co.; Amselco Exploration Inc., a subsidiary of British Petroleum Co. of Canada; and Exmin Corp., a subsidiary of the Belgian company Sibeka (Société d'Entreprises et d'Investissements S.A.), continued exploration for diamonds on leased lands in Michigan and Wisconsin. Exmin continued diamond exploration efforts in Minnesota.

Ashton Mining Co., a subsidiary of the Australian company Ashton Mining Inc., conducted exploration for diamond in the Crooked Creek and Goodnews Bay areas of Alaska during 1987. The work in the Goodnews Bay area resulted in the recovery of some microindustrial diamonds.

Diamond Co. NL, a wholly owned subsidiary of the Australian company Carr Boyd Minerals Ltd., negotiated mining leases and commenced diamond exploration work in northern Colorado. The joint venture between Lac Minerals Ltd. and Mobil Oil Co. continued its diamond exploration project in the State Line District on the Colorado-Wyoming border.

The Diamond Mining Task Force, appointed in 1986 by the Arkansas Governor to assist the State Parks, Recreation, and Travel Commission in determining if commercial diamond mining would be allowed at the Crater of Diamonds State Park, continued to collect data and undertake studies. The engineering firm of Howard, Needless, Tammer, and Bergendorf was hired to prepare an engineering and economic feasibility study of the proposed diamond mining project. At yearend, studies were under way and no decisions had been made concerning the mining project.

A major discovery of some of the finest topaz crystals ever found in the United States was made at a small pegmatite situated in Coos County, NH. The crystals were sharp, lustrous, blue to blue-green or bicolored blue and golden brown; many were flawless. The same deposit also yielded 30 kilograms of high-quality gem smoky quartz rough.

American Pearl Farms of Tennessee completed its first significant harvest of cultured freshwater pearls. American currently has five pearl farms under operation and acquired additional water acreage for a sixth farm to be established during 1988. The new farm is planned to be nine times larger than the existing farms.

The Zales Diamond, a 535-carat nontraditional-shaped stone, cut in the United States in 1986, was recut into a traditional shape. The loss in carat weight resulted in the stone's no longer being the world's largest polished diamond. A 3,500-carat blue sapphire was found in North Carolina, and a 5,500-carat North Carolina star sapphire was cut into a 3,000-carat stone. No value was established for either of the sapphires. The world's largest gem topaz, a 22,892-carat light golden topaz, was cut from a 26-pound waterworn crystal. The cushion-cut stone was purchased by the rockhound hobbyists of America for $40,000 and will be donated to the Smithsonian Museum of Natural History.

CONSUMPTION

Domestic gem materials production was consumed in commercial and amateur manufacture of jewelry, in gem and mineral collections, and in the production of objects of art. The value of U.S. apparent consumption was estimated to be $3,459 million, an increase of about 4%.

U.S. imports for consumption of colored gem stones, led by emerald, ruby, and sapphire, decreased slightly. The value of annual imports of emerald continued as the largest of any colored gem stone. The combined value of imported ruby and sapphire in 1987 was exceeded by the value of emerald by 6%. In 1986, the combined values of ruby and sapphire exceeded emerald by 17%.

The value of imports of other colored stones increased 21% compared with those of 1986, and the value of imported synthetic and imitation gem materials increased 28%. The value of pearls imported into the United States continued to decline for the third consecutive year, decreasing approximately 20% compared with that of 1986. The fluctuation in the value of imports is a direct reflection of purchasing trends in the marketplace.

PRICES

The U.S. price of a 1-carat, D-colored, flawless diamond fluctuated between $14,000 and $16,000, and was $14,000 at yearend. However, only a few hundred of these high-quality, 1-carat stones have been available each year, and their value has accounted for an insignificant percentage of the total value in the U.S. market. Prices of ruby, blue sapphire, and emerald rose 39%, 35%, and 45%, respectively, when their June 1987 prices were compared with their June 1986 prices. The price increases appear to be the result of a combination of things: the lower American dollar, the increased demand in the United States for quality stones, and a decrease in the supply of stones from the traditional producing areas. The price of American freshwater pearls increased slightly over that of 1986, and the demand remained firm.

Table 1.—Prices of U.S. cut diamonds, by size and quality

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Price range per carat,[3] 1987	Average price per carat[4]	
				June 1986	June 1987
0.04-0.07	H-I	VS	$440- $440	$420	$400
.04- .07	H-I	SI_1	420- 420	380	420
.08- .14	H-I	VS	470- 470	460	470
.08- .14	H-I	SI_1	440- 440	420	440
.18- .22	H-I	VS	680- 680	750	680
.18- .22	H-I	SI_1	600- 600	700	600
.23- .29	H-I	VS	900- 900	11,750	900
.23- .29	H-I	SI_1	750- 750	900	750
.30- .37	H-I	VS	1,175- 1,225	1,475	1,175
.30- .37	H-I	SI_1	950- 950	1,250	950
.46- .49	H-I	VS	1,425- 1,525	--	1,475
.46- .49	H-I	SI_1	1,300- 1,300	.	1,300
.70- .89	H-I	VS	2,175- 2,175	2,175	2,175
.70- .89	H-I	SI_1	1,900- 1,900	1,800	1,900
1.00[5]	D	IF	14,750-14,000	[6]12,000	[6]14,500
1.00	E	VVS_1	6,200- 5,875	[6]5,000	[6]6,000
1.00	G	VS_1	3,350- 3,475	[6]3,150	[6]3,250
1.00	H	VS_2	2,650- 2,950	[6]2,525	[6]2,550

[1]Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; and H-I—traces of color.
[2]Clarity: IF—no blemishes; VVS_1—very, very slightly included; VS—very slightly included; VS_2—very slightly included, but more visible; and SI_1—slightly included.
[3]Rapaport Diamond Report. V. 10, No. 1, Jan. 2, 1987; and v. 10, No. 45, Dec. 25, 1987. These figures represent Rapaport Diamond Report opinion of New York wholesale asking price.
[4]Rapaport Diamond Report. V. 9, No. 22, July 11, 1986; and v. 10, No. 23, June 26, 1987.
[5]The Diamond Registry Bulletin. V. 18, No. 1, Dec. 1986, p. 8; and v. 18, No. 1, Dec. 1987, p. 8.
[6]The Diamond Registry Bulletin. V. 17, No. 7, July 1986, p. 8; and v. 17, No. 6, July 1987, p. 8.

Table 2.—Prices of U.S. cut colored gem stones, by size[1]

Gem stone	Carat weight	Price range per carat, 1987[2]	Average price per carat[3]	
			June 1986	June 1987
Amethyst	1	$6- $10	$8	$8
Aquamarine	1	100- 250	175	175
Emerald	1	1,800-3,000	1,775	2,400
Garnet, tsavorite	1	500-1,200	950	950
Ruby	1	2,300-3,500	2,150	3,000
Sapphire	1	550-1,500	725	1,050
Tanzanite	1	275- 450	354	354
Topaz	1	6- 9	7.50	7.50
Tourmaline, red	1	60- 125	145	92.50

[1]Fine quality.
[2]Jewelers' Circular-Keystone. V. 159, No. 2, Feb. 1988, p. 400. These figures represent a sampling of net prices that wholesale colored stone dealers in various U.S. cities charged their cash customers during the month.
[3]Jewelers' Circular-Keystone. V. 159, No. 8, Aug. 1987, p. 442.

FOREIGN TRADE

Export value of all gem materials was $740.8 million. Export value of all gem materials other than diamond increased 36% to $80.4 million. Of this total, other precious and semiprecious stones, cut but unset, were valued at $45.4 million; other precious and semiprecious stones, not set or cut, $21.0 million; synthetic gem stones and materials for jewelry, cut, $5.8 million; pearls, natural, cultured, and imitation, not strung or set, $1.8 million; and other, $369.4 million. Reexports of all gem materials other than diamond increased 12% to $61.7 million. Reexport categories were synthetic gem stones and materials for jewelry, cut, $0.6 million; precious and semiprecious stones, cut but not set, $40.1 million; and other precious and semiprecious stones, natural, not cut or set, $1.31 million.

The customs value of U.S. imports of rough and polished natural diamond, excluding industrial diamond, was down slightly to about $3.4 billion. Total imports of polished diamond came principally from Israel, 32%; Belgium, 28%; and India, 21%. They were valued at $3.0 billion, essentially unchanged from those of 1986. Imports of diamond greater than 0.5 carat came mostly from Israel, 38%; Belgium, 36%; and Switzerland, 8%. They decreased 15% in value to $1.1 billion. Imports in the less-than-0.5-carat category came mostly from India, 35%; Israel, 32%; and Belgium, 24%. The value increased 6% to $1.9 billion. The imports of rough diamonds increased 5% in caratage and decreased slightly in value. The Republic of South Africa accounted for only 7% of the value of the imports, down from 52% in 1986. However, the average carat value of imports from the Republic of South Africa increased from $499 to $758.

The total customs value of imported emerald decreased 8% to $141.6 million. The total value of ruby imports decreased 29% to $59.4 million, and sapphire imports decreased 22% to $74.0 million. Average carat values increased 24% for emerald to $68, 14% for ruby to $25, and 27% for sapphire to $28.

Table 3.—U.S. exports and reexports of diamond (exclusive of industrial diamond), by country

Country	1986		1987	
	Quantity (carat weight)	Value[1] (millions)	Quantity (carat weight)	Value[1] (millions)
Exports:				
Belgium-Luxembourg	205,565	$108.9	162,009	$122.9
Canada	19,176	13.7	24,943	17.8
France	3,148	6.9	1,943	4.3
Germany, Federal Republic of	2,286	3.1	3,842	4.0
Hong Kong	67,393	97.1	100,365	148.2
Israel	156,819	87.2	172,634	110.8
Japan	48,266	93.6	62,404	144.1
Singapore	5,810	7.5	5,686	7.0
Switzerland	19,318	85.4	30,161	76.3
Thailand	16,958	6.4	14,028	9.3
United Kingdom	6,405	7.8	4,151	8.2
Other	9,915	8.0	5,221	7.5
Total	561,059	525.6	587,387	660.4
Reexports:[2]				
Belgium-Luxembourg	806,945	89.5	1,184,952	101.1
Canada	6,516	.5	5,424	.8
China	10,392	.6	2,062	.1
Germany, Federal Republic of	39,479	2.7	24,840	2.6
Hong Kong	59,969	20.3	82,491	27.2
India	127,221	3.3	84,893	2.9
Israel	210,333	59.2	199,579	70.3
Japan	105,827	8.8	95,919	7.2
Netherlands	68,079	5.1	47,313	3.2
Switzerland	30,797	35.1	39,765	57.7
United Kingdom	398,044	27.6	101,300	18.4
Other	102,348	9.4	74,333	16.2
Total	1,965,950	262.1	1,942,871	307.7

[1]Customs value.
[2]Artificially inflated in 1986 by auction of approximately 1 million carats of U.S. Government stockpile industrial diamond stones with subsequent reexports as gem stones to Belgium-Luxembourg and India.

Source: Bureau of the Census.

Table 4.—U.S. imports for consumption of diamond, by kind, weight, and country

Kind, range, and country of origin	1986 Quantity (carat weight)	1986 Value[1] (millions)	1987 Quantity (carat weight)	1987 Value[1] (millions)
Rough or uncut, natural:[2]				
Belgium-Luxembourg	418,782	$73.8	323,742	$82.0
Brazil	29,444	3.4	44,287	5.4
Cape Verde	940	1.0	--	--
Guyana	2,122	.3	--	--
Israel	45,240	12.2	28,029	7.3
Netherlands	7,318	3.7	2,930	2.9
South Africa, Republic of	452,973	225.9	37,870	28.7
Switzerland	22,629	8.1	5,185	12.6
United Kingdom	135,099	66.0	797,759	208.3
Venezuela	37,096	1.0	7,901	.7
Other	155,618	39.7	121,657	72.1
Total	1,307,261	435.1	1,369,360	420.0
Cut but unset, not over 0.5 carat:				
Belgium-Luxembourg	1,540,601	471.9	1,307,990	468.2
Brazil	23,013	7.5	33,352	8.7
Canada	30,485	4.0	21,750	8.8
Hong Kong	131,717	25.0	241,251	41.8
India	2,886,722	629.0	3,198,504	670.8
Israel	1,555,742	542.7	1,511,724	629.8
Malaysia	2,151	.7	--	--
Netherlands	28,296	11.0	51,959	13.6
South Africa, Republic of	139,692	19.1	14,461	11.8
Switzerland	75,629	28.7	73,268	40.3
United Kingdom	36,714	17.9	18,321	15.8
Other	172,873	21.9	144,708	33.3
Total	6,623,635	1,779.4	6,617,288	1,942.9
Cut but unset, over 0.5 carat:				
Belgium-Luxembourg	412,645	371.1	384,789	380.1
Hong Kong	34,236	45.4	12,361	21.3
India	50,098	13.2	110,019	28.0
Israel	529,226	429.0	468,132	406.1
Netherlands	24,673	23.8	8,403	11.6
South Africa, Republic of	65,180	73.7	27,654	41.3
Switzerland	48,898	169.6	37,583	81.7
United Kingdom	35,303	63.8	29,155	42.6
Other	60,871	55.9	56,345	47.5
Total	1,261,130	1,245.5	1,134,441	1,060.2

[1]Customs value.
[2]Includes some natural advanced diamond.

Table 5.—U.S. imports for consumption of natural precious and semiprecious gem stones, other than diamond, by kind and country

Kind and country	1986 Quantity (carats)	1986 Value[1] (millions)	1987 Quantity (carats)	1987 Value[1] (millions)
Emerald:				
Argentina	437	([2])	--	--
Belgium-Luxembourg	16,262	$3.1	30,190	$3.9
Brazil	144,899	6.4	112,194	7.0
Colombia	199,935	52.3	195,403	44.6
France	10,674	3.0	8,401	1.9
Germany, Federal Republic of	60,471	3.2	38,034	3.9
Hong Kong	187,525	12.0	170,853	15.2
India	1,267,481	14.5	1,231,033	17.0
Israel	59,724	14.1	60,942	19.4
Japan	3,816	.8	5,637	.6
South Africa, Republic of	37,795	1.8	5	([2])
Switzerland	448,580	27.4	58,789	18.3
Taiwan	5,056	.3	3,697	([2])
Thailand	138,284	2.6	104,058	3.0
United Kingdom	20,461	6.1	7,652	2.2
Other	155,735	4.8	48,032	4.6
Total	2,757,135	152.4	2,074,920	141.6

See footnotes at end of table.

Table 5.—U.S. imports for consumption of natural precious and semiprecious gem stones, other than diamond, by kind and country —Continued

Kind and country	1986 Quantity (carats)	1986 Value[1] (millions)	1987 Quantity (carats)	1987 Value[1] (millions)
Ruby:				
Belgium-Luxembourg	16,528	$4.3	12,078	$0.7
Brazil	579	(2)	3,102	(2)
Colombia	1,558	.1	3,198	(2)
France	4,563	1.9	6,219	1.6
Germany, Federal Republic of	14,412	.9	18,267	.8
Hong Kong	85,954	3.4	42,687	3.6
India	247,687	2.1	302,323	.9
Israel	35,433	1.3	7,043	.6
Japan	82,786	.4	335,381	.5
Switzerland	256,921	16.5	41,492	14.1
Thailand	3,020,440	44.4	1,536,723	31.4
United Kingdom	19,496	5.8	11,523	2.9
Other	82,677	2.4	37,781	2.3
Total	3,869,034	83.5	2,357,817	59.4
Sapphire:				
Australia	2,219	.2	--	--
Austria	--	--	1,000	(2)
Belgium-Luxembourg	19,152	3.0	21,356	1.2
Brazil	28,604	(2)	2,580	(2)
Canada	4,643	.7	6,905	.7
Colombia	1,769	(2)	2,234	(2)
France	26,764	1.9	7,048	1.1
Germany, Federal Republic of	20,699	1.2	12,067	1.6
Hong Kong	132,201	4.9	63,684	5.4
India	127,121	1.0	84,973	.5
Israel	40,322	1.2	14,254	1.1
Japan	29,157	.5	48,460	.4
Korea, Republic of	7,527	.1	9,793	(2)
Singapore	946	(2)	7	(2)
Sri Lanka	22,149	2.2	55,241	3.1
Switzerland	370,520	21.0	46,786	11.3
Thailand	3,394,602	50.3	2,121,376	42.7
United Kingdom	60,736	5.5	110,112	3.9
Other	71,587	1.4	37,847	1.0
Total	4,360,718	95.1	2,645,723	74.0
Other:				
Rough, uncut:				
Australia	NA	.6	NA	.8
Brazil		15.9		20.7
Colombia		7.5		5.5
Hong Kong		1.1		1.4
Nigeria		.3		.2
Pakistan		.6		1.2
South Africa, Republic of		.7		.3
Switzerland		.4		.1
United Kingdom		.4		(2)
Zambia		.7		.1
Other		3.0		3.8
Total	NA	31.2	NA	34.1
Cut, set and unset:				
Australia	NA	4.6	NA	6.1
Brazil		11.0		17.2
Canada		.8		.6
China		5.1		2.7
Germany, Federal Republic of		11.4		13.7
Hong Kong		29.3		28.7
India		4.8		5.7
Japan		161.9		128.8
Switzerland		2.9		3.0
Taiwan		12.1		11.1
Thailand		6.1		11.7
United Kingdom		2.5		1.0
Other		19.3		21.2
Total	NA	271.8	NA	251.5

NA Not available.
[1]Customs value.
[2]Less than 1/10 unit.

Source: Bureau of the Census.

Table 6.—Value of U.S. imports of synthetic and imitation gem stones, including pearls, by country

(Million dollars[1])

Country	1986	1987
Synthetic, cut but unset:		
Austria	0.5	1.3
France	.9	.8
Germany, Federal Republic of	6.4	9.2
Japan	9.0	1.8
Korea, Republic of	2.8	11.6
Switzerland	1.5	4.6
Other	1.0	5.0
Total	22.1	34.3
Imitation:		
Austria	34.4	50.7
Czechoslovakia	2.0	2.1
Germany, Federal Republic of	12.0	7.1
Japan	7.2	3.7
Other	7.0	8.0
Total	62.6	71.6

[1]Customs value.

Source: Bureau of the Census.

Table 7.—U.S. imports for consumption of precious and semiprecious gem stones

(Thousand carats and thousand dollars)

Stones	1986		1987	
	Quantity	Value[1]	Quantity	Value[1]
Diamonds:				
Rough or uncut[2]	1,307	$435,029	1,369	$420,004
Cut but unset	7,885	3,024,902	7,752	3,003,090
Emeralds: Cut but unset	2,757	152,396	2,075	141,575
Coral: Cut but unset, and cameos suitable for use in jewelry	NA	2,291	NA	3,060
Rubies and sapphires: Cut but unset	8,230	178,655	5,004	133,396
Marcasites	NA	139	NA	766
Pearls:				
Natural	NA	3,406	NA	3,879
Cultured	NA	190,497	NA	151,854
Imitation	NA	9,655	NA	6,259
Other precious and semiprecious stones:				
Rough, uncut	NA	30,589	NA	34,079
Cut, set and unset	NA	65,392	NA	78,215
Other	NA	8,102	NA	13,716
Synthetic:				
Cut but unset[3]	63,532	22,074	82,697	30,958
Other	NA	2,586	NA	3,858
Imitation gem stones	NA	52,939	NA	65,311
Total	XX	4,178,652	XX	4,089,520

NA Not available. XX Not applicable.
[1]Customs value.
[2]Includes 19,243 carats valued at $675,326 in 1986.
[3]Quantity in thousands of stones.

Source: Bureau of the Census.

WORLD REVIEW

De Beers Consolidated Mines Ltd.'s sales of uncut diamonds through the Central Selling Organization in 1987 were reported to be a record $3.07 billion compared with $2.56 billion in 1986, an increase of approximately 20%. Sales of colored gem stones also remained very strong.

Emerald was mined in Australia, Brazil, Colombia, Mozambique, Pakistan, the Republic of South Africa, the U.S.S.R., Zambia, and Zimbabwe. Sapphire was produced in Australia, Colombia, Kenya, Malawi, Nigeria, Sri Lanka, Tanzania, Thailand, and the United States. Aquamarine was produced in Afghanistan, Brazil, China, India, Nigeria, Pakistan, the Republic of South Africa, Tanzania, the United States, and Zambia. Ruby was produced in Afghanistan, Burma, India, Kenya, Sri Lanka, Tanzania, Thailand, and the United States.

Angola.—Sociedade Portugesa de Empreendimentas and Endeama (SPE), a Portuguese company, signed a 2-year agreement with the Angolan state mining company to mine and appraise diamonds. SPE will also assist in diamond exploration and training Angolan personnel.[2] Visitors to Angola reported that Cuban soldiers stationed there were becoming good sources for Angolan rough diamonds. Angolan diamond production continued to suffer because of the civil war.

Australia.—Argyle Diamond Mines Joint Venture completed the second year of production from the AK-1 lamproite pipe. Production of 30.3 million carats exceeded the planned production of 25 million carats. Argyle Diamond Sales Ltd. launched a major sales campaign in October 1987 directed at significantly increasing the international market for "cognac" or "champagne" colored diamonds. The terms are used to help market the brown-colored gem diamonds Argyle produces each year.[3] Additionally, Argyle formed a direct relationship with the India diamond-cutting trade to upgrade its diamond cutting technology to reduce the amount of Argyle near-gem material that is reclassified as industrial because of cutting difficulties.[4]

Freeport Bow River Properties Inc., the operating company of the Freeport-McMoRan Australia Ltd. and Gem Exploration and Minerals Ltd. joint venture, started construction of the Bow River alluvial diamond project. The project will process 4,000 metric tons per day of gravel. Diamond output is expected to exceed 600,000 carats per year. The diamond production is forecast to be 18% to 25% gem quality, 65% to 72% near-gem quality, and 8% to 10% bort. Also, Freeport-McMoRan Australia made an encouraging diamond discovery while drilling its project at Orraroo in South Australia. Work continued on the joint venture diamond project between Freeport-McMoRan Australia and Swan Resources at Springfield Basin in New South Wales.

Carr Boyd Minerals Ltd., in partnership with the De Beers subsidiary Stockdale Prospecting Ltd., and Afro-West Mining and Gem Exploration and Minerals Ltd. are continuing separate diamond exploration projects in various Australian locations. Capricorn Resources Australian NL initiated offshore diamond prospecting 150 kilometers northwest of Wyndham on the northern coast of Western Australia. Ashton Mining Ltd. continued the management of two ongoing diamond exploration ventures. Gem Exploration completed a bulk-sampling program on a diamond prospect near the Kununurra District of East Kimberley and investigated magnetic anomalies in West Kimberley. The results were not announced. Auridian Consolidated NL continued its diamond exploration activities in North Shaw, Halls Creek, Pilbara, Mount Behn, Van Emmereck, Mount Barnett, and Pentagon areas.

Production of sapphire in 1987 was estimated to be $18 million and represented about 75% of the rough sapphire imported into Thailand, the world's leading sapphire processing and marketing country. The opal production in 1987 was estimated to be $58 million and represented about 85% of the world production of natural opal.[5] The South Sea cultured pearl production was estimated at $20 million. Australia produces about 25% of all South Sea pearls; however, the production represents approximately 80% of the high-quality goods.[6]

Botswana.—Debswana, the Botswana diamond mining company that is a 50-50 joint venture between De Beers and the Government of Botswana, sold its significant diamond stockpile to De Beers. The stockpile was estimated to contain a high proportion of large, high-quality gem material. The purchase was paid for with a combination of cash and newly issued De Beers company shares. The Government of Botswana now owns 2.6% of De Beers and the right to appoint two members to the Board of Directors of De Beers and De Beers' Diamond Trading Co.[7] Botswana produced a record high 13.2 million carats in 1987; approximately 71% were gem quality.

Brazil.—Mining and production started on a diamond-rich kimberlite pipe in the State of Mato Grosso, approximately 20 kilometers from Julina. This is the first production from a kimberlite pipe in Brazil. All production to date was from secondary alluvial sources.

The new alexandrite deposit mine discovered in early 1987 near Italira in Gerau Mines was temporarily closed late in the year by the Government. The location produced a large quantity of fine gem-quality alexandrite and promises to be prolific for the next several years.[8]

Table 8.—Diamond (natural): World production, by country[1]

(Thousand carats)

Country	1983			1984			1985			1986[p]			1987[e]		
	Gem[2]	Industrial	Total	Gem[2]	Industrial	Total	Gem[2]	Industrial	Total	Gem[2]	Industrial	Total	Gem[2]	Industrial	Total
Angola	775	259	1,034	652	250	902	464	250	714	240	10	[e]250	180	10	190
Australia	3,720	2,480	6,200	3,415	2,277	5,692	4,242	2,828	7,070	13,145	16,066	29,211	[3]13,650	[3]16,683	[3]30,333
Botswana	4,829	5,902	10,731	5,810	7,104	12,914	6,318	6,317	12,635	9,610	3,500	13,110	[3]9,367	[3]3,840	[3]13,207
Brazil	90	450	530	200	550	750	233	217	450	310	315	625	320	325	645
Central African Republic	230	65	295	236	101	337	190	87	277	259	99	358	245	105	350
China[e]	200	800	1,000	200	800	1,000	200	800	1,000	200	800	1,000	200	800	1,000
Ghana	34	306	340	35	311	346	60	572	632	50	510	560	60	540	600
Guinea	23	17	[e]40	44	3	47	123	9	132	190	14	204	[3]163	[3]12	[3]175
Guyana[e]	5	5	10	6	8	14	4	7	11	3	6	[3]9	4	7	11
India	12	2	14	13	2	15	14	2	16	13	2	15	13	2	15
Indonesia[e]	5	22	27	5	22	27	5	22	27	5	22	27	5	25	30
Ivory Coast[e] [4]	NA	NA	NA	[r]20	[r]5	[r]25	[r]15	[r]5	[r]20	[r]10	[r]4	[r]14	15	5	20
Liberia	132	198	330	108	132	240	66	72	138	63	189	252	60	190	250
Namibia	915	48	963	884	46	930	865	45	910	[r]970	40	1,010	980	40	[3]1,020
Sierra Leone	242	103	345	240	105	345	243	106	349	215	100	315	200	100	300
South Africa, Republic of:															
Finsch Mine	1,765	3,278	5,043	1,714	3,184	4,898	1,770	3,184	4,954	1,821	3,208	5,029	1,455	2,701	[3]4,156
Premier Mine	800	1,844	2,644	765	1,785	2,550	820	1,864	2,684	882	1,977	2,859	772	1,713	[3]2,485
Other De Beers' properties[5]	1,400	569	1,969	1,452	593	2,045	1,500	569	2,069	1,428	529	1,957	1,427	546	[3]1,973
Other	589	66	655	585	65	650	460	35	495	342	41	383	409	30	439
Total	4,554	5,757	10,311	4,516	5,627	10,143	4,550	5,652	10,202	4,473	5,755	10,228	4,063	4,990	[3]9,053
Swaziland	--	--	--	7	10	17	9	12	21	17	23	[e]40	17	23	40
Tanzania	183	78	261	193	84	277	165	71	236	133	57	190	133	57	190
U.S.S.R.[e]	3,700	7,000	10,700	4,300	6,400	10,700	4,400	6,400	10,800	4,400	6,400	10,800	4,900	7,100	12,000
Venezuela	45	234	279	40	232	272	35	180	215	45	189	234	50	200	250
Zaire	3,355	8,627	11,982	5,169	13,290	18,459	4,032	16,127	20,159	4,661	18,643	23,304	4,670	18,680	23,350
Total	23,039	32,353	55,392	[r]26,093	[r]37,359	[r]63,452	26,233	39,781	66,014	39,012	52,744	91,756	39,295	53,734	93,029

[e]Estimated. [p]Preliminary. [r]Revised. NA Not available.

[1]Table includes data available through June 3, 1988. Total diamond output (gem plus industrial) for each country is actually reported except where indicated by a footnote to be estimated. In contrast, the detailed separate production data for gem and industrial diamond are Bureau of Mines estimates in the case of every country except Australia (1983-87), Botswana (1987), Central African Republic (1983-86), Guinea (1984-87), and Liberia (1984-86), for which source publications give details on grade as well as totals. The estimated distribution of total output between gem and industrial diamond is conjectural, and for most countries, is based on the best available data at time of publication.

[2]Includes near-gem and cheap-gem qualities.

[3]Reported figure.

[4]Estimates based on reported exports; excludes smuggled diamonds.

[5]Other De Beers Group output from the Republic of South Africa includes Kimberley Pool, Koffiefontein Mine, and the Namaqualand Mines.

Canada.—Dia Met Minerals of Vancouver continued to negotiate the financing for drilling the Jack kimberlite pipe in British Columbia. The pipe, located 55 kilometers north of Golden, British Columbia, contains minute gem-quality diamonds. Additional pipes in the area were sampled during the summer months. Information from the summer program is not available at this time.

Central African Republic.—African Star Mining Co., a subsidiary of the U.S. firm O'Hair Mining and Drilling Co., established the first large-scale mechanized diamond mining operation in the Central African Republic. Two mines and associated washing plants with an initial production rate of 2,500 cubic meters per day were under construction with production scheduled to begin in early 1988. The firm planned to increase production to 5,000 cubic meters per day in 60 to 90 days after startup. The estimated average grade of the project reserves is 0.4 carat per cubic meter that grade 95% gem quality. Annual production is forecast to be approximately 670,000 carats per year. The planned production of the two operations is 200% of the current total production of the Central African Republic.

China.—Boarara Mining Ltd. of Australia entered into an agreement with Southolme Ltd. of Hong Kong to explore and develop diamond projects in Hunan Province in China. Diamonds are found along the 1,000-kilometer length of the Yuan Jiang River terraces and channels, which are often 20 to 30 meters deep and up to 300 to 400 meters wide. The terraces have been mined for years by local farmers. A source pipe for the diamonds has not been found.

The Yuan Jiang River Alluvial Project, a joint venture between City Resources (Asia) Ltd. (a subsidiary of the Australian company City Resource Ltd.), China Hunan International Development Corp., and China Geology Import and Export Group, was formed to explore for and produce diamonds and gold on the lower reaches of the Yuan Jiang River. City Resources will supervise and control the work and the Chinese partners will furnish the labor force. The project area is approximately 120 square kilometers.

China produced diamonds, aquamarine, quartz crystal, citrine, turquoise, peridot, sapphire, jet, pearls, and jade.

Guinea.—Diamond production at Badge Oil's Aredor project decreased. The diamonds from Aredor are noted for their size and quality with an average price of $284 per carat in 1987. The stones average 0.82 carat; however, an average of 55 gems over 10 carats and 10 stones over 15 carats was recovered each month. During 1987, a 100.2-carat stone was sold for $1.6 million, and a 143-carat stone was sold for $3.9 million. Production costs have been lowered from $260 per carat in 1984 to about $90 per carat in 1987.[9]

India.—Orissa Mining Corp. discovered a large deposit of high-quality ruby in Orissa State. The deposit in the Jilligdhar area of the Kalahandi District has made the company one of the largest producers of gem stones in the country. The smaller fine-quality stones sell wholesale at about $1,000 per carat. The lower quality stones suitable for cabochons sell for a few hundred dollars per carat once they are cut. The Government-owned Mineral Development Corp. announced the discovery of a major new diamond deposit in Chittaurgarh Province. Early reports indicate that the deposit may be more productive than any area currently being mined.

Indonesia.—Acorn Securities Ltd. continued negotiations with the Government of Indonesia for a long-term production agreement for the South East Kalimantan diamond project. The first parcel of diamonds from the project, 1,032 carats, was evaluated at an average value of $170 per carat. The parcel of 6,342 stones was 97% gem quality. Acorn has a reserve base of 16 million cubic meters with an average grade of 0.2 carat of diamond, 80 milligrams of gold, and 20 milligrams of platinum per cubic meter.

Pakistan.—Production from a new emerald deposit in Gujjar Kallay in the Swat District resulted in an increase in the average monthly production from 350 carats to 4,000 carats. The stones are of very good quality. Pakistan continued to produce high-quality pink topaz, other gem topaz, and tourmaline.

Sierra Leone.—Diamond Corp., a subsidiary of De Beers, negotiated with the Government of Sierra Leone regarding a $3 million loan to rehabilitate the mining equipment for the National Diamond Mining Co.'s operations at Yengema.[10] Oliver Resources PLC, through its Sierra Leone subsidiary, was granted exclusive gold and diamond licenses on about 78 square kilometers of alluvial deposits along tributaries of the Pampana River.

South Africa, Republic of.—Thirteen additional marine diamond concessions were allocated off of the South African west coast. Fourteen companies or individuals are working the concessions that were issued in 1983 and 1984. The 1987 marine diamond production was estimated at 55,000 carats. De Beers began reactivation of the Koffiefontein Mine in the Orange Free State. The Mine, idle since 1982, is expected to be back in production in early 1988.

TECHNOLOGY

Shalev Computerized Systems Ltd. in Ramat Hasharon, Israel spent $2 million developing Robo Gem, a robot that automatically calculates the best possible shape and optimum yield of virtually all rough gems except diamond. The robot is more exact than human cutters, increases yields from rough stones an average of 10%, and reduces the cost of cutting by up to 70%.[11]

Zui Yehuda of Israel developed a method for treating diamonds that reportedly improves the clarity of fractured diamonds dramatically. In most diamonds the treatment can easily be identified with a 10X loupe. Many of the treated stones showed a yellow concentration of color along fractures. All of the treated stones displayed a distinct rainbow of color when viewed along the thin side of the fracture.[12]

Enhancement of all types of gem materials through chemical and physical means has become much more commonplace and has included a wider variety of gem materials in the past few years. Irradiation by the electromagnetic spectrum (X-rays, gamma rays, etc.) and by energetic particles (neutrons, electrons, alphas, etc.) is being used to enhance or change the color of diamonds, topaz, tourmaline, quartz, beryl, sapphire, zircon, scapolite, and pearls. Blue topaz is normally irradiated, but this does not imply that all of these gem materials are regularly irradiated.[13]

A number of gem materials can be enhanced by chemical treatment or impregnations. The treatment may alter the bulk of the gem material or only penetrate the surface. This includes bleaching, oiling, waxing, plastic impregnations, color impregnations, and dying. The treatments that alter only the surface of the gem material include surface coatings of various types, interference filters, foil backings, surface decoration, and inscribing. Chemical treatment is more widespread than the common dying of quartz, treatment of turquoise, and oiling of emeralds. Chemical treatment and impregnations have been used to enhance chalcedony, coral, ivory, pearl, tiger's eye, emerald, lapis lazuli, opal, ruby, sapphire, turquoise, beryl, quartz, jade, diamond, and amber.[14]

The oldest and most common method of gem material enhancement is heat treating. Heat treatment of gem materials was used in Greece and Rome well before the Christian Era. Heat treatment can cause color change, structural change, and improve clarity. In the past, heat treatment was common for quartz and gem corundum. Today, materials that are heat treated to enhance their appearance include sapphire, topaz, beryl, tourmaline, quartz, zircon, amber, diamond, and zoisite.[15]

Testing can determine if certain types of gem materials have been treated. However, not all types of treatments for all types of gem materials can be detected.

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[1]Physical scientist, Branch of Industrial Minerals.
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[4]———. V. 157, No. 5, May 1987, p. G.
[5]Australian Bureau of Mineral Resources. Australian Mineral Industry Annual Review. Preliminary Summary 1987. Gemstones, Feb. 1988.
[6]Jewelers' Circular-Keystone. South Sea Pearls. V. 158, No. 7, July 1987, p. 308.
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[12]Rapaport Diamond Report. Diamond Treatment Alert. No. 220, Dec. 4, 1987, p. 8.
[13]Nassau, K. Gemstone Enhancement. Buttersworth, 1984, pp. 46-60.
[14]Pages 61-78 of work cited in footnote 12.
[15]Pages 25-44 of work cited in footnote 12.

GEM STONES

By Gordon T. Austin[1]

Production value of natural gem materials in the United States during 1988 increased about 103% to $43.5 million. The materials produced included faceting rough, lapidary rough, carving material, specimen material, natural and cultured freshwater pearls, mother of pearl, and coral.

The combined production value of synthetic and simulant gem materials was reported to be $16.3 million, about a 7% increase over that of 1987. Synthetic gems are manmade and have the same optical, physical, and chemical properties and the same appearance as the natural gem that they represent. Synthetic gem materials produced in the United States include alexandrite, coral, diamond, emerald, garnet, lapis lazuli, quartz, ruby, sapphire, spinel, and turquoise. Simulants are manmade gem materials that have an appearance similar to that of a natural gem material but have different optical, physical, and chemical properties. The gem simulants produced in the United States include coral, cubic zirconia, lapis lazuli, malachite, and turquoise. Additionally, certain colors of synthetic sapphire and spinel, used to represent other gem stones, would be classed as simulants. Cubic zirconia is the major simulant and is produced in both colored and colorless varieties.

The gem materials were sold to wholesale and retail outlets, in gem and mineral shops, at gem and mineral shows, to cutting factories, and to jewelry manufacturers.

DOMESTIC DATA COVERAGE

Estimates of U.S. production were developed by the Bureau of Mines from the "Gems and Gem Stones Survey," a voluntary survey of U.S. operations, and from Bureau estimates of unreported production. Of the approximately 300 operations to which a survey request was sent, 82% responded, accounting for about 95% of the total production, 92% of the natural production, and 100% of the synthetic and simulant production.

The 300 operations surveyed in 1988 were an increase of about 14% compared with the number of operations surveyed in 1987. The response rate was essentially unchanged. Production by nonresponding operations, by professional collectors, and by amateur or hobbyist collectors was estimated by the Bureau. These estimates were based on information from published data, conversations with gem and mineral dealers, analyses of gem and mineral shows and sales statistics, and from information informally supplied by collectors. In the formal voluntary survey and the informal surveys, the Bureau is totally dependent upon the cooperation of the producers, brokers, dealers, and collectors. Individuals and companies have been very cooperative and forthcoming with information. The Bureau is very appreciative of this cooperation.

DOMESTIC PRODUCTION

Each of the 50 States produced at least $1,000 worth of gem materials. Ten States accounted for 95% of the total value of natural gem material produced. The States, in order of declining value of production, with their 1987 standing shown in parenthesis, were Tennessee (1), California (2), Arizona (3), Arkansas (4), Montana (5), Oregon (10), North Carolina (7), Idaho (8), Missouri (9), and Utah (19). Certain States were known for the production of a single gem material, i.e., Tennessee for freshwater pearls and Arkansas for quartz, whereas other States produced a wide variety of gem materials. Arizona is best known for the widest variety of gem materials. Production included agate, amethyst, antlerite, azurite, chrysocolla, fire agate, garnets, jade, malachite, onyx, peridot, petrified wood, precious opal, shattuchite, smithsonite, and turquoise. California, Idaho, Montana, and North Carolina also produced a wide variety of gem materials. North Carolina was the only State to have produced all four of the major gems: diamond, emerald, ruby, and sapphire.

The average production value of natural gem materials for the past 10 years was $12.5 million per year, with a high of $43.5 million in 1988 and a low of $6.9 million in 1980. The value of production for the past 10 years must be separated into two trends. The first trend was the period between 1979 and 1985, during which time approximately 24 producers were surveyed. Production averaged $7.5 million per year and was generally level. The second trend, 1986 to the present, production averaged $24.2 million and was the result of an increase of 1,150% in the number of producers surveyed.

The reported production value of synthetic and simulant gem materials was $16.3 million in 1988. The reported value of production increased 7%, however, the quantity of materials produced was significantly greater. A shift in the types of materials produced, primarily a change from colored cubic zirconia to colorless cubic zirconia, resulted in the production of lower value material. Thirteen firms, five in California, four in Arizona, and one each in Massachusetts, Michigan, New Jersey, and Ohio, produced synthetic and simulant gem material. The six States, in order of declining value of production, were Massachusetts, California, New Jersey, Michigan, Ohio, and Arizona.

Dia Em Resources Ltd. and LKA International Inc. completed the evaluation of their Rist and Ellis Emerald Mines at Hiddenite, NC. Using the beryllometer designed and built by LKA to assist in sorting emeralds from waste materials, approximately 3,000 carats of emerald was recovered. Analysis of all of the data collected indicated that the property did not have the degree of commercial viability required by LKA to continue to the next phase of the project. LKA plans to dispose of the property in 1989. It announced plans to also sell the two largest emerald crystals ever found in the United States, the 1,438-carat Stephenson and the 1,686.3-carat LKA crystal.

A 0.25-carat diamond was recovered during testing of a bulk ore sample from a North Carolina placer gold mine. The stone, positively identified by a mineralogist, was of industrial grade. The diamond was the seventh largest found in North Carolina, the largest being 4.33 carats. A company geologist stated that the find was interesting, but would not change the company's approach to the project.

The Dow Chemical Co. sold its 6-year-old diamond exploration project in the Upper Peninsula of Michigan to Crystal Exploration Inc. of Denver, CO, a subsidiary of Restech International Ltd. of Sydney, Australia. Dow discovered seven kimberlite pipes, and core drilling yielded a scattering of sand-grain-size diamonds. The diamonds were too few and too small for commercial production. A Dow spokesperson stated that more exploration and mining expertise was needed and that Dow was not a hard-rock mining company. Dow retained an option to take part in the exploration and development and to share in any profits.

Amselco Exploration Inc., a subsidiary of British Petroleum Co. of Canada, and Exmin Corp., a subsidiary of the Belgian company Sibeka (Société d'Entreprises et d'Investissements S.A.), continued exploration for diamonds on leased lands in Michigan and Wisconsin. Exmin continued diamond exploration efforts in Minnesota.

Three firms continued their diamond exploration project in the State Line District on the Colorado-Wyoming border.

The Diamond Mining Task Force, appointed in 1986 by the Arkansas Governor to assist the State Parks, Recreation, and Travel Commission in determining if commercial diamond mining would be allowed at the Crater of Diamonds State Park, recommended preliminary tests of the Park to determine the size of the reserve. Whether the area will be tested is up to the State Parks, Recreation, and Travel Commission. The recommended tests included drilling 10 angled core holes, about 2.5 inches in diameter and 850 feet long. The recommendations set a $350,000 price tag on the testing and stated that funding should come from private sources. Sunshine Mining Co., which started a joint venture called Arkansas Diamond Development Co., proposed to conduct an estimated $3 million in geological testing without any written guarantee that they will receive a commercial contract to mine diamonds. At yearend, studies were under way and no decisions had been made concerning the mining project.

Recent mining on private land at Opal Butte in Morrow County, OR, approximately 35 miles south of Heppner, produced a wide variety of very fine-quality opals. The varieties produced included hyalite, rainbow, contra luz, hydrophane, crystal opal, fire opal, blue opal, and dendritic opal. The opal occurs in rhyolite geodes in a decomposed perlite.[2]

A number of mines in southern Oregon started producing gem labordorite feldspar in 1988. The material comes in a wide range of colors, including yellow (the most common), pink, peach, salmon, red-orange, red-green, blue-green, and bicolored red and green. The best red faceting-grade material cuts some of the finest gem feldspar available. The mines also produce sunstone, a feldspar with schiller that is caused by millions of microscopic copper platelets on the cleavage planes of the feldspar. Sunstone is the State gem stone of Oregon.

American Pearl Farms of Tennessee completed its second significant harvest of cultured freshwater pearls. American currently has five pearl farms under operation and acquired additional water acreage for a sixth farm to be established during 1989. The new farm is planned to be nine times larger than the existing farms.

During December 1988, the largest and heaviest faceted gem stone ever cut was completed by a U.S. cutter. The 36,853-carat champagne colored topaz was cut from a 46-pound crystal mined in Brazil. The stone was cut in a diamond shape that was 13.75 inches long, 6.13 inches thick, and 4.75 inches wide. This was the third consecutive year in which record-size gem stones were cut in the United States. The unnamed stone was displayed for the first time at the Tucson Gem and Mineral Show in Tucson, AZ. The stone was offered for sale at $3 a carat, a total asking price of $110,600.

CONSUMPTION

Domestic gem materials production was consumed in commercial and amateur manufacture of jewelry, in gem and mineral collections, and in the production of objects of art. The value of U.S. apparent consumption was estimated to be a record high $3,703 million, an increase of about 7%. The average annual estimated consumption for the past 10 years was $2,506 million, with a high of $3,703 million in 1988 and a low of $1,238 million in 1979. The trend of estimated consumption for the past 10 years was one of continued growth with about 199% increase or an annual compounded growth rate of about 13%.

The U.S. estimated apparent consumption of diamonds increased about 25% in quantity and value to 8.3 million carats and $3.1 billion, respectively. The average annual apparent consumption of diamonds for the past 10 years was 4.6 million carats, with a high of 8.3 million carats in 1988 and a low of 1.2 million carats in 1981. The trend for apparent consumption, quantity and value, for the past 10 years was one of significant increase. Apparent consumption of diamonds increased about 153% in quantity and 216% in value over that period.

The estimated apparent consumption of colored stones, led by emerald, ruby, and sapphire, was valued at $353.8 million, an increase of 18%. The annual average consumption of colored stones for the past 7 years was valued at $316.3 million, with a high of $361.0 million in 1984 and a low of $252.4 million in 1982. The trend for apparent consumption of colored stones for the past 7 years was one of fluctuating increases and decreases, but the general tread was one of increased consumption.

The estimated apparent consumption of pearls—natural, cultured, and imitations—was $168.9 million, an increase of about 5%. This was the first increase after 3 years of decreases from the 7-year high in 1984. The value was about 82% greater than the 7-year low in 1982, but was about 7% less than the 7-year average of $181.8 million per year.

Estimated apparent consumption of synthetic and imitation gem materials decreased about 5% to $105.9 million. Average apparent consumption of synthetic and imitation gem materials for the past 7 years was $65.2 million, with a high of $109.1 million in 1987 and a low of $29.9 million in 1979. The trend for apparent consumption for the past 7 years was one of generally strong growth. Apparent consumption increased about 251% over the 7 years or averaged an annual compounded rate of growth of about 23% a year during the period.

It was estimated by the American Diamond Industry Association that U.S. jewelers sold 19.8 million pieces of diamond jewelry worth a total of $11.3 billion during 1988.

PRICES

The average U.S. wholesale asking price of the top 25 grades (D-H color and IF through VS_2 clarity) of a 1-carat diamond fluctuated between $6,200 and $7,000 and was $7,000 at yearend. The average value per carat of all grades, sizes, and types of gem-quality diamonds consumed in the United States, based on 1988 estimated apparent consumption, was $373, unchanged from that of 1987. The average value of diamonds consumed in the United States for the past 10 years, based on the estimated annual apparent consumption, was $490 per carat, with a high of $1,128 per carat in 1981 and a low of $298 per carat in 1979. The trend for the average annual value of diamonds consumed for the past 10 years was one of rapid increase from the 10-year low in 1979 to the 10-year high in 1981 followed by a general decline until an apparent stabilization in 1987.

The average yearend wholesale purchase price of a fine-quality 1-carat ruby, paid by retail jewelers on a per stone or memo basis, was $3,500, an increase of 17%. The average value of all rubies imported into the United States increased 19% to $30.06 per carat. The average annual value of all rubies imported into the United States for the past 7 years was $24.31 per carat, with a high of $34.04 per carat in 1982 and a low of $16.42 per carat in 1984. The trend for the value of ruby imports for the past 7 years was one of rapid decline, 52% for the period from 1982 to 1984. This was followed by a steady, moderate increase of 16% annual recovery.

The average yearend wholesale purchase price of a fine-quality 1-carat sapphire, paid by retail jewelers on a per stone or memo basis, was $1,400, an increase of 33%. The average value of all sapphires imported into the United States decreased 17% to $23.22 per carat. The average annual value of all sapphires imported into the United States for the past 7 years was $20.66 per carat, with a high of $27.97 per carat in 1987 and a low of $18.50 per carat in 1984. The trend for the value of sapphires imports for the past 7 years was one of fluctuating increases and decreases with the 1988 value ending the 7-year period about 5% below the beginning value in 1982.

The average yearend wholesale purchase price of a fine-quality 1-carat emerald, paid by retail jewelers on a per stone or memo basis, was $2,600, an increase of 8%. The average value of all emeralds imported into the United States increased 15% to $78.79 per carat. The average annual value of all emeralds imported into the United States for the past 10 years was $54.99 per carat, with a high of $78.79 per carat in 1988 and a low of $35.06 per carat in 1984. The trend for the value of emerald imports for the past 10 years was one of fluctuating increases and decreases from 1979 through 1984 followed by a steady moderate growth resulting in the 1988 average value being about 71% greater than 1979.

FOREIGN TRADE

Export value of all gem materials increased 36% to $1,010 million, the first time ever that exports have exceeded a billion dollars. The quantity of diamonds exported was essentially unchanged at 590,412 carats, however, the value of exports increased about 38% to $908.9 million. The average annual quantity of diamonds exported for the past 10 years was 369,264 carats, with a high of 590,412 in 1988 and a low of 184,871 in 1982. The trend for the quantity of diamonds exported for the past 10 years was one of moderate decline, 13%, during the first 4 years, followed by significant growth, 219%, from the low in the period from 1982 to 1988. The average annual value of diamond exports for the past 10 years was $521.6 million, with a high of $908.9 million in 1988 and a low of $292.8 million in 1982. The trend for the value of diamond exports for the past 10 years was one of significant decline, 113%, over 4 years, followed by 3 years of moderate growth, 32%, leading to 3

TABLE 1

PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Price range per carat[3] Jan. 1988–Jan. 1989	Average[4] July 1988
0.25	G	VS1	$1,100–$1,300	$1,300
.25	G	VS2	950– 1,100	1,100
.25	G	SI1	800– 880	880
.25	H	VS1	950– 1,100	1,100
.25	H	VS2	900– 1,000	1,000
.25	H	SI1	780– 860	860
.50	G	VS1	2,300– 2,500	2,500
.50	G	VS2	2,100– 2,300	2,300
.50	G	SI1	1,800– 1,900	1,900
.50	H	VS1	2,200– 2,300	2,300
.50	H	VS2	2,000– 2,100	2,100
.50	H	SI1	1,700– 1,800	1,800
.75	G	VS1	2,600– 3,000	2,900
.75	G	VS2	2,500– 2,700	2,700
.75	G	SI1	2,200– 2,300	2,300
.75	H	VS1	2,400– 2,600	2,600
.75	H	VS2	2,200– 2,300	2,300
.75	H	SI1	2,000– 2,100	2,100
1.00	G	VS1	4,200– 4,600	4,600
1.00	G	VS2	3,700– 4,100	4,100
1.00	G	SI1	3,200– 3,500	3,500
1.00	H	VS1	3,700– 4,100	4,100
1.00	H	VS2	3,300– 3,600	3,600
1.00	H	SI1	3,900– 3,200	3,200

[1] Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; H-I—traces of color.
[2] Clarity: IF—no blemishes; VVS1—very, very slightly included; VS—very slightly included; VS2—very slightly included, but more visible; SI1—slightly included.
[3] Jeweler's Circular-Keystone. V. 159, No. 2, Feb. 1989.
[4] Jeweler's Circular-Keystone. V. 154, No. 2, Aug. 1988.

TABLE 2

PRICES OF U.S. CUT COLORED GEM STONES, BY SIZE[1]

Gem stone	Carat weight	Price range per carat in 1988[2]	Average price per carat[2]	
			Jan. 1988	Jan. 1989
Amethyst	1	$6– $10	$8	$8
Aquamarine	1	100– 250	175	175
Emerald	1	1,800–3,000	2,400	2,600
Garnet, tsavorite	1	700–1,200	950	650
Ruby	1	2,500–3,500	3,000	3,500
Sapphire	1	600–1,500	1,050	1,400
Tanzanite	1	275– 450	354	300
Topaz	1	6– 9	7.50	9
Tourmaline, red	1	60– 125	92.50	92.50

[1] Fine quality.
[2] Jewelers' Circular-Keystone. V. 159, No. 2, Feb. 1989, p. 399. These figures represent a sampling of net prices that wholesale colored stone dealers in various U.S. cities charged their cash customers during.

years of significant growth, 136%, which resulted in a record-high year in 1988.

Exports of other precious and semiprecious stones, cut but unset, increased about 51% to $68.5 million. The average annual export value for the past 7 years for cut but unset natural gem stones, other than diamonds and pearls, was $38.8 million, with a high of $68.5 million in 1988 and a low of $27.7 million in 1984. The 7-year trend for the export value of these gem materials was one of fluctuating increases and decreases, but resulted in a significant overall increase of 131% for the period. Exports of the same types of gem materials, except as uncut and unset, increased 15% to $24.2 million. The average annual value of exports for the past 7 years was $16.9 million, with a high of $24.2 million in 1988 and a low of $12.2 million in 1985. The 7-year trend for the value of exports was one of 4 years of moderate, 29% decline, followed by 3 years of significant, 98% growth, which resulted in an overall growth of 58% for the period.

Exports of synthetic gem material, cut and uncut but not set, increased slightly to $6.0 million. The average annual value of exports for the past 7 years was $5.2 million, with a high of $7.7 million in 1982 followed by a low of $3.7 million in 1983. The 7-year trend for the value of exports was one of extreme decline, 52%, from 1982 to 1983; followed by a steady, moderate growth, 62%, over the next 5 years.

Exports of natural, cultured, and imitation pearls, not set or strung, increased about 22% to $2.2 million.

Reexports of gem material increased 10% to $407.9 million. The quantity of diamonds reexported decreased about 21% to 1.5 million carats, the third lowest amount in the past 10 years. However, the value of diamonds exported increased about 4% to $319.0 million. The average annual quantity of diamonds reexported for the past 10 years was 1.9 million carats, with a high of 3.0 million carats in 1981 and a low of 1.0 million in 1979. The 10-year trend for the quantity of diamonds reexported was highly mixed. The period started with an extreme increase, 207%, through 1981, followed by a moderate decline, 37%, through 1984, followed by 3 years of essentially level reexports, leading to the most recent decline in 1988. The average annual value of reexported diamonds for the past 10 years was $295.4 million, with a high of $412.8 million in 1981 and a low of $186.0 million in 1985. The 10-year trend for the value of reexports was one of extreme increase, 58%, for 1979–82, moderate decline, 55%, for the next 4 years, followed by 3 years of significant increase, 72%, which resulted in the average annual value ending the period 22% greater than it started.

The reexports of natural gem materials, cut but not set, other than diamonds and pearls, increased about 37% to $55.1 million, a record high for the 7-year period for which data were available. The average annual value of reexports for the past 7 years was $37.1 million, with a high of $55.1 million in 1988 and a low of $22.9 million in 1985. The 7-year trend for the value of reexports was one of alternating decreases and increases with the increases prevailing and resulting in a 70% rise in value during the period. The reexports of natural gem materials, not cut or set, other than diamonds and pearls, increased about 1,600% to $22.2 million. The extremely large increase was most likely the result of reexporting uncut colored stones to worldwide cutting centers for cutting and reexport to the United States as finished gems. The average annual value of reexports for the past 7 years was $12.2 million, with a high of $22.2 million in 1988 and a low of $1.3 million in 1987. The 7-year trend for the value of reexports was one of extreme increases and decreases, with the value at the end of the period increasing by 192%. Reexports of natural, cultured, and imitation pearls and synthetic gem materials was $11.3 million and $0.3 million, respectively.

The value of all gem materials imported increased about 24% to $5,063 million. The value of imported gem diamonds accounted for about 85% of the total. The value of imported gem diamonds increased 26% to a record high $4,306 million. The increase in the value of cut diamonds imported accounted for 81% of the total dollar increase. The average annual value of imports for the past 10 years was $2,330 million, with a high of $4,306 million in 1988 and a low of $1,859 million in 1979. The 10-year trend for the value of diamond imports was one of generally steady continuous growth with an increase of 132% for the period. During the period, the value of imported uncut diamonds increased 72%, while the value of imported cut stones increased 869%.

TABLE 3

U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY

Country	1987 Quantity (carats)	1987 Value[1] (millions)	1988 Quantity (carats)	1988 Value[1] (millions)
Exports:				
Belgium	162,009	$122.9	163,246	$142.4
Canada	24,943	17.8	24,104	18.4
France	1,943	4.3	7,946	11.4
Germany, Federal Republic of	3,842	4.0	3,736	4.7
Hong Kong	100,365	148.2	92,067	208.1
Israel	172,634	110.8	169,433	137.9
Japan	62,404	144.1	74,566	196.2
Singapore	5,686	7.0	5,135	9.2
Switzerland	30,161	76.3	23,929	141.9
Thailand	14,028	9.3	16,082	12.2
United Kingdom	4,151	8.2	3,641	20.6
Other	5,221	7.5	6,527	5.9
Total	**587,387**	**660.4**	**590,412**	**908.9**
Reexports:				
Belgium	1,184,952	101.1	833,081	104.4
Canada	5,424	.8	5,855	1.2
China	2,062	.1	14,009	.3
Germany, Federal Republic of	24,840	2.6	31,236	2.6
Hong Kong	82,491	27.2	34,682	19.6
India	84,893	2.9	139,684	5.0
Israel	199,579	70.3	137,820	65.9
Japan	95,919	7.2	114,904	10.2
Netherlands	47,313	3.2	89,000	9.4
Switzerland	39,765	57.7	34,234	77.5
United Kingdom	101,300	18.4	26,929	12.6
Other	74,333	16.2	83,026	10.3
Total	**1,942,871**	**307.7**	**1,544,460**	**319.0**

[1] Customs value.

Source: Bureau of the Census.

The value of imports for all other gem materials, led by emerald, ruby, and sapphire, increased 14% to $757.6 million. Emerald imports increased about 23% to $174.6 million. The average annual value of emerald imports for the past 10 years was $139.5 million, with a high of $174.6 million in 1988 and a low of $105.1 million in 1979. The 10-year trend for the value of emerald imports was one of fluctuating increases and decreases resulting in a 66% increase for the period.

The value of ruby imports increased 21% to $72.0 million, the fifth highest value in the past 10 years. The 10-year average annual value of imports was $70.6 million, with a high of $93.8 million in 1981 and a low of $30.0 million in 1979. The 10-year trend of import values was one of extreme fluctuations. The period ended with values having increased 140%, but were still 23% below the high for the period. The value of sapphire imports increased 10% to $81.5 million, the fifth highest value in the past 10 years. The 10-year average annual value of sapphire imports was $71.1 million, with a high of $95.1 million in 1986 and a low of $24.2 million in 1979. The 10-year trend for the value of imports was one of extremely fluctuating increases and decreases. The period ended with the value 237% greater than at the beginning, but still 14% below the high for the period.

The value of imported gem materials, other than diamond, emerald, ruby, and sapphire, increased 10% to $429.5 million. The average annual value of imports was $315.8 million, with a high of $429.5 million in 1988 and a low of $153.3 million in 1979. The 10-year trend for the value of imports was one of fluctuating increases and decreases resulting in an overall increase of 180% for the period.

WORLD REVIEW

De Beers Consolidated Mines Ltd.'s

TABLE 4

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY

Kind, range, and country of origin	1987 Quantity (carats)	1987 Value[1] (millions)	1988 Quantity (carats)	1988 Value[1] (millions)
Rough or uncut, natural:[2]				
Belgium	323,742	$82.0	305,142	$111.8
Brazil	44,287	5.4	349,461	10.7
Israel	28,029	7.3	38,734	8.2
Netherlands	2,930	2.9	57,791	7.9
South Africa, Republic of	37,870	28.7	48,515	44.9
Switzerland	5,185	12.6	14,307	8.2
United Kingdom	797,759	208.3	619,461	317.5
Venezuela	7,901	.7	684	.1
Other	121,657	72.1	210,203	79.3
Total	**1,369,360**	**420.0**	**1,644,298**	**588.6**
Cut but unset, not over 0.5 carat:				
Belgium	1,307,990	468.2	1,035,452	406.7
Brazil	33,352	8.7	34,554	13.7
Canada	21,750	8.8	9,156	4.1
Hong Kong	241,251	41.8	285,268	63.1
India	3,198,504	670.8	3,758,747	886.1
Israel	1,511,724	629.8	1,109,474	532.8
Netherlands	51,959	13.6	27,588	26.8
South Africa, Republic of	14,461	11.8	5,532	5.1
Switzerland	73,268	40.3	76,169	36.8
United Kingdom	18,321	15.8	23,406	22.9
Other	144,708	33.3	160,707	37.9
Total	**6,617,288**	**1,942.9**	**6,526,053**	**2,036.0**
Cut but unset, over 0.5 carat:				
Belgium	384,789	380.1	709,527	578.9
Hong Kong	12,361	21.3	59,949	40.1
India	110,019	28.0	386,422	111.3
Israel	468,132	406.1	906,752	675.2
Netherlands	8,403	11.6	7,859	12.9
South Africa, Republic of	27,654	41.3	22,762	40.6
Switzerland	37,583	81.7	24,281	95.1
United Kingdom	29,155	42.6	17,546	45.3
Other	56,345	47.5	92,028	81.8
Total	**1,134,441**	**1,060.2**	**2,227,126**	**1,681.2**

[1] Customs value.
[2] Includes some natural advanced diamond.

sales of uncut diamonds through the Central Selling Organization in 1988 were reported to be a record $4.17 billion compared with $3.07 billion in 1987, an increase of approximately 36%. Sales of colored gem stones also remained very strong.

Emerald was mined in Australia, Brazil, Colombia, India, Mozambique, Pakistan, the Republic of South Africa, the U.S.S.R., Zambia, and Zimbabwe. Sapphire was produced in Australia, Colombia, Kenya, Malawi, Nigeria, Sri Lanka, Tanzania, Thailand, and the United States. Aquamarine was produced in Afghanistan, Brazil, China, India, Nigeria, Pakistan, the Republic of South Africa, Tanzania, the United States, and Zambia. Ruby was produced in Afghanistan, Burma, India, Kenya, Sri Lanka, Tanzania, Thailand, and the United States.

Angola

Endiama, the Government-owned and operated diamond mining company, signed an agreement with Lazare-Kaplan International (LKI) of New York that allows LKI to export to the United States $20 million per year of Angolan rough diamonds. Endiama is marketing diamonds through a total of five rough dealers: LKI, Industrial Diamond Corp. of London, and three Antwerp firms, George Evens, Arslanian Freres, and IDH Diamonds.

The leaders of the Angolan UNITA movement announced the discovery of huge deposits of diamonds in the areas of Cuado and Cubango. The spokesperson stated that the deposits were in the firm control of UNITA and that they plan to develop the deposits as soon as possible.

Australia

Freeport Bow River Properties Inc., the operating company of the Freeport-McMoRan Australia Ltd. and Gem Exploration and Minerals Ltd. joint venture, started production from the Bow River alluvial diamond project. Diamond output was about 480,000

TABLE 5

U.S. IMPORTS FOR CONSUMPTION OF NATURAL PRECIOUS AND SEMIPRECIOUS GEM STONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY

Kind and country	1987 Quantity (carats)	1987 Value[1] (millions)	1988 Quantity (carats)	1988 Value[1] (millions)
Emerald:				
Belgium	30,190	$3.9	11,963	$5.6
Brazil	112,194	7.0	80,199	6.4
Colombia	195,403	44.6	243,521	63.8
France	8,401	1.9	13,817	3.2
Germany, Federal Republic of	38,034	3.9	34,376	2.4
Hong Kong	170,853	15.2	135,384	14.7
India	1,231,033	17.0	1,205,636	20.4
Israel	60,942	19.4	89,399	24.7
Japan	5,637	.6	20,102	1.0
South Africa, Republic of	5	(2)	4	(2)
Switzerland	58,789	18.3	65,021	20.6
Taiwan	3,697	(2)	256	(2)
Thailand	104,058	3.0	216,501	3.8
United Kingdom	7,652	2.2	8,026	2.9
Other	48,032	4.6	91,701	5.1
Total	**2,074,920**	**141.6**	**2,215,906**	**174.6**
Ruby:				
Belgium	12,078	.7	8,926	1.3
Brazil	3,102	(2)	4,945	.2
Colombia	3,198	(2)	258	(2)
France	6,219	1.6	5,885	3.4
Germany, Federal Republic of	18,267	.8	26,530	1.0
Hong Kong	42,687	3.6	47,152	4.6
India	302,323	.9	318,575	1.1
Israel	7,043	.6	38,593	1.6
Japan	335,381	.5	11,572	.8
Switzerland	41,492	14.1	40,183	11.6
Thailand	1,536,723	31.4	1,822,557	40.5
United Kingdom	11,523	2.9	8,443	3.6
Other	37,781	2.3	61,703	2.3
Total	**2,357,817**	**58.7**	**2,395,322**	**72.0**
Sapphire:				
Australia	—	—	2,883	.2
Austria	1,000	(2)	603	(2)
Belgium	21,356	1.2	20,024	.9
Brazil	2,580	(2)	9,528	.2
Canada	6,905	.7	16,177	.9
Colombia	2,234	(2)	1,398	(2)
France	7,048	1.1	46,296	2.3
Germany, Federal Republic of	12,067	1.6	26,750	1.0

See footnotes at end of table.

TABLE 5—Continued

U.S. IMPORTS FOR CONSUMPTION OF NATURAL PRECIOUS AND SEMIPRECIOUS GEM STONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY

Kind and country	1987 Quantity (carats)	1987 Value[1] (millions)	1988 Quantity (carats)	1988 Value[1] (millions)
Hong Kong	63,684	$5.4	123,689	$5.8
India	84,973	.5	149,488	1.2
Israel	14,254	1.1	8,931	1.1
Japan	48,460	.4	22,662	.6
Korea, Republic of	9,793	(2)	6,438	(2)
Singapore	7	(2)	4,705	.2
Sri Lanka	55,241	3.1	39,259	2.4
Switzerland	46,786	11.3	32,446	10.2
Thailand	2,121,376	42.7	2,878,129	50.2
United Kingdom	110,112	3.9	10,102	2.9
Other	37,847	1.0	110,301	1.4
Total	**2,645,723**	**74.0**	**3,509,809**	**81.5**
Other:				
Rough, uncut:				
Australia		.8		.9
Brazil		20.7		29.7
Colombia		5.5		2.4
Hong Kong		1.4		.5
Nigeria		.2		.2
Pakistan	NA	1.2	NA	1.0
South Africa, Republic of		.3		4.8
Switzerland		.1		1.7
United Kingdom		(2)		.6
Zambia		.1		.9
Other		3.8		5.5
Total	**NA**	**34.1**	**NA**	**48.2**
Cut, set and unset:				
Australia		6.1		12.6
Brazil		17.2		18.6
Canada		.6		.4
China		2.7		2.3
Germany, Federal Republic of		13.7		15.8
Hong Kong		28.7		27.4
India	NA	5.7	NA	5.1
Japan		128.8		144.5
Switzerland		3.0		3.1
Taiwan		11.1		11.3
Thailand		11.7		14.2
United Kingdom		1.0		1.7
Other		21.2		17.7
Total	**NA**	**251.5**	**NA**	**274.7**

NA Not available.
[1] Customs value.
[2] Less than 1/10 unit.

Source: Bureau of the Census.

TABLE 6

VALUE OF U.S. IMPORTS OF SYNTHETIC AND IMITATION GEM STONES, INCLUDING PEARLS, BY COUNTRY

(Million dollars)[1]

Country	1987	1988
Synthetic, cut but unset:		
Austria	1.3	2.0
France	.8	.6
Germany, Federal Republic of	9.2	9.1
Japan	1.8	2.1
Korea, Republic of	11.6	8.1
Switzerland	4.6	6.0
Other	5.0	5.6
Total	**34.3**	**33.5**
Imitation:		
Austria	50.7	49.4
Czechoslovakia	2.1	2.7
Germany, Federal Republic of	7.1	6.7
Japan	3.7	4.6
Other	8.0	6.2
Total	**71.6**	**69.6**

[1] Customs value.

Source: Bureau of the Census.

carats. The diamond production was about 20% gem quality, 70% near-gem quality, and 10% bort.

Argyle Diamond Mines Pty. Ltd.'s annual diamond production from the AK-1 pipe increased by nearly 14% to a record 34,553,724 carats. Argyle's annual production accounted for about 37% of the world's production of natural diamonds. Additional deposits of alluvial diamonds in the lower reaches of the Smoke and Limestone Creeks that drain the AK-1 pipe add about 60 million carats to Argyle's resources. Mining of these alluvial diamonds is scheduled to begin in 1989, annual production is projected to be about 2 million carats. Argyle Diamond Sales Ltd. announced the sale of a brilliant-cut 1.51-carat purple-red diamond for an Australian record price of $1 million per carat. The diamond was cut in Perth.

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF PRECIOUS AND SEMIPRECIOUS GEM STONES

(Thousand carats and thousand dollars)

Stones	1987 Quantity	1987 Value[1]	1988 Quantity	1988 Value[1]
Diamonds:				
Rough or uncut	1,369	$420,004	1,644	$588,611
Cut but unset	7,752	3,003,090	8,753	3,717,151
Emeralds: Cut but unset	2,075	141,575	2,216	174,623
Coral: Cut but unset, and cameos suitable for use in jewelry	NA	3,060	NA	2,967
Rubies and sapphires: Cut but unset	5,004	133,396	5,905	153,552
Marcasites		766		1,229
Pearls:				
Natural	NA	3,879	NA	3,389
Cultured	NA	151,854	NA	171,693
Imitation	NA	6,259	NA	7,198
Other precious and semiprecious stones:				
Rough, uncut	NA	34,079	NA	48,186
Cut, set and unset	NA	78,215	NA	79,056
Other	NA	13,716	NA	19,795
Synthetic:				
Cut but unset	82,697	30,958	81,096	28,995
Other	NA	3,358	NA	4,485
Imitation gem stone	NA	65,311	NA	62,404
Total	**XX**	**4,089,520**	**XX**	**5,063,334**

NA Not available. XX Not applicable.
[1] Customs value.

Source: Bureau of the Census.

Gem Exploration Ltd. reported success in a sampling program for the Kununurra project in Western Australia. Four alluvial diamonds weighing 1.42 carats were recovered from ancient alluvial deposits of the Ord River. The stones discovered included both gem and industrial quality.

Capricorn Resources Australia NL launched Australia's first underwater diamond exploration project. Using crocodile- and shark-proof cages to protect the divers, underwater work was started in the Joseph Bonaparte Gulf off the north coast of Western Australia. The company believes that diamonds from the Argyle and Bow River areas have washed into the gulf. To date the divers have recovered four diamonds averaging 0.27 carat from samples taken from the seabed.

Max Resources NL was preparing to develop a diamond prospect at Nullagine, about 200 kilometers southwest of Port Hedland. Nullagine would become Australia's third diamond mine. Annual production is projected to be 138,000 carats, of which 60% will be gem quality.

The value of sapphires exported from Australia increased by about 23% to $24.6 million. Sapphires were mined in the Anakie District and Lava Plains in Queensland, and in the New England District of New South Wales. The production value of opals increased about 17% to $97 million. Most of the increase was due to increased production from the Sheepyard Field, which started production in 1987. Australia also produced agate, amethyst, aquamarine, chrysoprase, garnet, peridot, rhodonite, and zircon; the export value of these materials increased 28% to $8.7 million.[3] Australia also produces the Pool Emerald, a laboratory grown hydrothermal emerald that was recrystallized from emerald from the Emerald Pool Mine in Western Australia.

Belgium

The total value of diamond imports and exports was about $12.4 billion, a record for any diamond center. Antwerp was the largest trading center.

Botswana

Debswana, the operator of the diamond mining joint venture between De Beers and the Botswana Government, announced plans to build a new diamond processing plant at the Jwaneng Mine. The plant would recover diamonds too small to be recovered by old methods. Annual production should increase about 10% from the present production of about 7.6 million carats.

Brazil

Brasaust Mineracal, the Brazilian subsidiary of the Australian companies Gem Exploration and Minerals and Titan Resources, completed the first phase of a bulk sampling program of the Estrela do Sul diamond project in Minas Gerais State. Of 20 samples totaling 574 cubic meters, 2 samples with a combined volume of 35.4 cubic meters yielded 8 diamonds weighing 3.75 carats. The best sample returned an equivalent grade of 11.8 carats per 100 cubic meters. A total of 1,290 cubic meters of material was collected from the palaeo-conglomerate.

Canada

Monopros Ltd., a subsidiary of De Beers, announced the discovery of a kimberlite near Prince Albert, Saskatchewan. Monopros conducted a bulk sampling program, but has not revealed the results. Rumors circulated that Monopros had exposed a diamond pipe on its property and that overburden removal could reveal additional potential. Other major companies have established large land positions in the area.

China

It was reported the Mount Yimeng area in Shandong Province has an estimated 11.2 million carats of diamond reserves, the largest of any Province in China. Two Government-owned mines currently operate in the area producing a total of 30,000 carats per year. Five of the largest diamonds discovered in China have come from this area.

Construction was started in northeast China on the country's largest diamond mine. Located in Wafangdian, Liaoning Province, the mine will cost an estimated $19 million. It was forecasted that the mine will produce about 118,000 carats per year once production begins in 1989.

A Hong Kong-based jewelry firm established a new diamond-polishing factory in the city of Shunde, Guangdong Province. The cutting facility, which began with 10 cutters trained in Thailand, was expected to eventually increase its work force to a total of 300 workers.

Argyle Diamond Sales and the Australian Government set up a diamond cutting and polishing factory at Shunyi, near Beijing. When in full operation, the factory will employ approximately 1,000 Chinese workers processing near-gem material.

Colombia

The Colombian Ministry of Mines and Ecominas, the state mining company, is attempting to improve the image of the emerald industry. The industry has been racked by violence, smuggling, and ecologically damaging mining practices. In an effort to correct the damaging mining practices and to better determine production, Ecominas began to periodically monitor the operations of the 4 large concessionaires and the 14 smaller subcontractors. Marketing improvements, through the establishment of a national federation of emerald producers and traders (supported by the state) and the creation of an emerald exchange in Bogota, were implemented.

Guinea

A 181.77-carat diamond, recovered in November from the Aredor Mine, was purchased by a syndicate of buyers for $8.6 million. At $47,400 per carat, it was the highest per carat price ever paid for a rough diamond. A spokesperson for Bridge Oil Ltd., Australia, a partner in the mine, said the stone should polish out to a D-color, between 85 and 100 carats. There are only 16 white diamonds over 100 carats in the world. If the stone is D-color, flawless, and 100 carats it could sell for more than $18 million.

India

A 50-carat rare blue diamond crystal was found in the gravel of the Mahanadi River between Boudh and Sonepur. The area produced alluvial diamonds, most were yellow to brown in color, in sizes up to 10 carats.

Israel

Exports of diamonds were about $2.6 billion, an increase of 23% compared with that of 1987. Approximately 43% was exported to the United States and about 35% to the Far East.

Namibia

CDM Ltd. experienced a decrease in total diamond production because of a decrease in the grade of the materials processed. Technical problems with the No. 1 plant and No. 4 plant pretreatment facility did not allow for an offset of the lower grades with higher throughput. The No. 4 pretreatment facility was put into production only to find that modifications were needed because of the extreme variations of the materials being treated. The modifications were completed by yearend. CDM announced that construction of a new mine at Auchas on the Orange River would begin in early 1989.

A new diamond-sorting operation was opened in Windhoek. Namibia Ltd. operates the plant with about 80 Namibians that were trained by the Central Selling Organization personnel. Previously, the sorting was done in Kimberly, the Republic of South Africa.

An extremely rich alluvial diamond deposit was discovered near Luderitz by the Namibian West Coast Diamond Co. The deposit was about 120 meters off the coast in about 6 meters of water. In 7 hours, two divers recovered 931 diamonds weighing a total of 1,550 carats, indicating a extremely rich deposit.

Sierra Leone

The Diamond Corp. West Africa Ltd., a subsidiary of De Beers, reportedly closed its operations in Sierra Leone where it had been involved in buying and exporting diamonds for over 30 years. Meanwhile, the Government of Sierra Leone announced it had licensed 15 exporters to legally export diamonds. Each exporter was required to deposit $0.5 million monthly in the Central Bank of which $0.3 million can be used. The remaining $0.2 million must be used to help local imports with hard currency. Currently, it is believed that a majority of Sierra Leone diamonds enter the world markets through Liberia.

South Africa, Republic of

The reopening of the Koffiefontein Mine was delayed when heavy rains flooded the No. 2 shaft and damaged underground installations. Underground production finally began in

July with full production planned for the second quarter of 1989.

At the Buffels inland complex, Langhoogte Mine reserves were exhausted early in the year, and thereafter, new reserves at Nuttabooi were mined. Extensions to the security area to include Nuttabooi, and the new haul road were completed during the first quarter of the year.

Sri Lanka

Reports indicated a diamond rush was underway in Koslanda township in the highland tea growing area. The diamond finds were concentrated along the course of the Menik Ganga River near the Diyaluma Waterfall, a famous tourist attraction. In the past, the local villagers, in their search for sapphires, had dismissed the diamonds as barren stones, but experts report they are high-quality diamonds.

TECHNOLOGY

Cutters Choice, a division of Dyna-Systems of Boise, ID, began marketing a new lap for cutting and polishing gem stones. The new laps were made of glass instead of the traditional metal. Glass gives the laps a flatter surface, which is less scratch-prone and not as harsh in cutting although it cuts faster. In commercial-cutting factory tests, the laps stayed sharp longer than metal laps. The company markets 12 different glass laps.

The U.S.S.R. announced the development of automatic crystal growth equipment that can produce large, 30-centimeter by 8-centimeter, synthetic crystals of all precious stones except diamond and tourmaline. The growth of the large tubelike crystals require about 38 hours. The "Diacont" automatic crystal growth equipment was developed by the Institute for Crystallography, Moscow, in collaboration with the Central Research Institute for Physics, Budapest.

The Laboratory for Hydrothermal Growth at the Institute of Geology and Geophysics, Siberian Branch of the U.S.S.R. Academy of Sciences in Novosibirsk, produced a selection of unusual hydrothermally grown synthetic beryl crystals. Deposited over colorless beryl seeds, ionic dopants resulted in a number of different colors. Purple resulted from doping with a combination of chromium and manganese. Intense pink was caused by manganese alone. Blue was the product of copper, and rich slightly orangy red color was from traces of cobalt. It is known that at least one other color, a dark sapphire blue, was produced. It is not known how much of the material has been grown or if it will be commercially produced.[4]

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[1] Physical scientist, Branch of Industrial Minerals.

[2] Gems and Gemology. V. 24, No. 4, Winter 1988, pp. 229-236.

[3] Australian Bureau of Mineral Resources. Australian Mineral Industry Annual Review. Preliminary Summary 1988. Gemstones, Feb. 1989.

[4] Page 252 of work cited in footnote 2.

TABLE 8

DIAMOND: WORLD PRODUCTION, BY TYPE AND COUNTRY[1]

(Thousand carats)

Country	Natural															Synthetic[3]
	1984			1985			1986			1987[p]			1988[e]			
	Gem[2]	Industrial	Total	Gem[2]	Industrial	Total	Gem[2]	Industrial	Total	Gem[2]	Industrial	Total	Gem[2]	Industrial	Total	
Angola	652	250	902	464	250	714	240	10	[e]250	180	10	[e]190	950	50	1,000	—
Australia	3,415	2,277	5,692	4,242	2,828	7,070	13,145	16,066	29,211	13,650	16,683	30,333	17,517	17,517	[4]35,034	—
Botswana	5,810	7,104	12,914	6,318	6,317	12,635	9,610	3,500	13,110	9,367	3,840	13,207	10,801	4,428	[4]15,229	—
Brazil	200	550	750	233	217	450	310	315	625	309	213	522	310	300	610	—
Central African Republic	236	101	337	190	87	277	259	99	358	304	108	412	[4]284	[4]59	[4]343	—
China[e]	200	800	1,000	200	800	1,000	200	800	1,000	200	800	1,000	200	800	1,000	15,000
Czechoslovakia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5,000
France	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4,000
Ghana	35	311	346	60	[r]576	[r]636	[r]83	[r]438	521	[r]65	[r]400	465	49	303	352	—
Greece	—	—	—	—	—	—	—	—	—	—	—	—	([5])	—	([5])	1,000
Guinea	44	3	47	123	9	132	190	14	204	163	12	175	136	10	146	—
Guyana[e]	6	8	14	[r]4	7	11	3	6	[3]9	4	7	11	1	3	[4]4	—
India	13	2	15	14	2	16	13	[r]3	16	[r]16	[r]3	19	16	3	19	—
Indonesia[e]	5	22	27	5	22	27	5	22	27	5	25	30	5	25	30	—
Ireland	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	90,000
Ivory Coast[e] [6]	20	5	25	15	5	20	10	4	14	15	[r]6	[r]21	15	5	20	—
Japan	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25,000
Liberia	108	132	240	66	72	138	63	189	252	60	190	[e]250	67	100	[4]167	—
Namibia	884	46	930	865	45	910	970	40	1,010	[r]987	[r]50	1,037	901	37	[4]938	—
Romania	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5,000
Sierra Leone[6]	240	105	345	243	106	349	215	100	315	[r]150	[r]75	225	100	75	175	—
South Africa, Republic of:																
Finsch Mine	1,714	3,184	4,898	1,770	3,184	4,954	1,821	3,208	5,029	1,455	2,701	4,156	1,372	2,548	3,920	—
Premier Mine	765	1,785	2,550	820	1,864	2,684	882	1,977	2,859	772	1,713	2,485	696	1,543	2,239	—
Other De Beers properties[7]	1,452	593	2,045	1,500	569	2,069	1,428	529	1,957	1,427	546	1,973	1,388	531	1,919	—
Other	585	65	650	460	35	495	342	41	383	409	30	439	283	21	304	—
Total	**4,516**	**5,627**	**10,143**	**4,550**	**5,652**	**10,202**	**4,473**	**5,755**	**10,228**	**4,063**	**4,990**	**9,053**	**3,739**	**4,643**	**8,382**	**25,000**
Swaziland	7	10	17	9	12	21	17	23	[e]40	17	23	[e]40	60	90	150	—
Sweden	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25,000
Tanzania	193	84	277	165	71	236	133	57	190	[r]105	[r]45	[r][e]150	105	45	150	—
U.S.S.R.[e]	4,300	6,400	10,700	4,400	6,400	10,800	4,400	6,400	10,800	[r]4,400	[r]6,400	[r]10,800	4,500	6,500	11,000	41,500
United States	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	W
Venezuela	40	232	272	35	180	215	45	189	234	50	200	[e]250	50	200	250	—
Yugoslavia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5,000
Zaire	5,169	13,290	18,459	4,032	16,127	20,159	4,661	18,643	23,304	[r]3,885	[r]15,540	19,425	3,800	15,200	19,000	—
Total	**26,093**	**37,359**	**63,452**	**[r]26,233**	**[r]39,785**	**[r]66,018**	**39,045**	**52,672**	**91,717**	**37,995**	**49,620**	**87,615**	**43,606**	**50,393**	**93,999**	**241,500**

[e]Estimated. [p]Preliminary. [r]Revised. W Withheld to avoid disclosing company propriety data.

[1] Table includes data available through May 31, 1989. Total diamond output (gem plus industrial) for each country actually is reported except where indicated by a footnote to be estimated. In contrast, the detailed separate production data for gem and industrial diamond are Bureau of Mines estimates in the case of every country except Australia (1984-87), Botswana (1987), Brazil (1987), Central African Republic (1984-88), Guinea (1984-87), and Liberia (1984-86), for which source publications give details on grade as well as totals. The estimated distribution of total output between gem and industrial diamond is conjectural, and for most countries, is based on the best available data at time of publication.

[2] Includes near-gem and cheap-gem qualities.

[3] Includes all synthetic diamond production.

[4] Reported figure.

[5] Less than 1/2 unit.

[6] Figures are estimates based on reported exports and do not include smuggled diamonds.

[7] Other De Beers Group output from the Republic of South Africa includes Kimberley Pool, Koffiefontein Mine, and the Namaqualand Mines.

GEM STONES

By Gordon T. Austin

Mr. Austin, a physical scientist with over 30 years industry and Government experience, has been the gem stones commodity specialist since 1986. Mr. William Field, mineral data assistant, prepared the domestic production survey data.

The value of production of natural gem materials in the United States during 1989 decreased slightly to $42.9 million. The materials produced included faceting rough, lapidary rough, carving material, specimen material, natural and cultured freshwater pearls, mother of pearl, agatized coral, and coral.

The reported combined production value of synthetic and simulant materials was $18.8 million, about a 15% increase over that of 1988. Synthetic gems are manmade and have essentially the same optical, physical, and chemical properties and the same appearance as the natural gem that they represent. Synthetic gem materials produced in the United States include alexandrite, coral, diamond, emerald, garnet, lapis lazuli, quartz, ruby, sapphire, spinel, and turquoise. Simulants are manmade gem materials that have an appearance similar to that of a natural gem material but have different optical, physical, and chemical properties. The gem simulants produced in the United States include coral, cubic zirconia, lapis lazuli, malachite, and turquoise. Additionally, certain colors of synthetic sapphire and spinel, used to represent other gem stones, would be classed as simulants. Colored and colorless varieties of cubic zirconia are the major simulants produced.

Wholesale and retail outlets, gem and mineral shops, gem and mineral shows, cutting factories, and jewelry manufacturers were the major purchasers of domestic gem materials.

DOMESTIC DATA COVERAGE

The Bureau of Mines estimates of U.S. production were from the "Natural and Synthetic Gem Material Survey," a voluntary survey of U.S. operations, and from Bureau estimates of unreported production. Of the approximately 358 operations surveyed, 82% responded, accounting for about 95% of the total production, 92% of the natural production, and 100% of the synthetic and simulant production.

The 358 operations surveyed in 1989 were an increase of about 19% compared with the number of operations surveyed in 1988. The response rate was essentially the same as that of 1988. The Bureau estimated the production by nonresponding operations, by professional collector, and by amateur or hobbyist collectors. The basis for these estimates were information from published data, conversations with gem and mineral dealers, analyses of gem and mineral shows and sales statistics, and from information informally supplied by collectors. The Bureau is totally dependent on the cooperation of the producers, brokers, dealers, and collectors for the formal voluntary survey and the informal surveys. Individuals and companies have been very cooperative and forthcoming with information. The Bureau is very appreciative of this cooperation.

PRODUCTION

Each of the 50 States produced at least $1,000 worth of gem materials. Ten States accounted for 95% of the total value of natural gem material produced. The States, in order of declining value of production, with their 1988 standing shown in parenthesis, were Tennessee (1), Arkansas (4), California (2), Arizona (3), Montana (5), Nevada (12), Oregon (6), North Carolina (7), Maine (16–17), and Utah (10). Certain States were known for the production of a single gem material (i.e., Tennessee for freshwater pearls and Arkansas for quartz). Other States produced a variety of gem materials. Arizona produced the greatest variety of gem materials. Production included agate, amethyst, antlerite, azurite, chrysocolla, fire agate, garnets, jade, malachite, obsidian, onyx, peridot, petrified wood, precious opal, shattuchite, smithsonite, and turquoise. California, Idaho, Montana, and North Carolina also produced a variety of gem materials. North Carolina was the only State to have ever produced all four of the major gems: diamond, emerald, ruby, and sapphire.

The average production value of natural gem materials for the past 10 years was $12.5 million a year, with a high of $43.5 million in 1988 and a low of $6.9 million in 1980. The value of production for the past 10 years must be separated into two trends. The first trend was the period between 1979 to 1985, during which time approximately 24 operations reported production. Production averaged $7.5 million a year and was generally level. During the second trend, 1986 to the present, production averaged $24.2 million and was the result of an increase of 1,392% in the number of producers surveyed.

The reported production value of synthetic and simulant gem materials was $18.8 million in 1989. The reported value of production increased 15%; however, the quantity of materials produced was significantly greater. A shift in the types of materials produced, primarily a change from colored cubic zirconia to colorless cubic zirconia, resulted in the production of lower valued material. Thirteen firms, five in California, four in Arizona and one each in Massachusetts, Michigan, New Jersey, and Ohio, produced synthetic and simulant gem material. The six States, in order of declining value of production were Massachusetts, California, New Jersey, Michigan, Ohio, and Arizona.

Dia Em Resources Ltd. and LKA International Inc. completed the evaluation of their Rist and Ellis Emerald Mines at Hiddenite, NC, in 1988, and disposed of the property in 1989. LKA's plans to sell the two largest emerald crystals ever found in the United States, the 1,438-carat Stephenson and the 1,686.3-carat LKA crystal, have not been successful to date.

Crystal Exploration Inc. of Denver, CO, a subsidiary of Restech International Ltd. of Sydney, Australia, continued exploration for diamonds on mineral leases in Michigan. It purchased the leases from Dow Chemical Co. in 1988. Crystal took advantage of the north-central U.S.'s cold winter weather to explore for diamonds on the frozen grounds of swamps in Michigan and Wisconsin.

Amselco Exploration Inc., a subsidiary of British Petroleum Co. of Canada, and Exmin Corp., a subsidiary of the Belgian company Sibeka (Societe d'Entreprises et d'Investissements S.A.), continued exploration for diamonds on leased lands in Michigan and Wisconsin. Exmin also continued diamond exploration efforts in Minnesota.

Three firms continued their diamond exploration project in the State Line district on the Colorado-Wyoming border.

The Arkansas State Parks, Recreation, and Travel Commission voted 12 to 0 to enter a cooperative agreement with four mining companies to undertake a testing program at Crater of Diamonds State Park. Their vote enacted the recommendation of the Diamond Mining Task Force. The program will decide if commercial diamond mining at the park would be feasible. The four companies will pay for the testing, plus any litigation costs. Each firm also will appoint a representative to a technical advisory team that will manage the testing. The four firms are (1) Continental Diamonds, a joint venture between Continental Diamonds Inc. and Galactic Resources Ltsd., (2) Diamond Development Co., a equal ownership joint venture between Sunshine Mining Co., Rhombus Inc., Exdiam Inc., and Boulle Partnership, (3) Capricorn Diamonds Ltd., and (4) Kennecott Inc. The testing would cost about $350,000 and would include drilling about 30 core holes. Two environmental groups, the Sierra Club and Friends of the Crater of Diamonds, have promised to sue to stop the testing.

In June, the U.S. Forest Service held the first ever bid opening for quartz mining parcels in the Ouachita National Forest. A total of 76 bids, worth more than $25,000, were received on 84 parcels. The successful bids covered only 46 of the 84 parcels, representing about 522 hectares (1,289 acres) valued at $18,464. The parcels ranged in size from about 4 hectares (10 acres) to about 32 hectares (80 acres). A successful bidder will be issued a 5-year contract on the parcel and will be required to pay an annual fee to retain the contract. The revenues generated by the program, bids, and annual fees will be divided equally between the Federal and State Governments. The State plans to return its share to the county containing the lease parcel.

Mines in southern Oregon continued to produce a large amount of gem Labradorite. Production included both material that contained schiller, commonly known as sunstone, and nonschiller material, called helidorite by some. The Ponderosa Mine furnished the material to cut an extremely fine bright red color stone of over 10 carats. The mine at Opal Buttes in Morrow County continued to produce several varieties of very high-quality opal.

Hobbyist and commercial production of sapphire in Montana increased significantly during the year. Improvements in the techniques for heat treating the material and better commercial acceptance of the Montana sapphires were the major reasons for this increase. The increase in production occurred at all three of the major producing areas, the Missouri River, Rock Creek, and Yogo Gulch.

Plumbago Mining Corp. of Rumford, ME, mined amethyst for the entire permitted mining season, June through September, at the Sweden, ME, property of the Saltman family. Gems & Gemology reported production was about 2,270 kilograms, of which most was specimen quality. An officer of Plumbago reported the cutting of a 12-carat stone from material from the mine and that some material recovered would yield stones as large as 20 carats.

Sugar Hill Minerals reported the recovery of the largest gem morganite ever found in North America. The rose colored beryl was found at the company's Bennett Quarry near Buckfield, ME. The large crystal produced about 23 kilograms of varying sized blocks of gem rough for the company's gem inventory.

American Pearl Farms of Tennessee completed its third significant harvest of cultured freshwater pearls. American currently has five pearl farms under operation and purchased additional water acreage for a sixth farm to be established during 1991. The new farm will be nine times larger than the existing farms.

Pala International reported the discovery in May of the largest gem pocket found at the Himalaya Mine during the past 12 years. The pocket was approximately 0.7 by 1 by 3.7 meters and yielded about 500 kilograms of tourmaline. Approximately 50% of the material was suitable for carving or cabochons, with less than 1% suitable for faceting. The Himalaya Mine is in the Mesa Grande District of San Diego County, CA.

CONSUMPTION AND USES

Consumption of domestic gem material production was in the commercial and amateur manufacture of jewelry, for exhibit in gem and mineral collections, and for decorative purposes in statuettes, vases, and other art objects. Some industrial applications requiring clean homogeneous stones used low-quality gem diamond.

Industrial uses of tourmaline include a simple laboratory instrument to show the polarization of light, as a material to measure the compressibility of fluids, and in gages for measuring high pressures. Mortar and pestle sets, knife edges for balances, textile rollers, and spatulas are some nongem uses of agate. The manufacturing of jewel bearings for timing devices, gages, meters, and many other types of instruments requiring precision elements used natural gem material. These uses are now mostly supplied by artificial and synthetic crystalline materials.

The uses of synthetic and simulant gem crystals include applications in frequency controllers, polarizers, transducers, radiation detectors, infrared optics, bearings, strain gages, amplifiers, lasers, lenses, crucibles, and many more. A recently developed use is as connectors for optical fibers.

The estimated value of U.S. apparent consumption was a record high $3,711 million, but only a slight increase over that of 1988. The average annual estimated consumption for the past 10 years was $2,737 million, with a high of $3,711 in 1989 and a low of $1,642 in 1982. The trend for estimated consumption for the past 10 years was one of continued growth with about 199% total increase or an annual compounded growth rate of about 13%.

The value of U.S. estimated apparent consumption of diamonds increased slightly to $3.1 billion. The average annual value of apparent consumption of diamonds for the past 10 years was $2,158 million, with a high of $3,115 million in 1989 and a low of $1,642 million in 1982. The trend for the value of apparent consumption for the past 10 years was one of significant increase. The value of apparent consumption of diamonds increased 216% over the period.

The 1989 estimated apparent consumption of colored stones, led by emerald, ruby, and sapphire, was valued at $406.9 million, an increase of 31%. The annual average value of consumption of colored stones for the past 8 years was $316.0 million, with a high of $406.9 million in 1989 and a low of $252.4 million in 1982. The trend for apparent consumption of colored stones for the past 8 years was one of fluctuating increases and decreases, but the general trend was one of increased consumption.

The estimated apparent consumption of pearls—natural, cultured, and imitations—was $146.9 million, a decrease of about 18% from 1988. The value was about 53% greater than the 8-year low in 1982, but was about 18% less than the 8-year average of $178.9 million a year.

Estimated apparent consumption of synthetic and imitation gem materials decreased about 49% to $43.7 million. Average apparent consumption of synthetic and imitation gem materials for the past 8 years was $50.3 million per year, with a high of $109.1 million in 1987 and a low of $13.9 million in 1982. The trend for apparent consumption for the past 8 years was one of generally strong growth until the significant decrease in 1989. Even with the 1989 decrease, annual apparent consumption increased about 214% over the 8 years.

Estimates of U.S. diamond jewelry sales by jewelers were $11.6 billion during 1989, up slightly from the $11.3 billion in 1988.

PRICES

Demand, beauty, durability, rarity, freedom from defects, and perfection of cutting determine the value of a gem stone. But the major factor in establishing the price of gem diamond is the control over output and prices as exercised by the Central Selling Organization's (CSO) Diamond Trading Co. Ltd. The CSO is a subsidiary of De Beers Consolidated Mines Ltd.

The average U.S. wholesale asking price of the top 25 grades (D–H color and IF through VS2 clarity) of a 1-carat diamond fluctuated between $7,256 and $7,202 and was $7,044 at yearend. The average value per carat of all grades, sizes, and types of gem-quality diamond imports was $408, a 9% increase compared with that of 1988. The average value of diamond imports for the past 10 years was $407 a carat, with a high of $541 in 1980 and a low of $353 in 1984. The trend for the average annual value of diamonds imported for the past 10 years was one of general decline from the 10-year high in 1980 to stable prices in 1986, 1987, and 1988, followed by the 1989 increase.

The average yearend wholesale purchase price of a fine-quality 1-carat ruby, paid by retail jewelers on a per stone or memo basis, was $3,500, unchanged from 1988. The average value of ruby imports increased 9% to $33.75 a carat. The average annual value of

TABLE 1

PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Price range per carat[3] Jan. 1989–Jan. 1990	Average[4] July 1989
0.25	G	VS1	$1,300–$1,400	$1,400
.25	G	VS2	1,100– 1,200	1,200
.25	G	SI1	880– 970	970
.25	H	VS1	1,100– 1,200	1,200
.25	H	VS2	1,000– 1,100	1,100
.25	H	SI1	860– 950	950
.50	G	VS1	2,500– 2,700	2,900
.50	G	VS2	2,300– 2,500	2,600
.50	G	SI1	1,900– 2,300	2,200
.50	H	VS1	2,300– 2,600	2,600
.50	H	VS2	2,100– 2,400	2,400
.50	H	SI1	1,800– 2,100	2,100
.75	G	VS1	2,900– 3,500	3,300
.75	G	VS2	2,700– 3,200	3,000
.75	G	SI1	2,300– 2,800	2,600
.75	H	VS1	2,600– 3,000	2,900
.75	H	VS2	2,300– 2,700	2,600
.75	H	SI1	2,100– 2,500	2,400
1.00	G	VS1	4,600– 4,600	4,600
1.00	G	VS2	4,100– 4,100	4,100
1.00	G	SI1	3,500– 3,500	3,500
1.00	H	VS1	4,100– 4,100	4,100
1.00	H	VS2	3,600– 3,600	3,600
1.00	H	SI1	3,200– 3,200	3,200

[1] Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; H-I—traces of color.
[2] Clarity: IF—no blemishes; VVS1—very, very slightly included; VS—very slightly included; VS2—very slightly included, but not visible; SI1—slightly included.
[3] Jeweler's Circular-Keystone V. 161, No. 3, Feb. 1990.
[4] Jeweler's Circular-Keystone V. 159, No. 2, Sept. 1989.

ruby imports for the past 8 years was $25.33 per carat, with a high of $34.04 in 1982 and a low of $16.42 in 1984. The trend for the value of ruby imports for the past 8 years was one of rapid decline, 52% for the period from 1982 to 1984. This was followed by a steady, moderate increase of 16% per year.

The average yearend wholesale purchase price of a fine-quality 1-carat sapphire, paid by retail jewelers on a per stone or memo basis, was $1,400, unchanged from 1988. The average value of sapphire imports increased 5% to $24.28 per carat. The average annual value of sapphire imports for the past 8 years was $23.43 per carat, with a high of $27.97 in 1987 and a low of $18.50 in 1984. The trend for the value of sapphire imports for the past 8 years was one of fluctuating increases and decreases. The 8-year period ended with the 1989 value slightly below the 1982 value.

The average yearend wholesale purchase price of a fine-quality 1-carat emerald, paid by retail jewelers on a per stone or memo basis, was $2,750, an increase of 6%. The average value of emerald imports decreased 23% to $61.00 per carat. The average annual value of emerald imports for the past 10 years was $56.47 per carat, with a high of $78.79 in 1988 and a low of $35.06 in 1984. The trend for the value of emerald imports for the past 10 years was one of fluctuating increases and decreases from 1980 through 1984. A steady moderate growth followed, resulting in the 1989 average value being about 55% greater than the 1980.

FOREIGN TRADE

The export value of gem materials increased 17% to $1,180 million, a record high. The quantity of diamonds exported increased 17% to 692,588 carats, and the value of diamond exports increased about 20% to $1,086.6 million. The average annual quantity of diamonds exported for the past 10 years was 369,264 carats, with a high of 590,412 in 1988 and a low of 184,871 in 1982. The trend for the quantity of diamonds exported for the past 10 years was one of moderate decline, 13%, during the first 4 years, followed by significant growth, 219%, from 1982 to 1989. The average annual value of diamond exports for the past 10 years was $521.6 million, with a high of $908.9 million in 1988 and a low of $292.8 million in 1982. The trend for the value of diamond exports for the past 10 years was one of significant decline, 113%, over 4 years, followed by a moderate growth of 32% in 3 years, and then a significant growth of 136% over the last 3 years. This resulted in record exports in 1989.

The export of other precious stones, cut but unset and other than diamonds and pearls, decreased about 36% to $43.6 million. The average annual export value for the past 8 years for these natural gem stones was $39.4 million, with a high of $68.5 million in 1988 and a low of $27.7 million in 1984. The 8-year trend for the value of exports for these types of gem materials was one of increases and decreases, but ultimately resulting in a significant total increase of 131% for the period.

Exports of synthetic gem material increased by 667%, to $46.0 million. The average annual value of exports for the past 8 years was $15.6 million, with a high of $46.0 million in 1989 and a low of $6.0 million in 1987 and 1988. The 8-year trend for the value of exports was one of extreme decline, 52%, for 1982–83, followed by steady moderate growth of 62% over the next 5 years and showing a significant gain in the last year.

Export of natural, cultured, and imitation pearls, not set or strung, increased about 55% to $3.4 million.

Reexports of gem material decreased 24% to $293.2 million. The quantity of diamonds reexported decreased about 77% to 0.4 million carat, the lowest amount in the past 10 years. The value of diamonds reexported decreased about 51% to $157.1 million. The average annual quantity of diamonds reexported for the past 10 years was 1.8 million carats, with a high of 3.0 million carats in 1981 and a low of 0.4 million in 1989. The 10-year trend for the quantity of diamonds reexported was highly mixed. The period started with 2 years of extreme increase, 171%, followed by 3 years of moderate decline, 37%, followed by 3 years of essentially stabile reexports, and then the most recent declines in 1988 and 1989. The average annual value of reexported diamonds for the past 10 years was $285.0 million, with a high of $412.8 million in 1981 and a low of $157.1 in 1989. The 10-year trend for the value of reexports was one of increase, 4%, for 1980–81, moderate decline, 55%, the next 4 years, followed by 3 years of significant increase, 72%, and then the major decrease in 1989. The value of 1989 reexports was 61% less than that of 1980.

The reexport of natural gem materials, cut but not set, other than diamonds and pearls, decreased about 92% to $4.6 million, a record low for the 8-year period for which data were available. The average annual value of reexports for the past 8 years was $33.0

TABLE 2

PRICES OF U.S. CUT COLORED GEM STONES, BY SIZE[1]

Gem stones	Carat weight	Price range per carat in 1989[2]	Average price per carat[2] Jan. 1989	Average price per carat[2] Jan. 1990
Amethyst	1	$6– $18	$8.00	$13.00
Aquamarine	1	100– 250	175.00	175.00
Emerald	1	1,900–3,500	2,400.00	2,750.00
Garnet, tsavorite	1	500– 800	950.00	650.00
Ruby	1	3,000–4,000	3,000.00	3,500.00
Sapphire	1	800–2,000	1,050.00	1,400.00
Tanzanite	1	250– 350	354.00	300.00
Topaz	1	6– 12	7.50	9.00
Tourmaline, red	1	60– 125	92.50	92.50

[1] Fine quality.
[2] Jewelers' Circular-Keystone V. 161, No. 3, Mar. 1990, p. 190. These figures represent a sampling of net prices that wholesale colored stone dealers in various U.S. cities charged their cash customers during the month for fine quality stones.

million, with a high of $55.1 million in 1988 and a low of $4.6 million in 1989. The 8-year trend for the value of reexports was one of alternating decreases and increases.

The reexport of natural gem materials not cut or set, other than diamonds and pearls, increased about 473% to $127.3 million. The extremely large increase was most likely the result of reexporting colored stones to worldwide cutting centers for cutting and reexport to the United States as finished gems. The average annual value of reexports for the past 8 years was $25.0 million, with a high of $127.3 million in 1989 and a low of $1.3 million in 1987. The 8-year trend for the value of reexports was one of extreme increases and decreases, with the value over the period increasing 1,575%.

Reexports of natural, cultured, and imitation pearls and synthetic gem materials were $3.9 million and $0.4 million, respectively.

The value of gem materials imported increased slightly to a record high of $5,115 million. The value of imported gem diamonds accounted for about 85% of the total. The average annual value of gem material imports for the past 10 years was $3,661 million, with a high of $5,115 million in 1989 and a low of $2,384 million in 1982.

The value of imported gem diamonds increased slightly to a record high of $4,358 million. The 10-year trend for the value of diamond imports was one of generally steady continuous growth with an increase of 94% for the period. During the period, the value of imported uncut diamonds decreased 44%, while the value of cut stones imported increased 203%.

The imports of cut diamonds increased slightly in quantity and value to 8.9 million carats and $3,805.5 million, respectively. The average annual quantity of cut diamonds imported was 6.3 million carats, with a high of 8.9 million in 1989 and a low or 1.3 million carats in 1980. The trend for cut diamond imports for the past 10 years was one of continued increases; the period ended with imports 246% greater than at the beginning of the period. The average annual value of imported cut diamonds was $2,549.6 million, with a high of $3,805.5 in 1989 and a low of $1,256.0 million in 1980. The trend for the value of imported cut diamonds for the past 10 years was of strong growth and increases. The value at the end of the period was 203% greater than at the beginning.

The value of imports of other gem materials, led by emerald, ruby, and sapphire, was $756.4 million, about the same as those of 1988. Emerald imports increased about 19% to 207.5 million. The average annual value of emerald imports for the past 10 years was $149.8 million, with a high of $207.5 million in 1989 and a low of $120.8 million in 1982. The 10-year trend for the value of emerald imports was one of fluctuating increases and decreases resulting in a 44% increase for the period.

The value of ruby imports increased 16% to 83.4 million, the fourth highest value for the past 10 years. The average annual value of imports for the past 10 years was $75.8 million, with a high of $93.8 in 1981 and a low of $58.7 in 1987. The 10-year trend for import values was one of extreme fluctuations. The period ended with values having increased 42% from the 10-year low, but still 11% below the high for the period.

The value of sapphire imports increased 23% to $100.0 million, the high

TABLE 3

U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY

Country	1988 Quantity (carats)	1988 Value[1] (millions)	1989 Quantity (carats)	1989 Value[1] (millions)
Exports:				
Belgium	163,246	$142.4	178,220	$187.1
Canada	24,104	18.4	24,957	30.0
France	7,946	11.4	5,577	11.4
Germany, Federal Republic of	3,736	4.7	2,717	4.4
Hong Kong	92,067	208.1	112,529	234.5
Israel	169,433	137.9	222,424	192.6
Japan	74,566	196.2	65,407	199.7
Singapore	5,135	9.2	3,274	10.1
Switzerland	23,929	141.9	16,800	133.3
Thailand	16,082	12.2	39,575	16.4
United Kingdom	3,641	20.6	7,263	44.6
Other	6,527	5.9	13,845	22.5
Total	590,412	908.9	692,588	1,086.6
Reexports:				
Belgium	833,081	104.4	101,462	29.7
Canada	5,855	1.2	765	1.1
China	14,009	0.3	677	(2)
Germany, Federal Republic of	31,236	2.6	5,523	0.9
Hong Kong	34,682	19.6	28,157	19.0
India	139,684	5.0	49,240	3.4
Israel	137,820	65.9	28,464	21.6
Japan	114,904	10.2	49,227	7.1
Netherlands	89,000	9.4	12,125	3.5
Switzerland	34,234	77.5	25,401	47.4
United Kingdom	26,929	12.6	3,188	16.0
Other	83,026	10.3	53,671	7.4
Total	1,544,460	319.0	357,900	157.1

[1] Customs value.
[2] Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 4

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY

Kind, range, and country of origin	1988 Quantity (carat)	1988 Value[1] (millions)	1989 Quantity (carat)	1989 Value[1] (millions)
Rough or uncut, natural:[2]				
Belgium	305,142	$111.8	57,962	$18.0
Brazil	349,461	10.7	33,709	5.7
Israel	38,734	8.2	12,979	7.1
Netherlands	57,791	7.9	24,424	11.7
South Africa, Republic of	48,515	44.9	9,130	13.8
Switzerland	14,307	8.2	12,268	11.9
United Kingdom	619,461	317.5	747,397	254.0
Venezuela	684	.1	7,275	.9
Other	210,203	79.3	284,292	229.5
Total	1,644,298	588.6	1,189,436	552.6
Cut but unset, not over 0.5 carat:				
Belgium	1,035,452	406.7	1,531,997	962.7
Brazil	34,554	13.7	39,200	16.2
Canada	9,156	4.1	7,754	5.5
Hong Kong	285,268	63.1	101,828	48.1
India	3,758,747	886.1	3,136,459	792.4
Israel	1,109,474	532.8	1,784,444	1,104.3
Netherlands	27,588	26.8	19,227	24.1
South Africa, Republic of	5,532	5.1	10,707	15.7
Switzerland	76,169	36.8	41,986	75.6
United Kingdom	23,406	22.9	37,581	37.3
Other	160,707	37.9	138,808	57.0
Total	6,526,053	2,036.0	6,849,991	3,138.9
Cut but unset, over 0.5 carat:				
Belgium	709,527	578.9	266,164	99.0
Hong Kong	59,949	40.1	68,930	19.5
India	386,422	111.3	1,176,503	312.0
Israel	906,752	675.2	318,288	178.5
Netherlands	7,859	12.9	4,809	10.5
South Africa, Republic of	22,762	40.6	1,245	.4
Switzerland	24,281	95.1	21,420	13.4
United Kingdom	17,546	45.3	11,116	8.2
Other	92,028	81.8	151,614	25.1
Total	2,227,126	1,681.2	2,020,089	666.6

[1] Customs value.
[2] Includes some natural advanced diamond.

Source: Bureau of the Census.

value for the past 10 years. The average annual value of sapphire imports for the past 10 years was $78.7 million, with a high of $100.0 million in 1989 and a low of $50.3 million in 1980. The 10-year trend for the value of imports was one of extremely fluctuating increases and decreases. The period ended with the value 96% greater than at the beginning and at the high for the period.

The value of imported gem materials other than diamond, emerald, ruby, and sapphire decreased 15% to $365.5 million. The average annual value of imports was $314.7 million, with a high of $429.5 in 1988 and a low of $110.6 in 1980. The 10-year trend for the value of imports was one of fluctuating increases and decreases resulting in a total increase of 230% for the period.

WORLD REVIEW

Diamond sales by De Beers Consolidated Mines Ltd.'s CSO in the second half of 1989 were $1.77 billion. This was 24% less than the $2.32 billion for the first half of 1989 and 10% less than for the second half of 1988. Total diamond sales by the CSO were $4.09 billion in 1989, about 2% less than the 1988 record high of $4.17 billion. According to diamond dealers, the reduced sales were most likely the result of a sagging U.S. demand. Estimates of the annual world market for diamond jewelry are approximately $40 billion. The U.S. share of this market dropped in 1989 from the historical level of about 33% to 29%. The three largest consumers are Japan (30%), the United States (29%), and Europe (18%). The amount of diamonds in the pipeline between the CSO rough sales and the retail purchaser is of equal importance to the CSO sales. Estimates of the material in the pipeline in 1989 were about $15 to $18 billion, measured at wholesale polished prices, or 2.5 years of sales. Sales of colored gem stones remained very strong.

Natural diamond production occurs in Africa, Asia, Australia, and South America. The principal producing localities are as follows: in Africa—Angola, Botswana, Namibia, the Republic of South Africa, and Zaire; in Asia—the U.S.S.R. (Northeastern Siberia and in the Yakut, A.S.S.R.); in Australia; and in South America—Venezuela and Brazil.

Foreign countries in which major gem stone deposits (other than diamond) occur are Afghanistan (beryl, kunzite, ruby, tourmaline); Australia (beryl, opal, sapphire); Brazil (agate, amethyst, beryl, kunzite, ruby, sapphire, tourmaline, topaz); Burma (beryl, jade, ruby, sapphire, topaz); Colombia (beryl, sapphire); Kenya (beryl, garnet, sapphire); Madagascar (beryl, rose quartz, sapphire, tourmaline); Mexico (agate, opal, topaz); Sri Lanka (beryl, ruby, sapphire, topaz); Tanzania (tanzanite, garnet, ruby, sapphire, tourmaline); and Zambia (amethyst, beryl).

Angola

Endiama, the Government-owned and operated diamond mining company, sold over 1 million carats of diamonds in 1989 valued at about $200 million. But when diamonds taken in UNITA raids and smuggling are considered, the county's production was most likely nearly double the official sales. UNITA representatives recently offered $10 million worth of rough for sale on the U.S. market.

De Beers signed a declaration of intent with Endiama to help in developing Angolan diamond deposits. The agreement, worth $180 million annually, is for co-operation in prospecting, mining, and marketing. Further discussions and technical studies, leading to the establishment of a joint venture, are underway. Endiama may start marketing a "significant proportion" of production through the CSO in 1990, moving toward an exclusive agreement as production increases. It is also the intentions of the parties to build a diamond sorting building in Luanda in which to sort Angolan production before its sale to the CSO.

Australia

Poseidon Exploration Ltd. purchased Freeport Bow River Properties Inc., the joint venture of Freeport-McMoRan Australia Ltd. and Gem Exploration and Minerals Ltd. The joint venture owned and operated the Bow River alluvial diamond project. Production from Bow River averages 20% gem quality, 70% near-gem quality, and 10% bort.

Argyle Diamond Mines Pty. Ltd.'s annual diamond production from the AK-1 pipe was essentially unchanged at about 34.4 million carats. Argyle's annual production accounted for about 37% of the world's production of natural diamonds.

Many firms continued their diamond exportation efforts. Gem Exploration Ltd. reported success in a sampling program for the Kununurra Project in Western Australia, and Terres Resources NL also worked in the Kununurra area. Poseidon-Trian Minerals continued to explore in the Phillips Range in Western Australia, as did the Capricorn Resources, Copperfield, and Moonstone joint venture. Auridiam-Afro-West worked on its project at Mount Wynne in Western Australia, as

TABLE 5

U.S. IMPORTS FOR CONSUMPTION OF NATURAL PRECIOUS AND SEMIPRECIOUS GEM STONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY

Kind and country	1988 Quantity (carats)	1988 Value[1] (millions)	1989 Quantity (carats)	1989 Value[1] (millions)
Emerald:				
Belgium	11,963	$5.6	10,605	$1.2
Brazil	80,199	6.4	80,829	12.8
Colombia	243,521	63.8	429,390	73.1
France	13,817	3.2	5,345	4.0
Germany, Federal Republic of	34,376	2.4	23,902	3.2
Hong Kong	135,384	14.7	135,423	18.9
India	1,205,636	20.4	2,068,254	25.9
Israel	89,399	24.7	89,559	24.7
Japan	20,102	1.0	10,178	1.1
South Africa, Republic of	4	(2)	146	(2)
Switzerland	65,021	20.6	60,265	28.6
Taiwan	256	(2)	1,681	.7
Thailand	216,501	3.8	366,925	5.0
United Kingdom	8,026	2.9	6,187	2.5
Other	91,701	5.1	112,866	5.8
Total	2,215,906	174.6	3,401,555	207.5
Ruby:				
Belgium	8,926	1.3	7,760	1.1
Brazil	4,945	.2	8,093	(2)
Colombia	258	(2)	337	(2)
France	5,885	3.4	21,483	3.5
Germany, Federal Republic of	26,530	1.0	20,822	.8
Hong Kong	47,152	4.6	79,583	6.1
India	318,575	1.1	455,954	1.6
Israel	38,593	1.6	26,326	3.8
Japan	11,572	.8	796	.4
Switzerland	40,183	11.6	70,098	19.7
Thailand	1,822,557	40.5	1,778,218	38.9
United Kingdom	8,443	3.6	3,596	2.9
Other	61,703	2.3	73,345	4.6
Total	2,395,322	72.0	2,546,411	83.4
Sapphire:				
Australia	2,883	.2	30,439	.4
Austria	603	(2)	377	(2)
Belgium	20,024	.9	26,155	2.2
Brazil	9,528	.2	8,705	.2
Canada	16,177	.9	5,622	.6
Colombia	1,398	(2)	358	.2
France	46,296	2.3	7,825	1.4
Germany, Federal Republic of	26,750	1.0	31,999	1.4
Hong Kong	123,689	5.8	102,671	8.4
India	149,488	1.2	112,937	1.0
Israel	8,931	1.1	29,535	4.7
Japan	22,662	.6	2,532	.6

See footnotes at end of table.

TABLE 5—Continued

U.S. IMPORTS FOR CONSUMPTION OF NATURAL PRECIOUS AND SEMIPRECIOUS GEM STONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY

Kind and country	1988 Quantity (carats)	1988 Value[1] (millions)	1989 Quantity (carats)	1989 Value[1] (millions)
Sapphire—Continued				
Korea, Republic of	6,438	(2)	9,024	(2)
Singapore	4,705	$.2	481	(2)
Sri Lanka	39,259	2.4	63,184	$4.1
Switzerland	32,446	10.2	67,086	15.6
Thailand	2,878,129	50.2	3,576,666	55.1
United Kingdom	10,102	2.9	9,435	2.5
Other	110,301	1.4	34,348	1.6
Total	3,509,809	81.5	4,119,379	100.0
Other:				
Rough, uncut:				
Australia	NA	.9	NA	1.4
Brazil		29.7		36.0
Colombia		2.4		10.5
Hong Kong		.5		2.2
Nigeria		.2		.7
Pakistan		1.0		1.4
South Africa, Republic of		4.8		.2
Switzerland		1.7		1.3
United Kingdom		.6		(2)
Zambia		.9		.5
Other		5.5		11.1
Total	NA	48.2	NA	65.3
Cut, set and unset:				
Australia	NA	12.6	NA	10.7
Brazil		18.6		5.0
Canada		.4		.2
China		2.3		1.1
Germany, Federal Republic of		15.8		12.2
Hong Kong		27.4		21.2
India		5.1		3.7
Japan		144.5		118.3
Switzerland		3.1		1.3
Taiwan		11.3		1.8
Thailand		14.2		10.0
United Kingdom		1.7		2.4
Other		17.7		15.7
Total	NA	274.7	NA	203.6

NA Not available.
[1] Customs value.
[2] Less than 1/10 unit.

Source: Bureau of the Census.

TABLE 6

VALUE OF U.S. IMPORTS OF SYNTHETIC AND IMITATION GEM STONES, INCLUDING PEARLS, BY COUNTRY

(Million dollars[1])

Country	1988	1989
Synthetic, cut but unset:		
Austria	2.0	3.7
France	.6	.4
Germany, Federal Republic of	9.1	9.4
Japan	2.1	0.4
Korea, Republic of	8.1	4.3
Switzerland	6.0	3.8
Other	5.6	7.4
Total	33.5	29.4
Imitation:		
Austria	49.4	40.0
Czechoslovakia	2.7	3.1
Germany, Federal Republic of	6.7	1.6
Japan	4.6	.4
Other	6.2	12.2
Total	69.6	57.3

[1] Custom value.

Source: Bureau of the Census.

did Stockdale, a subsidiary of De Beers, in the Ellendale area. Pemlya Mines NL and Noranda Pty. Ltd.'s joint venture searched for diamonds in the Eastern Pilbara. Cluff Resources Pacific Ltd. explored the Copeon-Bingara area of New South Wales. Cambridge Gulf Exploration NL started a search for diamonds on leases covering about 2,000 square kilometers on either side of the Ord rivermouth. Quicksilver Resources was seeking investors to finance the exploration of three diamond prospects in Western Australia, the Byro Project, Mount Edith, and Tier Range. The Mount Gipps Ltd. and Reedy Lagoon Corporation NL joint venture will begin drilling for diamonds in the Reedy Lagoon region of South Australia during 1990.

Australia held its first culture pearl auction in October at Darwin. Long the leading producer in the quantity of cultured South Sea pearls, it was time also to claim the title of number one in quality. For this reason, the nine pearl farms that account for an estimated 80% of the production decided to sell the bumper pearl crops at home instead of in Japan. The auction was a large success with 60 firms worldwide spending $33.5 million. The Japanese were the largest purchaser, buying about $23 million.[1]

A new form of gem orthoclase, named Rainbow Lattice Sunstone, was discovered in an area known as the

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF PRECIOUS AND SEMIPRECIOUS GEM STONES

(Thousand carats and thousand dollars)

Stones	1988 Quantity	1988 Value[1]	1989 Quantity	1989 Value[1]
Diamonds:				
Rough or uncut	1,644	588,611	1,189	552,557
Cut but unset	8,753	3,717,151	8,870	3,805,590
Emeralds: Cut but unset	2,216	174,623	3,402	207,546
Coral: Cut but unset, and cameos suitable for use in jewelry	NA	2,967	NA	NA
Rubies and sapphires: Cut but unset	5,905	153,552	6,666	183,344
Marcasites		1,229	NA	NA
Pearls:				
Natural	NA	3,389	NA	4,382
Cultured	NA	171,693	NA	144,335
Imitation	NA	7,198	NA	5,456
Other precious and semiprecious stones:				
Rough, uncut	NA	48,186	NA	65,298
Cut, set and unset	NA	79,056	NA	55,909
Other	NA	19,795	NA	NA
Synthetic:				
Cut but unset	81,096	28,995	99,292	29,368
Other	NA	4,485	NA	3,441
Imitation gem stone	NA	62,404	NA	57,323
Total	XX	5,063,334	XX	5,114,549

NA Not available. XX Not applicable.
[1] Customs value.

Source: Bureau of the Census.

Mud Tank Zircon Field in the Harts Range of the Northern Territory. The material was named for the unique lattice pattern of aventurescence it displays. Inclusions of ilmenite and hematite oriented on the crystal lattices causes this effect.[2]

Heavy rains during the month of March severely disrupted opal production from Coober Pedy, Mintabie, and Andamooka. The rains collapsed mine shafts and flooded tunnels and opencut mines. It will take 6 months, and in some cases a year, to get back into full production. The lost production will result in an increase in the price of Australian opal.

Brazil

Glencairn Explorations Ltd. received a positive feasibility study on the Feijao Cru diamond deposit in Bahia. It was estimated that production would be 42,000 to 84,000 carats annually and would average 80% gem quality. The original discovery was made by Mineracao Piracicaba Ltd., a Brazilian company. Glencairn can earn 50% interest in Piracicaba by investing an additional $250,000. There are about 25 small mines operating in the Chapada Diamantina region of Bahia.

Mineracao Tejucana, the joint venture between Sibeka's wholly owned Sibradiam Participacoes Ltda. and Union Miniere, produced more than 34,000 carats of diamonds and 107 kilograms of gold from its dredging operations on the Jequitinhoha River. The joint venture operated four dredges on the Lamarao flat and a fifth dredge was located outside of the main production area.

A discovery of tourmaline of unusual colors was made in Paraiba. The material, called "Paraiba" tourmaline, ranged in color from a highly saturated medium bluish green to medium dark blue-green and to a dark blue to violetish blue. The saturation and depth of color is outstanding. The stones demand a high price with 30 to 50 point stones selling for as much as $150 per carat and 5-carat stones going for as much as $2,500 per carat.

Canada

Cameco and Uranerz Exploration and Mining reportedly found seven kimberlite pipes on their joint-venture Fort a la Corne property east of Prince Albert, Saskatchewan. Microdiamonds were found in one pipe. The two firms have staked 170,000 hectares for exploration in the Fort a la Corne area. Additionally, Uaranerz is acquiring land to the north in the Choiceland-Snowden-Smeaton area for exploration. The race to claim land for diamond exploration in Saskatchewan is growing. The staking of a 200,000 hectare parcel between Prince Albert and Saskatoon increased the total amount of land held for diamond exploration to 647,000 hectares. Monopros, the Canadian exploration arm of De Beers, started the staking rush in 1988.

Corona Corp. discovered kimberlite rocks on the Sturgeon Lake exploration property of Claude Resources. A drill intersected kimberlite at a depth of 37 meters and was still in kimberlite at 111 meters. To date, there is no indication that the kimberlite contains diamonds; additional work will be necessary to determine if diamonds are present. The property is located north of Prince Albert, Saskatchewan.

Central African Republic

A joint venture, founded in 1987 between Osborne & Chappel Goldfields and Societe d'Enterprise et d'Investissements SA, continued their diamond exploration program with encouraging results. The joint venture has exploration rights for alluvial diamonds along a 170-kilometer stretch of the Mamber River. To date, reconnaissance drilling, geophysical testwork, and small-scale bulk sampling has been completed.

China

The production of colored gem stones increased about 30% in the past year. The five most commonly mined gem stones were aquamarine, tourmaline, sapphire, topaz, and nephrite jade. Other gem materials produced include amazonite, amber, amethyst, andalusite, aventurine, azurite, bowenite, diopside, garnets, jet, kunzite, malachite, peridot, quartz, ruby, turquoise, and zircon.[3]

Ashton Mining Ltd. of Australia was granted exclusive exploration, mining, and marketing rights for diamonds in the Hunan Province. The company will share equally in any production, processing, and sale of diamonds with the provincial government. A cutting factory will be established in Hunan when diamond production begins.

In Laioning Province, the Wafandian diamond deposit, potentially the largest in China, is being developed for mining and is scheduled to begin operation in late 1990. Production is forecasted to be 118,000 carats per year. The Wafandian Mine would be China's fifth diamond mine, joining the Bin-Hai also in Laioning Province, and the Chang Ma, Tao Cheng, and Linshu Mines in Shandong Province.

Columbia

At the Muzo emerald mine in Boyaca, two major leaseholders, Tecminas and Coesminas, have begun using shafts and underground tunnels in addition to strip mining to recover emeralds. The relative flatness of the Muzo mining area and the accumulation of hundreds of years of mine tailings resulted in limiting access to some areas for production and exploration. The shafts and tunnels may allow the producers to relocate some of the old production veins and to discover new productive areas. The tunnels have encountered problems both with ground support and the inflow of water.[4]

Finland

The Finnish Geological Survey (GSI) reported the discovery of a 2,250-carat emerald. The totally transparent gem was estimated to be valued at approximately $250,000. The GSI drew up plans to intensify the exploration work in a 2-hectare area.

Guinea

A 255.61-carat diamond, recovered from the Aredor Mine, was purchased for slightly more than $10 million. At $39,300 per carat, it was not the highest per carat price ever paid for a rough diamond; a 181.77-carat rough diamond from Aredor sold for $47,400 per carat in 1988. However, the total purchase price was the highest ever paid for a rough diamond. In February, Aredor was granted a 405-square-kilometer extension to its mining lease. The new ground is believed to contain high-quality alluvial reserves.

India

During fiscal year April 1, 1988, to March 31, 1989, the value of finished diamonds exported increased 75% to $2.95 billion. The value was the greatest for any country and accounted for about 28% of the value of diamonds and 70% of the stones used in diamond jewelry. The increase was the result of a general increase in demand for diamonds, a depreciation of the rupee, falling labor costs, and favorable Government policies aimed at boosting exports. India plans to increase its share of the market to near 50% of the value within 2 years. The diamond industry employs approximately 1 million skilled and semi-skilled workers.

The Indian Minerals Exploration Corp. Ltd. and the French BRGM company entered into an agreement to explore for diamonds and develop any commercial deposits discovered in the Pana, Krishna, and Vajnakarur areas.

Israel

Diamond imports and exports increased for the year. Imports increased about 6% to $2.6 billion and exports were approximately $2.7 billion, an increase of over 7% compared with that of 1988. Approximately 43% was exported to the United States and about 35% to the Far East.

Dov Riger of Israel and Tasaki Shinju of Japan opened a joint-venture automated polishing factory at Beit Shean, in northern Israel. The factory employs 30 workers using automatic piermatic polishing machines. The entire output of the factory is committed to the Japanese parent company. Tasaki Shinju has annual sales of about $200 million.

Namibia

Consolidated Diamond Mines of South-West Africa (CDM), the De Beers Consolidated Mines, Ltd. subsidiary that controls the majority of the diamond mining concessions in Namibia, began development of two new diamond operations. The Elizabeth Bay operation will recover about 250,000 carats per year of small stones from windblown deposits. The mine is located about 30 kilometers south of the town of Luderirtz and will mine and process about 4 million metric tons per year during its projected 10-year life. Production is scheduled to begin in March 1991. The Auchas Mine along the Orange River will recover about 40,000 carats per year of large stones. The mine is scheduled to begin production in July 1990. CDM also is undertaking offshore diamond recovery research at depths of up to 90 meters in its offshore concessions.[5]

The Namibian West Coast Diamond Co. started a major exploration program in the deep-sea area of its concession. The concession starts about 2 kilometers offshore, continues to about 10 kilometers, and is roughly 90 kilometers long. A 250-ton survey and research vessel was purchased to survey, test, and map the deepwater area. In the past 2 years, the company has recovered about 26,000 carats of diamonds from the concession. However, it is estimated that large-scale commercial mining of the concession is still 10 years in the future.

It was reported that in Swakopmund, fake diamond octahedra and imitation tsavorite garnet rough were being sold to gem stone buyers. The fake diamonds were made from cubic zirconia and the tsavorites from cut green bottle glass.

Sierra Leone

In January, the Ministry of Mines began issuing export licenses to private firms and individuals for the export of diamonds. The Ministry granted 26 licenses for diamond exporting, 11 of which were granted to foreign individuals or companies. Applicants must pay a fee for the licenses, a fixed fee and/or a royalty, post a performance bond of $500,000, and must achieve a performance goal of exporting 250,000 in diamonds monthly, or forfeit the bond. The new regulations eliminate the diamond dealers and recognizes only two legal players in the diamond fields—the miners and the exporters. The Ministry believes that privatization will increase diamond production as well as increasing diamonds sold or exported through official markets.

South Africa, Republic of

The Kim Diamond Cutting Works, currently under construction, will process 30,000 carats of rough a week. The cutting factory will employ at least 1,280 workers. Using local rough, it will process stones from 1 to 30 points for the overseas market. The factory is scheduled for completion by the end of April 1990.

A new open pit diamond mine, the Samanda, is being developed in the Orange Free State Province. The mine is forecasted to begin production in the second quarter of 1990. The developer is apparently a private concern.

De Beers announced that, in cooperation with Saturn Mining Ltd. of the Anglovaal group, it will open a new diamond mine on the Venetia farm in The Transvaal. The mine will cost approximately $280 million and will be the largest investment De Beers has ever made in a single mine. The mine is scheduled to begin production in the second half of 1990 at a rate of about 4 million carats per year.

Gemgold Mining Ltd. commenced mining diamonds from a open pit mine in the Cape Province. The company expects to produce about 40,000 carats in 1990 and 100,000 carats in 1991.

Tanzania

Williamson Diamonds Co. received a $4.7 million loan from Willcroft Co. Ltd. The funds will be used to modernize Williamson's diamond treatment plant, which has been in operation for over 30 years. The condition of the treatment plant has adversely affected Tanzania's diamond production for a number of years.

Zaire

In April, the Government of Zaire enacted new regulations on the purchase and export of diamonds. The purchasers of artisanal diamonds, called comptoirs, were required to pay a license fee and deposit of $300,000, compared with the old fee and deposit of $100,000. Additionally, comptoirs were allowed to purchase diamonds in Kinshasa if stones were offered for sale. Because Kinshasa is not an official buying location, there are not the same controls that are present in the interior where representatives from the National Evaluation Center are required to be present at all transactions.

Pilfering and smuggling from the diamond-producing areas was rampant according to the Societe Miniere de Bakwanga (Miba). Miba estimated that illegal mining and trafficking of diamonds in the two Kasai provinces cost the Government somewhere between $140,000 and $350,000 every month. Tough security measures are difficult to enforce because state security men connive with the smugglers, giving them protection as they go about their business. The law allows Zairian nationals the freedom to mine industrial diamonds anywhere in the country as long as the diamonds are sold through Miba. The system is no longer working because of access to better markets outside of Miba.

A substantial diamond deposit was reportedly discovered at a rubber plantation owned by the Amcit Blattner family at Kaparata. The plantation was sealed off by soldiers, which denied the owners access. The Blattners may enter into an agreement with a well-known diamond firm to exploit the deposit. It is possible that local residents are digging diamonds after gaining access by bribing the soldiers that are guarding the plantation.

Zambia

The Government of Zambia centralized the future marketing of emeralds by allowing the export only of cut and polished stones. Gem-Impex Ltd. of Zurich, Switzerland, was appointed the sole distributor of emeralds cut and polished in Zambia to implement the centralization. Gem-Impex will market Zambian emeralds worldwide for the state-owned Zambian Emerald Industries Ltd. Zambian Emerald, which operates a 50-cutter factory in Ndola, has the exclusive right to cut and polish emeralds produced in Zambia. Production from the Ndola factory was about 5,000 carats per month in a variety of shapes and sizes.

CURRENT RESEARCH

Mr. Zvi Yehuda of Ramat Gan, Israel, developed a new diamond enhancement process. The process improves the apparent clarity of diamonds by filling surface-reaching cleavages and fractures. The process replaces the air that normally fills the cleavages and fractures with a transparent material that has an index of refraction near that of diamond. The result is that the cleavages and/or fractures are less visible and thus the appearance and apparent clarity of the diamond is improved. The treatment can be detected using a standard darkfield-equipped gemological microscope. The orange and blue flash effects, flow structures, and flattened, trapped gas bubbles evident in the filled areas are easily detected. Yehuda also has founded a firm in the United States that uses a similar procedure to improve the appearance and apparent clarity of emeralds.[6]

The technology to improve the apparent color of diamonds in the very light to light yellow color ranges has been used occasionally to increase the value of a stone. The addition of a grayish or bluish material to the surface of "J" or "K" color stones can give the stone the appearance of a "G" color. This deceptive treatment could affect the value of a 1.00 carat "VS1" "K" stone by as much as $1,600 by changing its appearance to that of a "VS1" "G." The coating may be a fluoride compound similar to that used for lens coating in optics. The coating generally can be detected by careful examination under 30 to 45 power magnification.

Miners from Santa Terezinha de Goias, Brazil, developed a new process for treating rough and cut emeralds to improve their appearance, similar to the use of oil and Canada balsam on emeralds in the past. The treatment is based on the filling of the fractures that reach the surface of the stones. The stones are cleaned, dried, heated, and then treated with a synthetic fracture sealant marketed under the trade name Opticon. Individuals in the United States have improved and expanded upon the process to include treating stones, primarily cut emeralds, with Opticon in a heated vacuum vessel.

OUTLOOK

World demand for gem diamond can be expected to rise because of the rising average personal income of the population of the United States and other industrialized countries. Demand is expected to increase because of highly effective promotional campaigns. These promotions are changing social customs in many Far East countries, particularly in the use of diamond engagement rings.

TABLE 8

DIAMOND: WORLD PRODUCTION, BY TYPE AND COUNTRY[1]

(Thousand carats)

Country	Natural													Natural			
	1985			1986			1987			1988[p]			Synthetic[3]	1989[e]			Synthetic[3]
	Gem[2]	Industrial	Total	Gem[2]	Industrial	Total	Gem[2]	Industrial	Total	Gem[2]	Industrial	Total		Gem[2]	Industrial	Total	
Angola	464	250	714	240	10	[e]250	180	10	[e]190	950	50	[e]1,000	—	950	50	1,000	—
Australia	4,242	2,828	7,070	13,145	16,066	29,211	13,650	16,683	30,333	17,517	17,517	35,034	—	17,540	17,540	35,080	—
Botswana	6,318	6,317	12,635	9,590	3,500	[r]13,090	9,368	3,840	13,208	10,660	4,569	15,229	—	10,676	4,576	[4]15,252	—
Brazil	233	217	450	310	315	625	320	325	645	353	180	533	—	350	200	550	—
Central African Republic	190	87	277	259	99	358	304	108	412	284	59	343	—	280	60	340	—
China[e]	200	800	1,000	200	800	1,000	200	800	1,000	200	800	1,000	15,000	200	800	1,000	15,000
Cote d'Ivoire (formerly Ivory Coast)[e] [5]	15	5	20	10	4	14	15	6	21	[r]8	[r]3	[r]11	—	11	4	15	—
Czechoslovakia	—	—	—	—	—	—	—	—	—	—	—	—	[e]5,000	—	—	—	5,000
France	—	—	—	—	—	—	—	—	—	—	—	—	[e]4,000	—	—	—	4,000
Ghana[6]	60	576	636	88	498	[r]586	65	400	465	165	495	[r] [e] [7]660	—	168	452	[7]620	—
Greece	—	—	—	—	—	—	—	—	—	([8])	—	([8])	[e]1,000	—	—	—	1,000
Guinea[6]	123	9	132	190	14	204	163	12	175	136	10	146	—	[4]138	[4]10	[4]148	—
Guyana[e]	4	7	11	3	6	[4]9	[r]2	[r]5	[r]7	1	3	[4]4	—	2	3	5	—
India	14	2	16	13	3	16	13	3	[r]16	12	3	15	—	3	11	14	—
Indonesia[e]	5	22	27	[r]6	22	[r]28	[r]7	[r]22	[r]29	[r]7	[r]22	[r]29	—	7	25	32	—
Ireland	—	—	—	—	—	—	—	—	—	—	—	—	[r]60,000	—	—	—	60,000
Japan	—	—	—	—	—	—	—	—	—	—	—	—	[e]25,000	—	—	—	25,000
Liberia	66	72	138	63	189	252	60	190	[e]250	67	100	167	—	68	102	170	—
Namibia	865	45	910	970	40	1,010	971	50	1,021	901	37	938	—	970	30	1,000	—
Romania	—	—	—	—	—	—	—	—	—	—	—	—	[e]5,000	—	—	—	4,500
Sierra Leone[5]	243	106	349	215	100	315	150	75	225	100	75	[e]175	—	100	75	175	—
South Africa, Republic of:																	
Finsch Mine	1,770	3,184	4,954	1,821	3,208	5,029	1,455	2,701	4,156	1,372	2,548	3,920	—	1,613	2,997	[4]4,610	—
Premier Mine	820	1,864	2,684	882	1,977	2,859	772	1,713	2,485	696	1,543	2,239	—	689	1,526	[4]2,215	—
Other De Beers' properties[9]	1,500	569	2,069	1,428	529	1,957	1,427	546	1,973	1,388	531	1,919	—	1,360	520	[4]1,880	—
Other	460	35	495	342	41	383	409	30	439	361	65	[r] [e]426	—	348	63	411	—
Total	4,550	5,652	10,202	4,473	5,755	10,228	4,063	4,990	9,053	[r]3,817	[r]4,687	[r] [e]8,504	[r] [e]55,000	4,010	5,106	9,116	60,000
Swaziland	13	8	21	23	16	39	[r]48	[r]32	[r] [e]80	44	29	73	—	33	22	[4]55	—
Sweden	—	—	—	—	—	—	—	—	—	—	—	—	[e]25,000	—	—	—	25,000
Tanzania	165	71	236	133	57	190	105	45	[e]150	105	45	[e]150	—	105	45	150	—
U.S.S.R.[e]	4,400	6,400	10,800	4,400	6,400	10,800	4,400	6,400	10,800	4,500	6,500	11,000	41,500	4,500	6,500	11,000	41,500
United States	—	—	—	—	—	—	—	—	—	—	—	—	W	—	—	—	W
Venezuela	35	180	215	45	189	234	35	63	98	55	53	108	—	55	60	115	—
Yugoslavia	—	—	—	—	—	—	—	—	—	—	—	—	[e]5,000	—	—	—	5,000
Zaire	4,032	16,127	20,159	4,661	18,643	23,304	3,885	15,540	19,425	2,734	15,493	18,227	—	2,850	16,150	19,000	—
Total	[r]26,237	[r]39,781	66,018	[r]39,037	[r]52,726	[r]91,763	38,004	49,599	87,603	42,616	50,730	93,346	[e]241,500	43,016	51,821	94,8372	46,000

[e] Estimated. [p] Preliminary. [r] Revised. W Withheld to avoid disclosing company proprietary data.

[1] Table includes data available through May 16, 1990. Total diamond output (gem plus industrial) for each country actually is reported except where indicated by a footnote to be estimated. In contrast, the detailed separate production data for gem diamond and industrial diamond are Bureau of Mines estimates in the case of every country except Australia (1985–87), Botswana (1987), Brazil (1987), Central African Republic (1985–88), Guinea (1985–89), and Liberia (1985–86), for which source publications give details on grade as well as totals. The estimated distribution of total output between gem and industrial diamond is conjectural, and for most countries, is based on the best available data at time of publication. Estimated distribution figures have been revised as necessary to correspond to reported total production figures.

[2] Includes near-gem and cheap-gem qualities.

[3] Includes all synthetic diamond production.

[4] Reported figure.

[5] Figures are estimates based on reported exports and do not include smuggled diamonds.

[6] Figures do not include smuggled artisanal production.

[7] Includes estimates for artisanal production.

[8] Revised to zero.

[9] Other De Beers' Group output from the Republic of South Africa includes Kimberley Pool, Koffiefontein Mine, and the Namaqualand Mines.

The changes are resulting in significant growth in the diamond market.

Demand for other precious gems will continue to grow as diamonds become more expensive and the popularity and acceptance of colored stone increases. Demand for synthetic and simulant gem materials for both personal and industrial consumption is expected to increase. The diversity of sizes, types, uses, and values of gem materials precludes any meaningful forecasting of future demand.

BACKGROUND

The history of production and preparation of gem stones begins with the wearing of items for personal adornment in prehistoric times. This preceded even the wearing of clothes. Amber was mined in the Baltic countries for use as a gem material before 25000 B.C. Later, the Phoenicians in their writings described trade routes to the Baltic for amber and to areas in Asia and Africa for other gem materials. The voyages of Columbus brought increased interest in gem deposits, especially emerald, in South America. The discovery of diamond in Africa in 1859 focused major interest on Africa. More recently, the discovery of diamond in Western Australia in 1967 has resulted in the development of one of the largest deposits in the world.

Commercial mining of gem materials has never been extensive in the United States. Although more than 60 gem minerals and materials have been produced commercially from domestic sources, most of the deposits are relatively small. In many instances, production rests in the hands of the numerous hobbyists and members of mineralogical and lapidary clubs. The Crater of Diamonds State Park near Murfreesboro, AR, is open to the public on a daily fee basis. Many gem-quality stones are found there each year.

Definitions, Grades, and Specifications

Select rocks, certain varieties of mineral specimens, and some organic materials such as pearl, amber, jet, and coral are included in gem stones data. Customarily, diamond, ruby, sapphire, and emerald are considered the major gems.

The designation "gem stone" refers to a material appropriate for personal adornment. The most important qualities of gem stones are beauty, durability, uniqueness, and rarity. Beauty, indicated as splendor, purity, or attractiveness, is judged mainly according to the taste of the beholder and includes such appearances as luster, transparency, brilliance, and color. Luster of a mineral or stone is independent of color and is the surface appearance in reflected light. Apart from materials that have a metallic luster, the chief contributors to luster are transparency and refractive index. The perfection of polish enhances the luster of a stone. Visible imperfections impair the luster of transparent stones. However, defects, described as "jardens" or "inclusions," may enhance the beauty and value of natural rubies, sapphires, and other gem stones and may be used to identify the country of origin and even the mine. Durability is measured by the resistance of a stone to abrasion, pitting, chipping, or splitting. Resistance to abrasion is correlated with relative hardness, but intrinsic brittleness and toughness indicate resistance to wear in other aspects. Rarity is an essential qualification and is more important for some stones in determining their value than their physical characteristics.

Of the 1,500 mineral species, only about 100 possess all of the attributes required in gems. Silicates furnish the greatest number, including such minerals as beryl, topaz, tourmaline, and feldspar. Oxides such as corundum (ruby and sapphire) and quartz (amethyst, agate, etc.) comprise the second largest group. Sulfides, carbonates, and sulfates are of small importance; the phosphates yield only turquoise and variscite. An exception is pearl, essentially calcium carbonate, which is ranked high as a gem. Diamond, the best known gem stone, is an isometric crystalline form of the element carbon.

In general, gem materials are classified the same as minerals, that is, into group, species, and variety. Group refers to two or more gem materials that are similar in crystal structure and physical properties but have different chemical properties. Each individual member of the group is called a species. Varieties of species have similar crystal structure and chemical characteristics but differ in color. An example of this would be the hessonite variety of the grossular species of the garnet group.

Products for Trade and Industry

Cutting and polishing of gem materials are done to obtain the most effective display of the material. No significant change is made in the fundamental properties, and the preparation is intended to enhance the desirable characteristics that are present initially. Gem materials are cut into gem stones in three main styles; cabochons, baroque, and faceted.

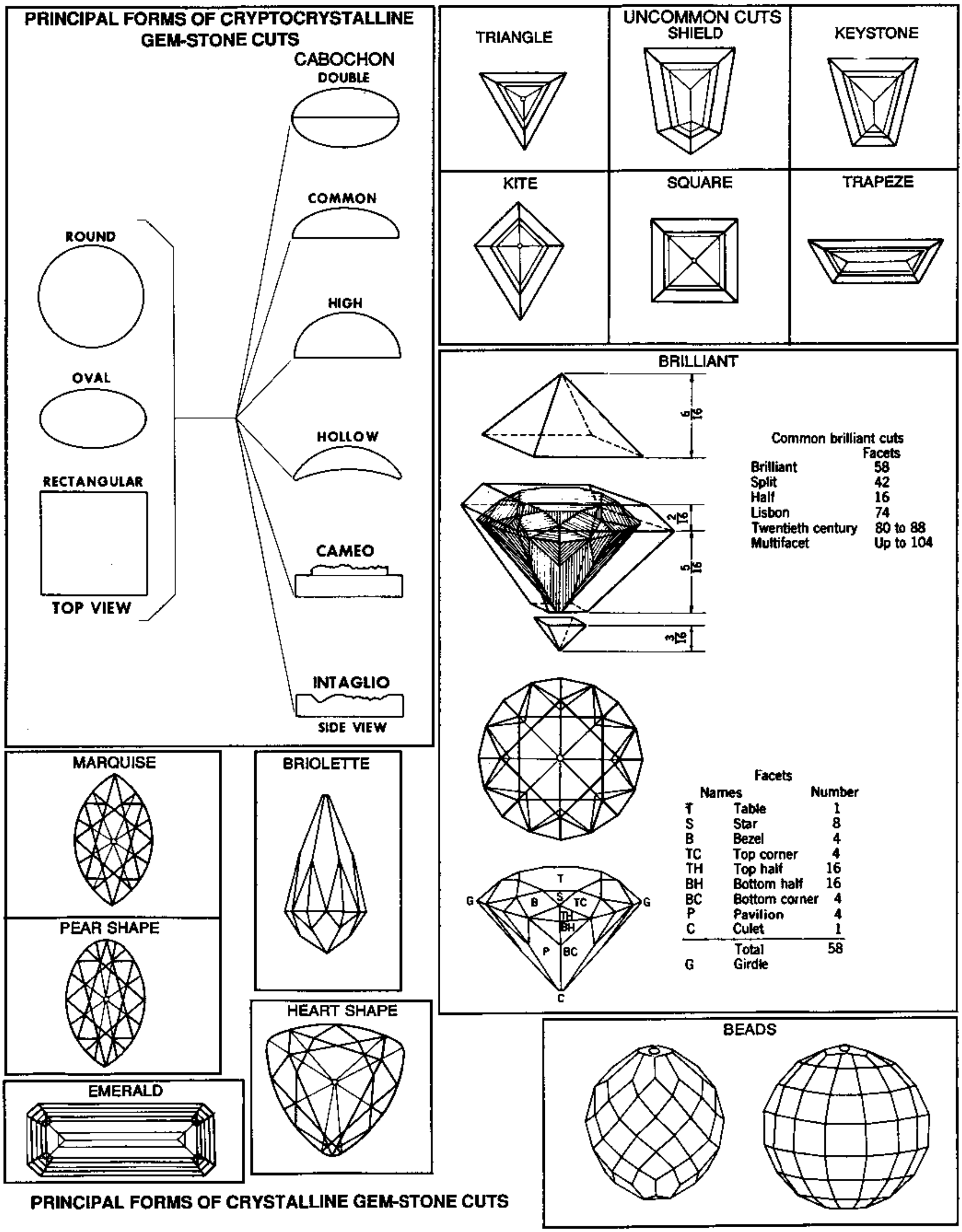
Cabochons are cut in four operations: sawing, grinding, sanding, and polishing. Sawing, the initial step in cutting, is customarily done with a diamond saw to obtain a slab or slice of the desired size and thickness from the rough gem material. The cabochon outline is scribed onto a flat surface, most often using a template for making a standard size for jewelry mountings. Rough grinding of the stone may be by metal-bond diamond, silicon carbide, or aluminum oxide wheels or coated abrasive disks. In grinding, the hardness of the gem material determines the grit and hardness of the abrasive used. Multiple grinding steps starting with 80- to 100-mesh (grit) through 600-mesh abrasives are normally used. The scratches left by grinding are removed by progressively finer grinding and sanding. Disk or belt sanders use bonded to cloth abrasives, waterproof reinforced paper abrasives, or cloth charged with abrasive pastes. The final polish is obtained by using hard felt, wood, or leather laps, with various polishing agents such as fine diamond compound, tin oxide, tripoli, chromium oxide, cerium oxide, alumina, and rouge.

Polished irregular shapes are called baroque gems. An inexpensive method of polishing baroque gems consists of tumbling them in rubber-lined drums, using a grinding and polishing medium with or without water.

Facet cutting is employed ordinarily on transparent gem stones to increase brilliancy and appearance and is generally confined to the harder materials. Softer materials may be faceted, but extreme care must be exercised in cutting and polishing the stones and in their use in jewelry. The "round brilliant" cut, most commonly used in faceting, has 58 facets, 33 above the circle "girdle" and 25 below it, arranged in eightfold symmetry. The

FIGURE 1

PRINCIPAL FORMS OF CRYPTOCRYSTALLINE AND CRYSTALLINE GEM STONE CUTS



"round brilliant" and some other common cuts are illustrated in figure 1.

Industry Structure

The world market for diamonds is controlled by De Beers Consolidated Mines Ltd. It is by far the most strictly controlled of the world's commodity markets. An estimated 80% to 85% of gem and natural industrial diamond is marketed by De Beers' wholly owned subsidiary, the Diamond Corp. Ltd. The marketing is done through the CSO by the Diamond Trading Co. Ltd. and the Industrial Distributors Ltd., divisions of the CSO. The CSO sells uncut gem diamonds on behalf of De Beers and most other major producers at sights (approved bidder viewings) in London, England; Lucerne, Switzerland; and Kimberley, Republic of South Africa.

Diamonds reach the CSO sights through three channels. First, South African and Namibian production goes directly to the Diamond Producers Association. The principal members of this association are De Beers, the South African Government, and the Namibian administration. Second, contractual sales by foreign producers are handled by the Diamond Corp. Ltd., which represents the foreign producers on the Diamond Producers Association. Third, open-market competitive sales and West African sales go directly through the Diamond Trading Co.

The Diamond Producers Association funnels the production of the first two groups into the Diamond Purchasing and Trading Co. (50% held by De Beers), part of the CSO. From this point, the diamonds go through the Diamond Trading Co. The Diamond Trading Co. markets diamond to South African cutters at a 10% discount on world prices; and, through its branch in London, diamonds are sold at sights on world markets. The third group's production is handled directly by the Diamond Trading Co.'s London Branch.

The CSO has been extremely successful at maintaining the rough diamond market for about 100 years. In modern times there has never been a decrease in CSO's price of rough diamonds. Table 9 illustrates the timing and the amounts of the average CSO price increases for rough gem diamonds from 1949 until the present. The compounded effect of these increases is a price increase of about 1,800% over the approximate 41.5 years. Thus, a piece of rough that sold for $100 in August 1949 would sell for about $1,800 in April 1990.

For more than 30 years, the major diamond cutting and polishing centers of the world were located in Belgium and Israel, with a certain amount of the larger stones being cut in the United States. Today there is estimated to be over 450,000 cutters as the result of the development of a large cottage industry in India that started in the early 1980's. This has had a major impact on world diamond trade. Indian consumption of most of the world's small-gem, cheap-gem, and near-gem rough material in the manufacture of small stones resulted in annual cut-stone exports of almost $3 billion from April 1, 1988, to March 31, 1989. These small stones averaged less than one-fifth of a carat (0.20 carat). The availability of small inexpensive stones resulted in substantial changes in the design of jewelry. The utilization of small cut diamond stones (usually 0.07–0.14 carats each called melee) to create a pavé effect (set close together to conceal the metal base) is but one example. Cutting and polishing of colored, synthetic, and simulant gem stones is centered in Thailand, India, Hong Kong, and Brazil, where cheap labor and favorable export laws ensure the lowest total costs for finished gems.

Geology-Resources

Gem materials occur in a large variety of igneous, metamorphic, and sedimentary rocks and mineral deposits, usually as a small fraction of the total deposit. The origins are as varied as the occurrences. Principal formation of gem materials is by precipitation from watery solutions, by crystallization from molten rock, and by metamorphic processes. Approximately one-third of gem minerals are composed of silicate minerals, about one-fifth of alumina-silicates, and nearly one-seventh of oxides. The remaining compositional groups include the sulfides, phosphates, borosilicates, carbonates, and, in the single case of diamond, an element. The composition of selected gem materials is included as one of the items in table 10.

The United States has no defined large resources of major gem materials. Emerald deposits are known in North Carolina, as are ruby and sapphire. Historically, sapphires have been mined in Montana, and commercial mining once again is underway. Numerous other domestic deposits of gem minerals are known and have been mined for many years. However, no systematic evaluations of the magnitude of these deposits have been made, and no positive statements can be made about them.

Occasional finds of diamond have been made, but no great diamond pipes or alluvial deposits similar to those of Africa have been reported. Several companies are involved in diamond exploration in the Colorado-Wyoming State Line area, in Michigan, Minnesota, Wisconsin, and Arkansas. Diamond-bearing kimberlites have been located, and bulk samples have been processed for diamond recovery. Results have not been made public.

World resources of gem materials are nearly all unevaluated. However, world gem diamond reserve is estimated to be about 300 million carats, including

TABLE 9

DE BEERS CSO ROUGH DIAMOND PRICE INCREASES, BY PERCENTAGE

Sept. 1949	25.0%	Nov. 1967	16.0%	Aug. 1973	10.2%	Sept. 1982	2.5%
Mar. 1951	15.0	Sept. 1968	2.5	Dec. 1974	1.5	Apr. 1983	3.5
Sept. 1952	2.5	July 1969	4.0	Jan. 1976	3.0	Aug. 1986	7.5
Jan. 1954	2.0	Nov. 1971	5.0	Sept. 1976	5.8	Nov. 1986	7.0
Jan. 1957	5.7	Jan. 1972	5.4	Mar. 1977	15.0	Sept. 1987	10.0
May 1960	2.5	Sept. 1972	6.0	Dec. 1977	17.0	Apr. 1988	13.5
Mar. 1963	5.0	Feb. 1973	11.0	Aug. 1978	30.0	Mar. 1989	15.5
Feb. 1964	7.5	Mar. 1973	7.0	Sept. 1979	13.0	Mar. 1990	5.5
Aug. 1966	7.5	May 1973	10.0	Feb. 1980	12.0		

TABLE 10

GUIDE TO SELECTED GEM STONES AND GEM MATERIALS USED IN JEWERLY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0-2.5	1.0-1.1	Single	1.54	Synthetic or pressed, plastics	Fossil resin, soft.
Beryl:										
Aquamarine	Beryllium alluminum silicate	Blue-green to light blue	do.	Medium to high	7.5-8.0	2.63-2.80	Double	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Emerald	do.	Green	Medium	Very high	7.5	2.63-2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet, doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5-8.0	2.63-2.80	do.	1.58	Genuine emerald	Flaws, brilliant, fluorescence in ultraviolet light.
Golden	do.	Yellow to golden	Any	Low to medium	7.5-8.0	2.63-2.80	do.	1.58	Citrine, topaz, glass, doublets	
Morganite	do.	Pink to rose	do.	do.	7.5-8.0	2.63-2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Refractive index.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	Low	3.0	2.72	Double (strong)	1.49-1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.6	do.	Banded, translucent.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day, red by artificial light	U.S.S.R. (small), Sri Lanka (medium)	High	8.5	3.50-3.84	Double	1.75	Synthetic	Dichroism, inclusions in synthetic sapphire.
Catseye	do.	Greenish to brownish	Small to large	do.	8.5	3.50-3.84	do.	1.75	Synthetic, shell	Gravity and translucence.
Chrysolite	do.	Yellow, green, and or brown	Medium	Medium	8.5	3.50-3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Coral	Calcium carbonate	Orange, red, white, black, or green	Branching, medium	Low	3.5-4.0	2.6-2.7	do.	1.49-1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95-4.10	do.	1.78	Synthetics, including spinel	Inclusions, fluorescence.

See footnotes at end of table.

TABLE 10—Continued

GUIDE TO SELECTED GEM STONES AND GEM MATERIALS USED IN JEWERLY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Corundum—Continued										
Sapphire	Aluminum oxide	Blue	Medium	High	9.0	3.95–4.10	Double	1.78	Synthetics, including spinel	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, white, orange, green, or violet	Medium to large	Medium	9.0	3.95–4.10	do.	1.78	Synthetics, glass and doublets	Inclusions, double refraction, refractive index.
Sapphire and ruby stars	do.	Red, pink, violet blue, gray	do.	High to low	9.0	3.95–4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color on side view.
Sapphire or ruby synthetic	do.	Yellow, pink, blue, or red	Up to 20 carats	Low	9.0	3.95–4.10	do.	1.78	Synthetic spinel, glass	Curved strae, bubble inclusions.
Diamond	Carbon	White, blue-white, yellow, brown, green, pink, blue	Any	Very high	10.0	3.516–3.525	Single	2.42	Zircon, titania, cubic zirconia	High index, dispersion, single refraction, hardness, cut, luster.
Feldspar:										
Amazonstone	Alkali aluminum-silicate.	Green	Large	Low	6.0–6.5	2.56	—	1.52	Jade	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play	do.	do.	6.0–6.5	do.	—	1.56	do.	do.
Moonstone	do.	White	do.	do.	6.0–6.5	2.77	—	1.52–1.54	Glass or white onyx	Blue sheen, opalescent.
Garnet	Complex silicate	Brown, black, yellow, green, ruby red, or orange	Small to medium.	Low to high	6.5–7.5	3.15–4.30	Single strained	1.79–1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Jade:										
Jadeite	do.	Green, yellow, black, white, or mauve	Large	Low to very high	6.5–7.0	3.3–3.5	Crypto-crystalline	1.65–1.68	Onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.
Nephrite	Complex hydrous silicate.	do.	do.	do.	6.0–6.5	2.96–3.10	do.	1.61–1.63	do.	do.

See footnotes at end of table.

TABLE 10—Continued

GUIDE TO SELECTED GEM STONES AND GEM MATERIALS USED IN JEWERLY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refrac-tion	Refractive index	May be confused with-	Recognition characters
Peridot	Iron magnesium silicate	Yellow or green	Any	Medium	6.5-7.0	3.27-3.37	Double (strong)	1.65-1.69	Tourmaline chrysoberyl	Strong double refraction, low dichroism.
Opal	Hydrous silica	Colors flash in white, gray, black, red, or yellow	Large	Low to high	5.5-6.5	1.9-2.3	Isotropic	1.45	Glass, synthetics, triplets	Play of color.
Pearl	Calcium carbonate	White, pink, or black	Small	do.	2.5-4.0	2.6-2.85	—	—	Cultured and imitation	Luster, structure, X-ray.
Quartz:										
Agate	Silica	Any color	Large	Low	7.0	2.58-2.64	—	—	Glass, plastic, Mexican onyx	Crypto-crystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65-2.66	Double	1.55	do.	Refractive index, double refraction, transparent.
Cairngorm	do.	Smoky	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Citrine	do.	Yellow	do.	do.	7.0	2.65-2.66	do.	do.	do.	Do.
Crystal, rock	do.	Colorless	do.	do.	7.0	2.65-2.66	do.	do.	do.	Do.
Jasper	do.	Uniform or spotted red, yellow, or green	do.	do.	7.0	2.58-2.64	—	—	do.	Opaque, vitreous.
Onyx	do.	Many colors	do.	do.	7.0	2.58-2.64	—	—	do.	Uniformly banded.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65-2.66	Double	1.55	do.	Refractive index, double refraction, translucent.
Spinel	Magnesuim aluminum oxide	Any	Small to medium	Medium	8.0	3.5-3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5-3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Kunzite	Lithium aluminum silicate	Pink to lilac	Medium	Medium	6.5-7.0	3.13-3.20	do.	1.66	Amethyst, morganite	Refractive index.
Hiddenite	do.	Yellow to green	do.	do.	do.	do.	do.		Synthetic spinel	Do.

See footnotes at end of table.

TABLE 10—Continued

GUIDE TO SELECTED GEM STONES AND GEM MATERIALS USED IN JEWERLY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Tanzanite	Complex silicate	Blue	Small	High	6.0-7.0	3.30	Double	1.69	Sapphire, synthetics.	Strong trichroism.
Topaz	do.	White, blue, or green	Medium	Low to medium	8.0	3.4-3.6	do.	1.62	Beryl, quartz	Refractive index.
Tourmaline	do.	All, including mixed	do.	do.	7.0-7.5	2.98-3.20	do.	1.63	Peridot, beryl, corundum, glass	Double refraction, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green phosphate	Large	Low	6.0	2.60-2.83	do.	1.63	Glass, plastics	Difficult if matrix not present, matrix usually limonitic.
Zircon	Zirconium silicate	White, blue, brown, yellow, or green	Small to medium	Low to medium	6.0-7.5	4.0-4.8	Double (strong)	1.79-1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

[1] Small—up to 5 carats; medium—up to 50 carats; large—over 50 car.
[2] Low—up to $25 per carat; medium—up to $200 per carat; high—over $200 per carat.

near-gem and cheap-gem qualities. Nearly all of the reserves are in Australia, Africa, and the U.S.S.R. (Siberia). The estimates for diamond reserves are of limited value because data needed for reliable estimates are not available from the producers. Reserve data on other gem materials are even less available than for diamond.

Technology

Synthetic Gems.—The first synthetic gem produced was ruby, and later, by various melt techniques, sapphire, spinel, rutile, strontium titanate, and cubic zirconia. The Verneuil flame-fusion process, developed in 1902, consists of growing a single crystal in a simple, downward-impinging oxyhydrogen blowpipe flame. In manufacturing synthetic gems, pure oxides of aluminum and titanium, and as needed, moderating and coloring oxides, are charged at the top of a small furnace and melted as they pass through an oxygen-hydrogen flame. The molten material is solidified on a fireclay peg as a carrot-shaped single crystal known as a boule, usually ½ to 1 inch in diameter, 2 to 4 inches long, and weighing 75 to 250 carats. After cooling, the boule is heat treated and tapped at one end to relieve the internal strain that causes the boule to split into two vertical halves. The halves are then cut and polished into gems. Other melt techniques used are the Czochralski pulled-growth method for ruby, sapphire, spinel, yttrium-aluminum-garnet (YAG), gadolinium-gallium-garnet (GGG), and alexandrite; the Bridgman solidification method for sapphire; and skull melting for cubic zirconia and sapphire.

Solution techniques for manufacturing synthetic gems include flux methods for emerald, ruby, sapphire, spinel, YAG, GGG, and alexandrite; hydrothermal methods for emerald, quartz, and the colored varieties of quartz such as smoky, yellow, citrine, and amethyst; and the high temperature ultra-high-pressure presses used in the manufacture of synthetic diamond in which a molten metal is used as the solvent.

Other techniques involve solid- or liquid-state reactions and phase transformations for jade and lapis lazuli; vapor phase deposition for ruby and sapphire; ceramics for turquoise, lapis lazuli, and coral; and others for opal, glass, and plastics. However, the Verneuil, Czochralski, and scull melting processes are the melt techniques most often used for gem materials. The various synthetics and the method of production are shown in table 11.

Enhancement of Gem Stones.—Enhancement of all types of gem materials through chemical and physical means has become much more commonplace and in the past few years has included a wider variety of gem materials. Irradiation by electromagnetic spectrum (X-rays, gamma rays, etc.,) and by energetic particles (neutrons, electrons, alphas, etc.) is being used to enhance or change the color of diamonds, topaz, tourmaline, quartz, beryl, sapphire, zircon, scapolite, and pearls. Blue topaz is normally irradiated, but this does not imply that all of these gem materials are regularly irradiated.[7]

A number of gem materials can be enhanced by chemical treatment or impregnations. The treatments may alter the bulk of the gem material or only penetrate the surface. This includes bleaching, oiling, waxing, plastic impregnations, color impregnations, and dying. The treatments that alter only the surface of the gem material include

TABLE 11

SYNTHETIC GEM STONE PRODUCTION METHODS

Gem stone	Production methods	Company	Date of first production
Ruby	Flux	Chatham	1950's
		Kashan	1960's
		Knischka	1980's
		J. O. Crystal (Ramaura)	Do.
	Zone melt	Seiko	Do.
	Melt pulling	Kyocera (Inamori)	1970's
	Verneuil	Various producers	1900's
Star ruby	do.	Linde (Div. of Union Carbide)	1940's
	Melt pulling	Kyocera	1980's
		Nakazumi	Do.
Sapphire	Flux	Chatham	1970's
	Zone melt	Seiko	1980's
	Melt pulling	Kyocera	Do.
	Verneuil	Various producers	1900's
Star sapphire	do.	Linde	1940's
Emerald	Flux	Chatham	1930's
		Gilson	1960's
		Kyocera	1970's
		Seiko	1980's
		Lennix	Do.
		U.S.S.R.	Do.
	Hydrothermal	Lechleitner	1960's
		Regency	Do.
		Biron	1980's
		U.S.S.R.	Do.
Alexandrite	Flux	Creative crystals	1970's
	Melt pulling	Kyocera	Do.
	Zone melt	Seiko	1980's
Cubic zirconia	Skull melt	Various producers	1970's

surface coatings of various types, interference filters, foil backings, surface decoration, and inscribing. Chemical treatment is more widespread than the common dying of quartz, treatment of turquoise, and oiling of emeralds. Chemical treatment and impregnations have been used to enhance chalcedony, coral, ivory, pearl, tiger's eye, emerald, lapis lazuli, opal, ruby, sapphire, turquoise, beryl, quartz, jade, diamonds, and amber.[8]

The oldest and most common method of gem material enhancement is heat treating. Heat treatment of gem materials was used in Greece and Rome well before the Christian Era. Heat treatment can cause color change, structural change, and improve clarity. In the past, heat treatment was common for quartz and gem corundum. Today, materials that are heat treated to enhance their appearance include sapphire, topaz, beryl, tourmaline, quartz, zircon, amber, diamond, and zoisite.[9]

Mining

Gem materials mining operations can range from the most primitive to the most sophisticated. In hard rock, at shallow depths, an operation by one, two, or three persons may be mined by prybar, pick, shovel, and baskets for carrying material. A larger operation may include drilling, blasting, and minimum timbering. Mechanized hauling and hoisting is done only at the larger mines.

Diamond mining in the kimberlite pipes of Africa and the U.S.S.R. and the lamproite pipes of Australia represent the ultimate in that huge quantities of ore must be mined to extract small quantities of diamond produced at as low a cost as possible.

Placer mining for gem stones ranges from small-scale, simple procedures to huge complicated operations. In some areas, digging is by hand and sorting and recovery is by panning, screening, or sluicing. Diamond miners in the larger placer operations use bucket dredges and heavy-duty excavating equipment, as, for example, in Australia, Brazil, Namibia, the Republic of South Africa, and the U.S.S.R.

Processing

Most gem stone material is broken or crushed where necessary and concentrated by various combinations of hand picking, washing, screening, or jigging. In large-scale operations, mineral beneficiation methods employ mechanization and the latest technology in all steps from primary crushing and screening to the final recovery processes. Diamond recovery, in particular, makes use of standard gravity methods, grease belts, electrostatic separation, skin-flotation, magnetic separation, separation by X-ray luminescence, and separation by optical sorting.

[1] Focus. Modern Jeweler, v. 89, No. 2, Feb. 1990, pp. 46–48.

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[6] Koivula, J. I., Kammerling, Fritsch, Fryer, Hargett, and Kane. The Characteristics and Identification of Filled Diamonds. Gems & Gemology, v. 25, No. 2, Summer 1989, pp. 68–83.

[7] Nassau, K. Gemstone Enhancement. Butterworth, 1984, pp. 221.

[8] ———. pp. 61–78.

[9] ———. pp. 25–44.

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Bureau of Mines Publications

Gem Stones. Ch. in Mineral Commodity Summaries, 1990.

GEM STONES

By Gordon T. Austin

Mr. Austin, a physical scientist with more than 30 years industry and Government experience, has been the gem stones commodity specialist since 1986. Mr. William Field, mineral data assistant, prepared the domestic production survey data.

Production value of natural gem materials in the United States during 1990 was essentially unchanged at $52.9 million. The materials produced included faceting rough, lapidary rough, carving material, specimen material, natural and cultured freshwater pearls, mother of pearl, agatized coral, and coral.

The reported combined production value of synthetic and simulant materials was $20.5 million, about a 9% increase over that of 1989. Synthetic gems are laboratory grown and have essentially the same optical, physical, and chemical properties, and the same appearance as the natural gem that they represent. Synthetic gem materials produced in the United States include alexandrite, coral, diamond, emerald, garnet, lapis lazuli, quartz, ruby, sapphire, spinel, and turquoise. Simulants are laboratory grown gem materials that have an appearance similar to that of a natural gem material but have different optical, physical, and chemical properties. The gem simulants produced in the United States include coral, cubic zirconia, lapis lazuli, malachite, and turquoise. Additionally, certain colors of synthetic sapphire and spinel, used to represent other gem stones, would be classed as simulants. Colored and colorless varieties of cubic zirconia are the major simulants produced.

Wholesale and retail outlets, gem and mineral shops, gem and mineral show dealers, cutting factories, and jewelry manufacturers were the major purchasers of domestic gem materials.

DOMESTIC DATA COVERAGE

The U.S. Bureau of Mines estimates of U.S. production were from the "Natural and Synthetic Gem Material Survey," a voluntary survey of U.S. operations, and from Bureau estimates of unreported production. Of the approximately 400 operations surveyed, 82% responded, accounting for about 95% of the total production, 92% of the natural production, and 100% of the synthetic and simulant production.

The 400 operations surveyed in 1990 were an increase of about 10% compared with the number of operations surveyed in 1989. The response rate was essentially the same as that of 1989. The Bureau estimated the production by nonresponding operations, by professional collectors, and by amateur or hobbyist collectors. The basis for these estimates were information from published data, conversations with gem and mineral dealers, analyses of gem and mineral shows and sales statistics, and from information informally supplied by collectors. In the formal voluntary survey and the informal surveys, the Bureau is totally dependent upon the cooperation of the producers, brokers, dealers, and collectors. Individuals and companies have been very cooperative and forthcoming with information. The Bureau is very appreciative of this cooperation.

BACKGROUND

The history of production and preparation of gem stones begins with the wearing of items for personal adornment in prehistoric times; this preceded even the wearing of clothes. Amber was mined in the Baltic countries for use as a gem material before 25,000 B.C. Later, the Phoenicians in their writings described their trade routes to the Baltic for amber and to areas in Asia and Africa for other gem materials. The voyages of Columbus brought increased interest in gem deposits, especially emerald, in South America. The discovery of diamond in Africa in 1859 focused major interest on Africa. More recently, the discovery of diamond in Western Australia in 1967 has resulted in the development of one of the largest deposits in the world.

Commercial mining of gem materials has never been extensive in the United States. Although more than 60 gem minerals and materials have been produced commercially from domestic sources, most of the deposits are relatively small. In many instances, production rests in the hands of the numerous hobbyists and members of mineralogical and lapidary clubs. The Crater of Diamonds State Park near Murfreesboro, AR, is open to the public on a daily fee basis. Many gem-quality stones are found there each year.

Definitions, Grades, and Specifications

Select rocks, certain varieties of mineral specimens, and some organic materials, such as pearl, amber, jet, and coral, are included in gem stones data. Customarily, diamond, ruby, sapphire, and emerald are considered the major gems.

The designation "gem stone" refers to a material appropriate for personal adornment. The most important qualities of gem stones are beauty, durability, uniqueness, and rarity. Beauty, indicated as splendor, purity, or attractiveness, is judged mainly according to the taste of the beholder and includes such appearances as luster, transparency, brilliance, and color. Luster of a mineral or stone is independent of color and is the surface appearance in reflected light. Apart from materials that have a metallic luster, the chief contributors to luster are transparency and refractive index. The perfection of polish enhances the luster of a stone. Visible imperfections impair the luster of transparent stones. However, defects, described as "jardens" or "inclusions," may enhance the beauty and value of natural rubies, sapphires, and other gem stones and may be used to identify the country of origin and even the mine. Durability is measured by the resistance of a stone to abrasion, pitting, chipping, or splitting. Resistance to abrasion is correlated with relative hardness, but intrinsic brittleness and toughness indicate resistance to wear in other aspects. Rarity is an essential qualification and is more important for some stones in determining their value than their physical characteristics.

Of the 1,500 mineral species, only about 100 possess all of the attributes required in gems. Silicates furnish the greatest number, including such minerals as beryl, topaz, tourmaline, and feldspar. Oxides such as corundum (ruby and sapphire) and quartz (amethyst, agate, etc.) comprise the second largest group. Sulfides, carbonates, and sulfates are of small importance; the phosphates yield only turquoise and variscite. An exception is pearl, essentially calcium carbonate, which is ranked high as a gem. Diamond, the best known gem stone, is an isometric crystalline form of the element carbon.

In general, gem materials are classified the same as minerals, that is, into group, species, and variety. Group refers to two or more gem materials that are similar in crystal structure and physical properties but have different chemical properties. Each individual member of the group is called a species. Varieties of species have similar crystal structure and chemical characteristics but differ in color. An example of this would be the hessonite variety of the grossular species of the garnet group.

Products for Trade and Industry

Cutting and polishing of gem materials are done to obtain the most effective display of the material. No significant change is made in the fundamental properties, and the preparation is intended to enhance the desirable characteristics that are present initially. Gem materials are cut into gem stones in three main styles; cabochons, baroque, and faceted.

Cabochons are cut in four operations: sawing, grinding, sanding, and polishing. Sawing, the initial step in cutting, is customarily done with a diamond saw to obtain a slab or slice of the desired size and thickness from the rough gem material. The cabochon outline is scribed onto a flat surface, most often using a template for making a standard size for jewelry mountings. Rough grinding of the stone may be by metal-bond diamond, silicon carbide, or aluminum oxide wheels or coated abrasive disks. In grinding, the hardness of the gem material determines the grit and hardness of the abrasive used. Multiple grinding steps starting with 80- to 100-mesh (grit) through 600-mesh abrasives are normally used. The scratches left by grinding are removed by progressively finer grinding and sanding. Disk or belt sanders use bonded to cloth abrasives, waterproof reinforced paper abrasives, or cloth charged with abrasive pastes. The final polish is obtained by using hard felt, wood, or leather laps, with various polishing agents such as fine diamond compound, tin oxide, tripoli, chromium oxide, cerium oxide, alumina, and rouge.

Polished irregular shapes are called baroque gems. An inexpensive method of polishing baroque gems consists of tumbling them in rubber-lined drums, using a grinding and polishing medium with or without water.

Facet cutting is employed ordinarily on transparent gem stones to increase brilliancy and appearance and is generally confined to the harder materials. Softer materials may be faceted, but extreme care must be exercised in cutting and polishing the stones and in their use in jewelry. The "round brilliant" cut, most commonly used in faceting, has 58 facets, 33 above the circle "girdle" and 25 below it, arranged in eightfold symmetry. The "round brilliant" and some other common cuts are illustrated in figure 1.

Industry Structure

An estimated 80% to 85% of gem and natural industrial diamond is marketed through the Central Selling Organization (CSO) by the Diamond Trading Co. Ltd. and the Industrial Distributors Ltd. The CSO sells uncut gem diamonds on behalf of De Beers and most other major producers at sights (approved bidder viewings) in London, England, in Lucerne, Switzerland, and Kimberley, Republic of South Africa.

The CSO has been extremely successful at maintaining the rough diamond market for about 50 years. In modern times there has never been a decrease in CSO's price of rough diamonds. Table 9 illustrates the timing and the amounts of the average CSO price increases for rough gem diamonds from 1949 until the present. The compounded affect of these increases is a price increase of about 1,800% over the approximately 41.5 years. Thus, a piece of rough that sold for $100 in August 1949, would sell for about $1,800 in April 1990.

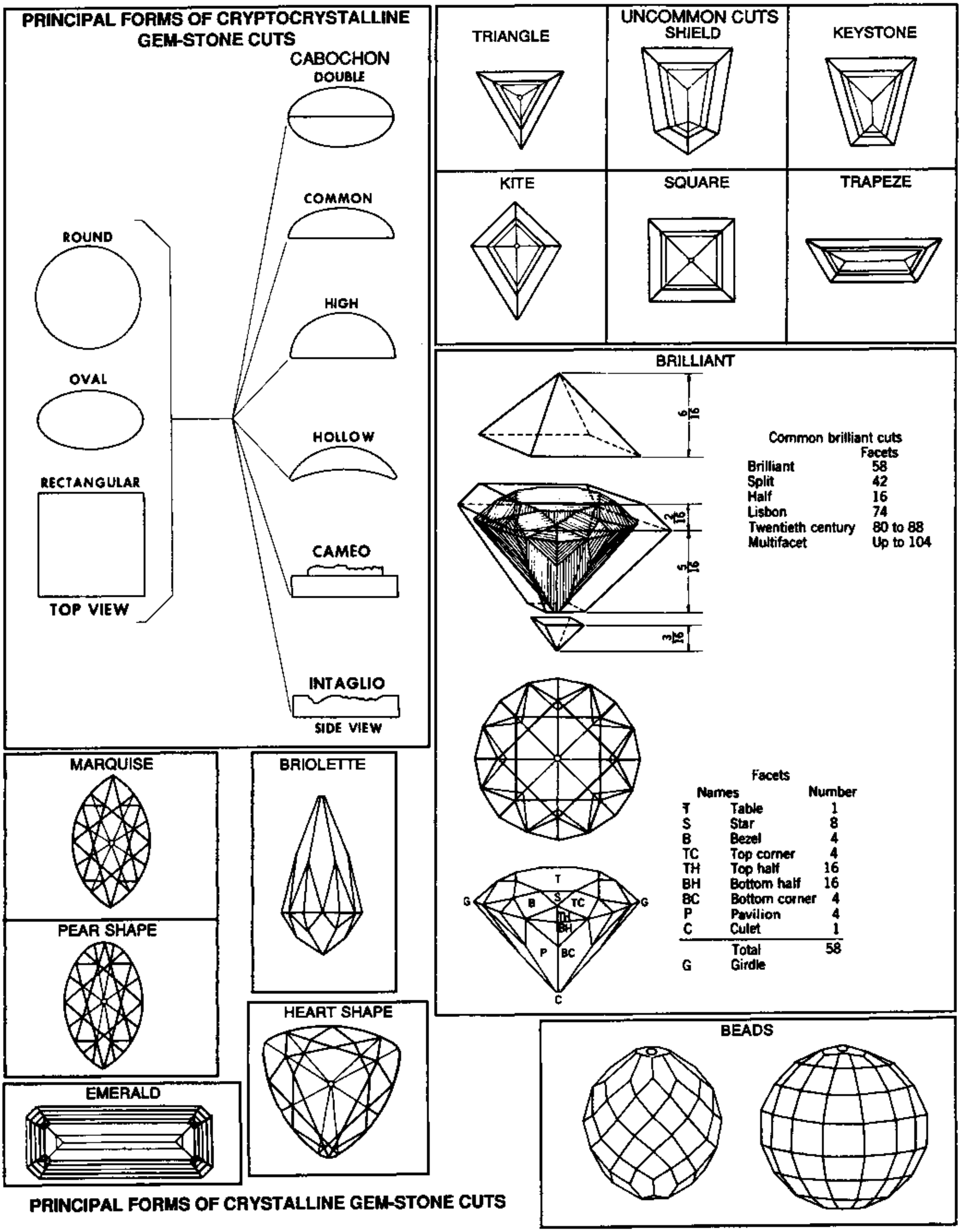
For more than 30 years, the major diamond cutting and polishing centers of the world were in Belgium and Israel, with a certain amount of the larger stones being cut in the United States. However, in the early 1980's, the development of a large cottage industry in India—today there is estimated to be more than 450,000 cutters—made a major impact on world diamond trade. Indian consumption of most of the world's small-gem, cheap-gem, and near-gem rough material in the manufacture of small stones resulted in annual cut-stone exports of almost $3 billion from April 1, 1988, to March 31, 1989. These small stones averaged less than one-fifth of a carat (0.20 carat). The availability of small inexpensive stones resulted in substantial changes in the design of jewelry. The utilization of small cut diamond stones (usually 0.07 to 0.14 carats each, called melee) to create a pavé effect (set close together to conceal the metal base) is but one example. Cutting and polishing of colored, synthetic, and simulant gem stones is centered in Thailand, India, Hong Kong, and Brazil, where cheap labor and favorable export laws ensure the lowest total costs for finished gems.

Geology-Resources

Gem materials occur in a large variety of igneous, metamorphic, and sedimentary rocks and mineral deposits, usually as a small fraction of the total deposit. The origins are as varied as the occurrences. Principal formation of gem materials is by precipitation from watery solutions, by crystallization from molten rock, and by metamorphic processes. Approximately one-third of gem minerals is composed of silicate minerals, about one-fifth of alumina-silicates, and nearly one-seventh of oxides. The remaining compositional groups include the sulfides, phosphates, borosilicates, carbonates, and, in the single case of diamond, an element. The composition of selected gem materials is included as one of the items

FIGURE 1

PRINCIPAL FORMS OF CRYPTOCRYSTALLINE AND CRYSTALLINE GEM STONE CUTS



in table 2.

The United States has no defined large resources of major gem materials. Emerald deposits are known in North Carolina, as are ruby and sapphire. Historically, sapphires have been mined in Montana, and commercial mining once again is underway. Numerous other domestic deposits of gem minerals are known and have been mined for many years. However, no systematic evaluations of the magnitude of these deposits have been made, and no positive statements can be made about them.

Occasional finds of diamond have been made, but no great diamond pipes or alluvial deposits similar to those of Africa have been reported. Several companies are involved in diamond exploration in the Colorado-Wyoming State line area, in Michigan, Minnesota, Wisconsin, and Arkansas. Diamond-bearing kimberlites have been located, and bulk samples have been processed for diamond recovery. Results have not been made public.

World resources of gem materials are nearly all unevaluated. However, world gem diamond reserve is estimated to be about 300 million carats, including near-gem and cheap-gem qualities. Nearly all of the reserves are in Australia, Africa, and the U.S.S.R. (Siberia). The estimates for diamond reserves are of limited value because data needed for reliable estimates are not available from the producers. Reserve data on other gem materials are even less available than for diamond.

Technology

Synthetic Gems.—The first synthetic gem produced was ruby, and later, by various melt techniques, sapphire, spinel, rutile, strontium titanate, and cubic zirconia. The Verneuil flame-fusion process, developed in 1902, consists of growing a single crystal in a simple, downward-impinging oxyhydrogen blowpipe flame. In manufacturing synthetic gems, pure oxides of aluminum and titanium, and as needed, moderating and coloring oxides, are charged at the top of a small furnace and melted as they pass through an oxygen-hydrogen flame. The molten material is solidified on a fireclay peg as a carrot-shaped single crystal known as a boule, usually ½ to 1 inch in diameter, 2 to 4 inches long, and weighing 75 to 250 carats. After cooling, the boule is heat treated and tapped at one end to relieve the internal strain that causes the boule to split into two vertical halves. The halves are then cut and polished into gems. Other melt techniques used are the Czochralski pulled-growth method for ruby, sapphire, spinel, yttrium-aluminum-garnet (YAG), gadolinium-gallium-garnet (GGG), and alexandrite; the Bridgman solidification method for sapphire; and skull melting for cubic zirconia and sapphire.

Solution techniques for manufacturing synthetic gems include flux methods for emerald, ruby, sapphire, spinel, YAG, GGG, and alexandrite; hydrothermal methods for emerald, quartz, and the colored varieties of quartz such as smoky, yellow, citrine, and amethyst; and the high temperature ultra-high-pressure presses used in the manufacture of synthetic diamond in which a molten metal is used as the solvent.

Other techniques involve solid- or liquid-state reactions and phase transformations for jade and lapis lazuli; vapor phase deposition for ruby and sapphire; ceramics for turquoise, lapis lazuli, and coral; and others for opal, glass, and plastics. However, the Verneuil, Czochralski, and scull melting processes are the melt techniques most often used for gem materials. The various synthetics and the method of production are shown in table 3.

Enhancement of Gem Stones.—Enhancement of all types of gem materials through chemical and physical means has become much more commonplace and in the past few years has included a wider variety of gem materials. Irradiation by electromagnetic spectrum (X-rays, gamma rays, etc.) and by energetic particles (neutrons, electrons, alphas, etc.) is being used to enhance or change the color of diamonds, topaz, tourmaline, quartz, beryl, sapphire, zircon, scapolite, and pearls. Blue topaz is normally irradiated, but this does not imply that all of these gem materials are regularly irradiated.[1]

A number of gem materials can be enhanced by chemical treatment or impregnations. The treatments may alter the bulk of the gem material or only penetrate the surface. This includes bleaching, oiling, waxing, plastic impregnations, color impregnations, and dying. The treatments that alter only the surface of the gem material include surface coatings of various types, interference filters, foil backings, surface decoration, and inscribing. Chemical treatment is more widespread than the common dying of quartz, treatment of turquoise, and oiling of emeralds. Chemical treatment and impregnations have been used to enhance chalcedony, coral, ivory, pearl, tiger's eye, emerald, lapis lazuli, opal, ruby, sapphire, turquoise, beryl, quartz, jade, diamonds, and amber.[2]

TABLE 1

CSO ROUGH DIAMOND PRICE INCREASES, BY PERCENTAGE

Sept.	1949	25.0	Nov.	1967	16.0	Aug.	1973	10.2	Sept.	1982	2.5
Mar.	1951	15.0	Sept.	1968	2.5	Dec.	1974	1.5	Apr.	1983	3.5
Sept.	1952	2.5	July	1969	4.0	Jan.	1976	3.0	Aug.	1986	7.5
Jan.	1954	2.0	Nov.	1971	5.0	Sept.	1976	5.8	Nov.	1986	7.0
Jan.	1957	5.7	Jan.	1972	5.4	Mar.	1977	15.0	Sept.	1987	10.0
May	1960	2.5	Sept.	1972	6.0	Dec.	1977	17.0	Apr.	1988	13.5
Mar.	1963	5.0	Feb.	1973	11.0	Aug.	1978	30.0	Mar.	1989	15.5
Feb.	1964	7.5	Mar.	1973	7.0	Sept.	1979	13.0	Mar.	1990	5.5
Aug.	1966	7.5	May	1973	10.0	Feb.	1980	12.0			

TABLE 2

GUIDE TO SELECTED GEM STONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with—	Recognition characters
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0–2.5	1.0–1.1	Single	1.54	Synthetic or pressed, plastics	Fossil resin, soft.
Beryl:										
Aquamarine	Beryllium alluminum silicate.	Blue green to light blue	Any	Medium to high	7.5–8.0	2.63–2.80	Double	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Emerald	do.	Green	Medium	Very high	7.5	2.63–2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet, doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5–8.0	2.63–2.80	do.	1.58	Genuine emerald	Flaws, brilliant, fluorescence in ultraviolet light.
Golden	do.	Yellow to golden	Any	Low to medium	7.5–8.0	2.63–2.80	do.	1.58	Citrine, topaz, glass, doublets	
Morganite	do.	Pink to rose	Any	do.	7.5–8.0	2.63–2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Refractive index.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	Any	Low	3.0	2.72	Double (strong)	1.49–1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	Any	Low	3.0	2.72	do.	1.6	do.	Banded, translucent.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day, red by artificial light	U.S.S.R. (small), Sri Lanka (medium)	High	8.5	3.50–3.84	Double	1.75	Synthetic	Dichroism, inclusions in synthetic sapphire.
Catseye	do.	Greenish to brownish	Small to large	do.	8.5	3.50–3.84	do.	1.75	Synthetic, shell	Gravity and translucence.
Chrysolte	do.	Yellow, green, and/or brown	Medium	Medium	8.5	3.50–3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Coral	Calcium carbonate	Orange, red, white, black, or green	Branching, medium	Low	3.5–4.0	2.6–2.7	do.	1.49–1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95–4.10	do.	1.78	Synthetics, including spinel	Inclusions, fluorescence.
Sapphire	do.	Blue	Medium	High	9.0	3.95–4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.

See footnotes at end of table.

TABLE 2—Continued

GUIDE TO SELECTED GEM STONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with—	Recognition characters
Corundum—Continued										
Sapphire, fancy	Aluminum oxide	Yellow, pink, white, orange, green, or violet	Medium to large	Medium	9.0	3.95–4.10	Double	1.78	Synthetics, glass and doublets	Inclusions, double refraction, refractive index.
Sapphire and ruby stars	do.	Red, pink, violet blue, or gray	do.	High to low	9.0	3.95–4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color on side view.
Sapphire or ruby synthetic	do.	Yellow, pink, or blue	Up to 20 carats	Low	9.0	3.95–4.10	do.	1.78	Synthetic spinel, glass	Curved strae, bubble inclusions.
Diamond	Carbon	White, blue-white, yellow, brown, green, pink, blue	Any	Very high	10.0	3.516–3.525	Single	2.42	Zircon, titania, cubic zirconia	High index, dispersion, single refraction, hardness, cut, luster.
Feldspar:										
Amazonstone	Alkali aluminum-silicate	Green	Large	Low	6.0–6.5	2.56	—	1.52	Jade	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	Alkali aluminum-silicate	Gray with blue and bronze sheen color play	do.	Low	6.0–6.5	2.56	—	1.56	do.	Cleavage, sheen, vitreous to pearly opaque, grid.
Moonstone	do.	White	do.	Low	6.0–6.5	2.77	—	1.52–1.54	Glass or white onyx	Blue sheen, opalescent.
Garnet	Complex silicate	Brown, black, yellow, green, ruby red, or orange	Small to medium	Low to high	6.5–7.5	3.15–4.30	Single straine	1.79–1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Jade:										
Jadeite	do.	Green, yellow, black, white, or mauve	Large	Low to very high	6.5–7.0	3.3–3.5	Cryptocrystall	1.65–1.68	Onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0–6.5	2.96–3.10	do.	1.61–1.63	do.	Do.
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5–7.0	3.27–3.37	Double (strong	1.65–1.69	Tourmaline chrysoberyl	Strong double refraction, low dichroism.
Opal	Hydrous silica	Colors flash in white, gray, black, red, or yellow	Large	Low to high	5.5–6.5	1.9–2.3	Isotropic	1.45	Glass, synthetics, triplets	Play of color.
Pearl	Calcium carbonate	White, pink, or black	Small	do.	2.5–4.0	2.6–2.85	—	—	Cultured and imitation	Luster, structure, X-ray.

See footnotes at end of table.

TABLE 2—Continued

GUIDE TO SELECTED GEM STONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refrac-tion	Refractive index	May be confused with—	Recognition characters
Quartz:										
Agate	Silica	Any color	Large	Low	7.0	2.58–2.64	—	—	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65–2.66	Double	1.55	do.	Refractive index, double refraction, transparent.
Cairngorm	do.	Smoky	do.	Low	7.0	2.65–2.66	do.	1.55	do.	Do.
Citrine	do.	Yellow	do.	Low	7.0	2.65–2.66	do.	1.55	do.	Do.
Crystal, rock	do.	Colorless	do.	Low	7.0	2.65–2.66	do.	1.55	do.	Do.
Jasper	do.	Uniform or spotted red, yellow, or green	do.	Low	7.0	2.58–2.64	—	—	do.	Opaque, vitreous.
Onyx	do.	Many colors	do.	Low	7.0	2.58–2.64	—	—	do.	Uniformly banded.
Rose	do.	Pink, rose red	do.	Low	7.0	2.65–2.66	Double	1.55	do.	Refractive index, double refraction, translucent.
Spinel	Magnesium aluminum oxide.	Any	Small to medium	Medium	8.0	3.5–3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	Any	Up to 40 carats	Low	8.0	3.5–3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Kunzite	Lithium aluminum silicate	Pink to lilac	Medium	Medium	6.5–7.0	3.13–3.20	do.	1.66	Amethyst, morganite	Refractive index.
Hiddenite	do.	Yellow to green	do.	do.	6.5–7.0	do.	do.		Synthetic spinel	Do.
Tanzanite	Complex silicate	Blue	Small	High	6.0–7.0	3.30	do.	1.69	Sapphire, synthetics.	Strong trichroism.
Topaz	do.	White, blue, green	Medium	Low to medium	8.0	3.4–3.6	do.	1.62	Beryl, quartz	Refractive index.
Tourmaline	do.	All, including mixed	do.	do.	7.0–7.5	2.98–3.20	do.	1.63	Peridot, beryl, corundum, glass	Double refraction, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green phosphate	Large	Low	6.0	2.60–2.83	do.	1.63	Glass, plastics	Difficult if matrix not present, matrix usually limonitic.
Zircon	Zirconium silicate	White, blue, or brown, yellow, or green	Small to medium	Low to medium	6.0–7.5	4.0–4.8	Double (strong)	1.79–1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

[1] Small—up to 5 carats; medium—up to 50 carats; large—more than 50 carats.
[2] Low—up to $25 per carat; medium—up to $200 per carat; high—more than $200 per carat.

The oldest and most common method of gem material enhancement is heat treating. Heat treatment of gem materials was used in Greece and Rome well before the Christian Era. Heat treatment can cause color change, structural change, and improve clarity. In the past, heat treatment was common for quartz and gem corundum. Today, materials that are heat treated to enhance their appearance include sapphire, topaz, beryl, tourmaline, quartz, zircon, amber, diamond, and zoisite.[3]

Mining.—Gem materials mining operations can range from the most primitive to the most sophisticated. In hard rock, at shallow depths, an operation by one, two, or three persons may be mined by prybar, pick, shovel, and baskets for carrying material. A larger operation may include drilling, blasting, and minimum timbering. Mechanized hauling and hoisting is done only at the larger mines.

Diamond mining in the kimberlite pipes of Africa and the U.S.S.R. and the lamproite pipes of Australia represent the ultimate in that huge quantities of ore must be mined to extract small quantities of diamond produced at as low a cost as possible.

Placer mining for gem stones ranges from small-scale, simple procedures to huge complicated operations. In some areas, digging is by hand, and sorting and recovery is by panning, screening, or sluicing. Diamond miners in the larger placer operations use bucket dredges and heavy-duty excavating equipment, as, for example, in Australia, Brazil, the Republic of South Africa, Namibia, and the U.S.S.R.

Processing.—Most gem stone material is broken or crushed where necessary and concentrated by various combinations of hand picking, washing, screening, or jigging. In large-scale operations, mineral benefication methods employ mechanization and the latest technology in all steps from primary crushing and screening to the final recovery processes. Diamond recovery, in particular, makes use of standard gravity methods, grease belts, electrostatic separation, skin-flotation, magnetic separation, separation by X-ray luminescence, and separation by optical sorting.

TABLE 3

SYNTHETIC GEM STONE PRODUCTION METHODS

Gem stone	Production methods	Company	Date of first production
Ruby	Flux	Chatham	1950's
		Kashan	1960's
		Knischka	1980's
		J.O. Crystal (Ramaura)	1980's
	Zone melt	Seiko	1980's
	Melt pulling	Kyocera (Inamori)	1970's
	Verneuil	Various producers	1900's
Star ruby	do.	Various producers (Div. of Union Carbide)	1900's
	Melt pulling	Kyocera	1980's
		Nakazumi	1980's
Sapphire	Flux	Chatham	1970's
	Zone melt	Seiko	1980's
	Melt pulling	Kyocera	1980's
	Verneuil	Various producers	1900's
Star sapphire	do.	Linde	1940's
Emerald	Flux	Chatham	1930's
		Gilson	1960's
		Kyocera	1970's
		Seiko	1980's
		Lennix	1980's
		U.S.S.R.	1980's
	Hydrothermal	Lechleitner	1960's
		Regency	1960's
		Biron	1980's
		U.S.S.R.	1980's
Alexandrite	Flux	Creative crystals	1970's
	Melt pulling	Kyocera	1970's
	Zone melt	Seiko	1980's
Cubic zirconia	Skull melt	Various producers	1970's

ANNUAL REVIEW

Production

In 1990, all 50 States produced at least $1,000 worth of gem materials. Ten States accounted for 95% of the total value of natural gem material produced. The States, in order of declining value of production, were Tennessee, Arkansas, Arizona, Montana, California, Oregon, Alabama, North Carolina, Utah, and Texas. Certain States were known for the production of a single gem material (i.e., Tennessee for freshwater pearls and Arkansas for quartz). Other States produced a variety of gem materials. Arizona produced the greatest variety of gem materials. Production included agate, amethyst, antlerite, azurite, chrysocolla, fire agate, garnets, jade, malachite, obsidian, onyx, peridot, petrified wood, precious opal, shattuchite, smithsonite, and turquoise. California, Idaho, Montana, and North Carolina also produced a variety of gem materials. North Carolina was the only State to have produced all four of the major gems: diamond, emerald, ruby, and sapphire.

The average production value of natural gem materials for the past 10 years was $20.7 million per year, with a high of $52.9 million in 1990 and a low of $7.2 million in 1982. The value of production for the past 10 years must be separated into two trends. The first trend was the period between 1981 through 1985, during which time approximately 24 operations reported production. Production average $7.4 million per year and was generally level. During the second trend, 1986 to the present, production averaged $34.0 million and was the result of an increase of 1,567% in the number of producers surveyed.

The reported production value of synthetic and simulant gem materials was $20.5 million in 1990. The reported value of production increased 9%. The average value of production of synthetic and simulant gem materials for the past 5 years was $16.2 million, with a high of $20.5 million in 1990 and a low of $10.3 million in 1986. Thirteen firms, five in California, four in Arizona, and one each in Massachusetts, Michigan, New Jersey, and Ohio, produced synthetic and simulant gem material. The six States, in order of declining value of production, were Massachusetts, California, New Jersey, Michigan, Ohio, and Arizona.

Arizona is well known for the widest variety of gem materials produced by any State. In 1990, gem material production included agate, amethyst, antlerite, azurite, chrysocolla, fire agate, fluorite, garnet, jade, jasper, malachite, obsidian (Apache tears), onyx, peridot, petrified wood, precious opal, shattuchite, smithsonite, and turquoise. Yet, turquoise, peridot, petrified wood, and azurite/malachite accounted for more than 90% of the total value of gem material produced. Arizona was the largest producer of turquoise, peridot, and petrified wood in terms of dollar value in the United States. It was also the world's largest producer of the first two gem materials. Additionally, there are four manufacturers of synthetic or simulant gem materials in Arizona that produce about $100,000 worth of material each year.

Arkansas is famous for the production of quartz crystals. Yet, Arkansas is second in value of production of freshwater pearls and shells and the only State in the United States that has had any sustained diamond production.

For the past 19 years hobbyists have found from 300 to 1,500 diamonds per year at the Crater of Diamonds State Park. Since 1972, about 13,000 diamonds have been recovered; this amount of diamond production is insufficient to classify the United States as a diamond-producing country. Still, the potential to become a diamond producer may be there, and efforts were underway to evaluate this potential more fully. The program to evaluate the diamond deposit was halted by legal actions after completing three exploration drill holes. The program is currently on hold, awaiting the outcome of the litigations.

Gem material production from California includes a variety of materials. California is the leading tourmaline producer in the United States and the only producer of benitoite. Additionally, California produces agate, alabaster, beryl, dumortierite, fire agate, garnet, gem feldspar, jade, jasper, kunzite, lepidolite, obsidian, quartz, rhodonite, topaz, and turquoise. Yet, even with this long list of gem materials, most people think of California in terms of its State gem benitoite, the production of high-quality tourmalines, and its fine orange spessartine garnets.

In May 1989, Pala International reported the discovery of the largest gem tourmaline pocket found in the Himalaya Mine during the past 12 years. The pocket yielded about 500 kilograms of tourmaline; 50% was carving or cabochon grade, less than 1% was faceting grade, and the remainder was specimen grade.

California also has four manufacturers of synthetic or simulant gem materials. The State is the second largest producer of synthetics and simulants in terms of value of total production.

Colorado is not known as a gem material producing State, but it does hold some gem stone honors. For 4 or 5 years prior to 1988, Colorado had the only commercially operated amethyst mine in the United States. It has the only commercially mined deposit of lapis lazuli in the United States and one of the few dig-for-fee topaz deposits currently operating. Additionally, the State was the first to commercially produce turquoise and still has commercially operated turquoise mines. The State also produced the United States' finest gem-quality rhodochrosite and a quantity of high-quality rhodonite.

Many different locations in the State produce aquamarine, the Colorado State gem stone. The best known locations and the locations with the longest history of continued production (since about 1884) are Mount Antero and White Mountain in Chaffee County. Mount Antero, at 14,269 feet, may be the highest gem stone location in the United States. White Mountain, separated from Antero by a small saddle, is only slightly lower at 13,900 feet.

Star garnet, the Idaho State gem stone, leads the list of gem materials produced in the State. Idaho is one of two places that produce significant amounts of star garnet; India is the other. These almandite garnets are translucent, purplish-red stones that show four- or six-ray stars when cabochon cut or are transparent deep red stones that can be faceted. The primary sources of Idaho star garnet are the placer deposits on the East Fork of Emerald Creek and its tributary gulches in Benewah County. Additionally, the placers of Purdue Creek in Latah County yield star garnets. Currently, garnets that do not cut stars also are commercially mined from areas in Clearwater County. These garnets range from purplish rose-red to a highly prized "special pink." Gem-quality garnets occur at several other locations in Idaho and are mined periodically by hobbyists or professional collectors for the gem stone market.

Opal is the second largest contributor to the total value of gem material produced in Idaho. The varieties produced include precious, yellow, blue, pink, and common. The Spencer opal mine is the largest producer. At the Spencer Mine, precious opal occurs as one or more thin layers within common opal that have partially filled gas cavities within a rhyolite-obsidian flow. About 10% of the material is thick enough to cut into solid gems; the remainder is suitable for making doublets and triplets. The Spencer Mine is also the source of the pink opal, which occurs as either pink common opal or pink bodied precious opal.

In recent years, an increasing amount of gem material (smokey quartz, aquamarine, topaz, and garnets) has been recovered from the Sawtooth batholith. A significant portion of the batholith lays within the Sawtooth National Recreation Area, administered by the Forest Service, U.S. Department of Agriculture. Herein lies a possible problem. The Forest Service may prohibit the collection of gem and mineral specimens from the National Recreation Area under CFR Title 36, 269.9b, which prohibits the removal of "natural features of the land." Additionally, all mining is prohibited in a recreation area. It appears that material is still being collected from the area, but this may stop in the future. Hopefully, collectors and the Forest Service can arrive at some mutual understanding where hobbyists can collect material or possibly collect controlled amounts for the commercial market.

In the U.S. gem stone industry, Maine and tourmaline are almost synonymous. In 1822, Maine's Mount Mica was the site of the first gem stone production in the United States. In September 1991, Plumbago Mining Corp. was actively mining the Mount Mica pegmatite for gem material and mineral specimens. Over the years, Mount Mica produced hundreds of pounds of fine-quality gem and mineral specimen tourmaline.

Mount Mica is not the only large producer of high-quality tourmalines. Dunton Mine of Newry Hill is the most prolific gem tourmaline producer in Maine. Since its discovery in 1898, the mine has produced tons of gem- and specimen-grade tourmaline. Other mines and quarries in a three county area produce gem- and mineral specimen-grade tourmalines. These include the Bennett, BB #7, Emmons, Harvard, Tomminen, Waisenen, Black Mountain and Red Hill Quarries, and Nevel Mine in Oxford County. It also includes the Mount Apatite Quarries in Androscoggin County and the Fisher and Porcupine Hill Quarries in Sagadahoc County.

Maine also produces fine-quality beryls—aquamarine, heliodor, and morganite. Pegmatites in Oxford, Androscoggin, and Sagadahoc Counties regularly produce fine-quality blue and blue-green aquamarine, rich yellow and gold colored heliodor, and rose and peach colored morganite. In 1989, the largest rose colored morganite on record was found at the Bennett Quarry near Buckfield in Oxford County.

In 1989, Plumbago Mining Corp. opened the most significant commercial amethyst mine in the United States near the town of Sweden in Oxford County. Reported production in the first year of operation was about 5,000 pounds of gem-quality and specimen-grade amethyst. The gem material has good deep purple color, but is mostly small pieces. An officer of the company did report the cutting of a 12-carat stone from the material and that some material recovered would yield stones as large as 20 carats.

Montana produces many different gem materials, some suited to faceting, while others are better suited to the cutting of cabochons, carvings, or objects of art. The gem materials that come to mind when Montana is mentioned are sapphires and Montana moss agate, with Dryhead agates a very close third. Yet, amethyst, amazonite, azurite, covellite, cuprite, garnet, onyx, opal, petrified wood, rhodochrosite, rhodonite, smokey quartz, sphalerite, and wonderstone (banded rhyolite) are also produced or have been produced in the State for use as gem material.

Since 1865 Montana has produced sapphires. In recent years, it appears that the Montana sapphire has gained in popularity, and because of the improved popularity, production has increased significantly. Currently, commercial sapphire production is from deposits on the Missouri River in Lewis and Clark County, the Rock Creek area in Granite County, and from the Yogo Gulch area in Judith Basin County. Additionally, there are dig-for-fee sapphire operations on the Missouri River and Rock Creek.

Until 1989, the value of Nevada's gem material production was essentially dependent upon the production of turquoise and opal, and the production of turquoise was, and still is, declining. In 1989, Nevada reported the first major production of nephrite jade.

The Nevada jade is from a deposit near Tonopah. The material varies in color from different shades of green to black, and some is mottled with off-white to tan markings. The reported quality is from fine gem to carving-grade. Mine run jade is available from fist-size pieces to individual boulders that weigh more than 1 ton. The jade is very similar to good to fine Wyoming jade.

Nevada has been a major producer of turquoise since the 1930's, and until the early 1980's, the State was the largest turquoise producer in the United States. Estimates indicate that over the years, 75 to 100 different mines and/or prospects have produced sizable quantities of turquoise. Production varied from a few thousand dollars worth of material at some properties to more than a million dollars at others. Estimates of total production to date are between $40 to $50 million.

Precious opal production from deposits in the Virgin Valley area began in about 1906. The opal from Virgin Valley is comparable to any in the world for its vivid play of color and is unsurpassed in terms of the size of material available. The material varies in color from deep pure black to brown to yellowish-white to white to colorless. The play of color includes all the colors common to precious opal—red, blue, green, yellow, orange, and so on. The opal occurs primarily as replacement of wood, or sometimes, the replacement of cones of conifer trees. The uses of the opal are greatly restricted because of a severe problem with crazing. Currently, two mines in Virgin Valley are open to individuals on a dig-for-fee basis during the summer months. The operators of these mines also mine the deposits for their own inventories.

North Carolina is the only State in the United States where all four major gem materials, diamond, ruby, sapphire and emerald, are found. During 1988 was the last time all four major gem materials were found in the same year. The diamond was found in a gold placer mine, rubies and sapphires were recovered from the Cowee Valley, and emeralds were found near Hiddenite and Little Switzerland.

Production of ruby and sapphire from the Cowee Valley in Macon County began in 1895 when the American Prospecting and Mining Co. systematically mined and washed the gravels of Cowee Creek. Today some dig-for-fee operations are in the Cowee Valley. Many people pay to dig or purchase buckets of gravel to wash to recover gem corundum, garnets, and other gem materials.

Every year there is publicity concerning the discovery of large and valuable rubies and sapphires at one or more of the mines in Cowee Valley. No doubt large corundum crystals and pieces of corundum are found each year. Similarly, valuable rubies and sapphires may be found, but the number of large and valuable gems and the values of these gems often are over-stated. During the period when commercial mines operated in the area, gem material was found that would cut fine-quality 3- to 4-carat stones. Today, the amount of quality gem material has greatly declined. Most of the rubies found are not of top color or clarity and on average are suitable for cutting stones of a carat or less. The sapphires tend to be larger than the rubies and high-quality sapphires are more abundant than high-quality rubies.

In 1875, emeralds were discovered near what is now Hiddenite, with the first attempts at commercial mining of emeralds in the Hiddenite area in 1881. Other attempts at mining were made in the 1920's, the 1950's, the 1970's, and the latest ended in 1990. At different times the emerald deposits in the Hiddenite area have produced large emerald crystals, and some significant stones have been cut from Hiddenite material. Yet, to date, it has not been possible to maintain an economically viable mine operation on any of the deposits. This includes the last attempt that would have mass mined the deposit and used a berylometer to sort the emerald from the waste rock. The berylometer worked well, but the amount of emerald present did not support the project.

Historically, Oregon has been known for the production of various picture and scenic jaspers, agates, thundereggs, petrified wood, and to a certain degree, gem labradorite. Oregon's State rock, the "thunderegg," may be the best known gem material from Oregon. Graveyard Point, Priday, and Polka Dot are names that are uniquely associated with beautiful Oregon agates. The same is true for the relationships between the names Biggs, Deschutes, and Sucker Creek and picture or scenic jasper. Yet, gem labradorite, which includes both sunstone and heliolite, is currently the largest single contributor to the value of annual gem material production in Oregon. At least seven firms or individuals currently are producing sunstone and/or heliolite from three different geographic areas.

The other gem material to contribute significantly to the value of Oregon gem material production is opal. During 1988, the first significant commercial mining and marketing of a variety of very fine quality opals from Opal Butte began. The varieties produced include hyalite, rainbow, contra luz, hydrophane, crystal, fire, blue, and dendritic. Exquisite stones as large as 315 carats have been cut from contra luz rough from this deposit.

Tennessee has the largest U.S. production of freshwater pearls and freshwater mussel shells of the 11 producing States. The fishing and marketing of freshwater pearls and mussel shells are not new in the United States or in Tennessee. There has been an established U.S. freshwater mussel fishing industry since the mid-1850's. The mussels are from the family Unioidae, of which about 20 different species are commercially harvested. During 1990, the value of U.S. mussel shell exports was more than $50 million.

To date, freshwater pearls from the United States have been a byproduct of the shell industry. Currently, the primary use of the shells is to make the bead nucleus used by the Japanese cultured pearl industry. Additionally, the shells are used in making cameos and as mother-of-pearl. With the coming of the freshwater cultured pearl farms in Tennessee and the increasing popularity of freshwater pearl jewelry with the U.S. consumer, this may change. In 1963, the first experimental U.S. freshwater cultured pearl farm was established. Since the technology for culturing freshwater pearls was proven in the late 1970's, six freshwater pearl farms have been established. These farms are the beginning of the U.S. freshwater cultured pearl industry, and the cultured pearl is the heart and future of the U.S. pearl industry.

The gem material that Utah is best known for, topaz, is not well suited for use as a gem stone, but it does make a fine mineral specimen. Topaz crystals have been collected from certain rhyolite flows in the Thomas Mountains for more than 100 years. Similar crystals also are found in select rhyolites in the Wah Wah Mountains. The crystals from the Thomas Mountains are predominately small, 10 to 20 millimeters long and 4 to 6 millimeters across, and crystals from the Wah Wah Mountains are even smaller. Occasionally, large gem-quality crystals are found. The color of the topaz varies from colorless to light yellow, sherry brown, rose or light pink. Unfortunately, the light yellow to sherry brown color fades to colorless if exposed to sunlight or heat and rose or light pink colored crystals are rare. Because of the size of the crystals and problem with color fading, the material yields only small to very small colorless stones.

Another Utah gem material with nearly a 100-year production history is gem variscite, first produced in about 1893 near Fairfield. The latest recorded commercial production was from near Lucin during the summer of 1990. Variscite occurs as fracture fillings or as nodules. The nodules may be solid, almost geode in nature, or fractured solid nodules that have undergone alteration. The color of the variscite varies from deposit to deposit and from location to location within the same deposit. It is a shade of light to dark yellow-green, but can occur as a dark, nearly jade green and so pale as to appear almost white. It also can have black and brown spiderwebbing.

Another gem material from Utah is snowflake obsidian. Snowflake obsidian (also known as flower obsidian) earns its name from the bluish-white or grayish-white patterns of cristobalite included into the normally black obsidian. During 1990, two different firms produced this material commercially.

Topaz, variscite, and obsidian from Utah are well known and are nice materials. But, in the author's opinion, the red beryl from the Wah Wah Mountains is the most remarkable and desirable of Utah's gem materials. Bixbite, the variety name for red beryl (called red emerald by some) occurs in rhyolites at several locations in the Thomas and Wah Wah Ranges. The beryl varies in color from a pink to bright red, with the bright red being what could be called strong raspberry-red. The material from most of the locations is not as spectacular, either in crystal size or color, as the crystals from the Violet claims in the Wah Wah's.

The Violet claims in the Wah Wah's are the only known location for commercial production of red beryl. In recent years, the claims have furnished a small but steady supply of materials for both mineral specimens and a few fine-quality cut stones. The crystals average about 10 millimeters in length, and most are flawed. Because of the size of the crystals and flaws, finished stones only average about 0.40 carats with few more than 1 carat. The largest finished stone to date is only 4.46 carats. The material is expensive, but justifiably so, because of its beauty and rarity.

Certain other States produce a single gem material of note; they are Alaska with its two jade mines; Florida's agatized coral; Hawaii's black coral; Minnesota's thomsonite; New York's herkimer quartz; Ohio's flint; and South Dakota's rose quartz.

The value of production by individual gem material can be reported for those materials that have three of more producers and if one of the three does not account for more than 75% of the total or two of the producers account for 95% or more of the production. Table 4 is a list by commodity in alphabetic order, with values in dollars rounded to the nearest thousand.

Consumption and Uses

Consumption of domestic gem material production was in the commercial and amateur manufacture of jewelry, for exhibit in gem and mineral collections, and for decorative purposes in statuettes, vases, other art objects, and certain industrial applications.

Industrial uses of tourmaline include a simple laboratory instrument to show the polarization of light, as a material to measure the compressibility of fluids, and in gages for measuring high pressures. Mortar and pestle sets, knife edges for balances, textile rollers, and spatulas are some nongem uses of agate. The manufacturing of jewel bearings for timing devices, gages, meters, and many other types of instruments requiring precision elements used natural gem material. These uses are now mostly supplied by artificial and synthetic crystalline materials.

TABLE 4

VALUE OF 1990 U.S. GEM STONE PRODUCTION, BY GEM MATERIALS

Gem materials	Value
Agate	$250,000
Beryl	105,000
Coral (all types)	60,000
Garnet	78,000
Gem feldspar	500,000
Geode/nodules	240,000
Fire agate	20,000
Jasper	148,000
Obsidian	27,000
Opal	146,000
Peridot	884,000
Petrified wood	633,000
Quartz	1,767,000
Sapphire/ruby	3,727,000
Topaz	26,000
Tourmaline	350,000
Turquoise	1,105,000
Total	10,066,000

Some industrial applications requiring clean homogeneous stones used low-quality gem diamond. The quantity of natural and synthetic industrial-grade diamonds used in the United States each year is 12 to 15 times greater than the amount of diamonds consumed by the jewelry industry.

The uses of synthetic and simulant gem crystals include applications in frequency controllers, polarizers, transducers, radiation detectors, infrared optics, bearings, strain gages, amplifiers, lasers, lenses, crucibles, and many more. A recently developed use is as connectors for optical fibers.

The 1990 estimated value of U.S. apparent consumption was $3,059 million, down about 18% from 1989's record high. The average annual estimated consumption for the past 10 years was $2,871 million, with a high of $3,711 in 1989 and a low of $1,642 in 1982. The trend for estimated consumption for the past 10 years was one of continued growth with about 68% total increase.

In 1990, the value of U.S. estimated apparent consumption of diamonds decreased 18% to $2.6 billion. The average annual value of apparent consumption of diamonds for the past 10 years was $2,293 million, with a high of $3,115 million in 1989 and a low of $1,642 million in 1982. The trend for the value of apparent consumption for the past 10 years was one of significant increase. The value of apparent consumption of diamonds increased 90% over the period.

The 1990 estimated apparent consumption of colored stones, led by emerald, ruby, and sapphire, was valued at $397.1 million, a decrease of 3%. The annual average value of consumption of colored stones for the past 9 years was $325.0 million, with a high of $406.9 million in 1989 and a low of $252.4 million in 1982. The trend for apparent consumption of colored stones for the past 9 years was one of fluctuating increases and decreases, but the general tread was one of increased consumption.

The estimated apparent consumption of pearls—natural, cultured, and imitations—was $16.5 million, a decrease of about 89% from that of 1989. This large decrease makes one wonder if there is not an error in the import data for pearls. The value was only 17% of the 9-year low reached in 1982.

Estimated apparent consumption of synthetic and imitation gem materials increased about 115% to $94.1 million. Average apparent consumption of synthetic and imitation gem materials for the past 9 years was $55.2 million per year, with a high of $109.1 million in 1987 and a low of $13.9 million in 1982. The trend for apparent consumption for the past 9 years was one of generally strong growth except for the significant decrease in 1989. Annual apparent consumption increased about 577% over the 9 years.

Prices

Demand, beauty, durability, rarity, freedom from defects, and perfection of cutting determine the value of a gem stone. But the major factor in establishing the price of gem diamond is the control over output and prices as exercised by the CSO Diamond Trading Co. Ltd. The CSO is a subsidiary of De Beers Consolidated Mines Ltd.

The average U.S. wholesale asking price of the top 25 grades (D through H color and IF through VS2 clarity) of a 1-carat diamond fluctuated between $6,200 and $7,000 and was $7,000 at yearend. The average value per carat of all grades, sizes, and types of gem-quality diamond imports was $525, a 29% increase compared with that of 1989. The average value of diamond imports for the past 10 years was $405 per carat, with a high of $525 in 1990 and a low of $353 in 1984. The trend for the average annual value of diamonds imported for the past 10 years was one of general decline, from the 10-year high in 1980 to stable prices in 1986, 1987, and 1988, followed by the 1989 and 1990 increases.

The average yearend wholesale purchase price of a fine-quality 1-carat ruby, paid by retail jewelers on a per stone or memo basis, was $4,200, an increase of 20% from that of 1989. The average value of ruby imports increased 49% to $48.71 per carat. The average annual value of ruby imports for the past 9 years was $37.93 per carat, with a high of $48.71 in 1990 and a low of $16.42 in 1984. The trend for the value of ruby imports for the past 9 years was one of rapid decline, 52% for the period from 1982 to 1984. This was followed by a steady, moderate increase.

The average yearend wholesale purchase price of a fine-quality 1-carat sapphire, paid by retail jewelers on a per stone or memo basis, was $1,600, a 14% increase from that of 1989. The average value of sapphire imports decreased 11% to $21.57 per carat. The average annual value of sapphire imports for the past 9 years was $23.22 per carat, with a high of $27.97 in 1987 and a low of $18.50 in 1984. The trend for the value of sapphire imports for the past 9 years was one of fluctuating increases and decreases. The 9-year period ended with the 1990 value 12% below the 1982 value.

The average yearend wholesale purchase price of a fine-quality 1-carat emerald, paid by retail jewelers on a per stone or memo basis, was $2,750, the same as for 1989. The average value of emerald imports decreased 28% to $43.65 per carat. The average annual value of emerald imports for the past 10 years was $57.18 per carat, with a high of $78.79 in 1988 and a low of $35.06 in 1984. The trend for the value of emerald imports for the past 10 years was one of fluctuating increases and decreases from 1981 through 1984. A steady moderate growth followed until the 2 years of decline in 1989 and 1990, the average value in 1990 being about 76% of the 1981 value.

Foreign Trade

The export value of gem materials increased 33% to $1,566 million, a record high. The quantity of diamonds exported increased 45% to 1,003,760 carats, and the value of diamond exports increased about 29% to $1,398.8 million. The average annual quantity of diamonds exported for the past 10 years was 496,477 carats, with a high of 1,003,760 in 1990 and a low of 184,871 in 1982. The trend for the quantity of diamonds exported for the past 10 years was one of moderate decline, 13%, during the first 2 years, followed by significant growth, 443%, from 1983 to 1990. The average annual value of diamond exports for the past 10 years was $643.6 million, with a high of $1,398.8 million in 1990 and a low of $292.8 million in 1982. The trend for the value of diamond exports for the past 10 years was one of decline, 16%, over 3 years, followed by 3 years of moderate growth, 32%, and then 3 years of significant growth, 112%. This resulting in record-high exports in 1990.

The export of other precious stones, cut but unset and other than diamonds and pearls, increased about 62% to $70.6 million. The average annual export value for the past 9 years for these natural gem stones was $42.9 million, with a high of $70.6 million in 1990 and a low of $27.7 million in 1984. The 9-year trend for exports value of these types of gem materials was one of fluctuating increases and decreases, but one resulting in a significant total increase, 139% for the period.

Exports of synthetic gem material decreased 8% to $42.5 million. The average annual value of exports for the past 9 years was $18.6 million, with a high of $46.0 million in 1989 and a low of $6.0 million in 1987 and 1988. The 9-year trend for the value of exports was one of extreme decline, 52%, for 1982–88, followed by steady significant growth, 608%, during the past 2 years.

Exports of natural, cultured, and imitation pearls, not set or strung, decreased about 74% to $0.9 million.

Reexports of gem material decreased 84% to $47.3 million.

The value of gem materials imported decreased 10% to $4,609.3 million from the 1989 record high of $5,115 million. The value of imported gem diamonds accounted for about 86% of the total. The average annual value of gem material imports for the past 10 years was $3,839 million, with a high of $5,115 million in 1989 and a low of $2,384 million in 1982.

The value of imported gem diamonds decreased about 9% to $3,955.2 million from the 1989 record high of $4,358 million. The 10-year trend for the value of diamond imports was one of generally steady continuous growth

TABLE 5

PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Price range per carat[3] Jan. 1989–Jan. 1990	Average[4] July 1989
0.25	G	VS1	$1,300–$1,400	$1,400
.25	G	VS2	1,100– 1,200	1,200
.25	G	SI1	880– 970	970
.25	H	VS1	1,100– 1,200	1,200
.25	H	VS2	1,000– 1,100	1,100
.25	H	SI1	860– 950	950
.50	G	VS1	2,500– 2,700	2,900
.50	G	VS2	2,300– 2,500	2,600
.50	G	SI1	1,900– 2,300	2,200
.50	H	VS1	2,300– 2,600	2,600
.50	H	VS2	2,100– 2,400	2,400
.50	H	SI1	1,800– 2,100	2,100
.75	G	VS1	2,900– 3,500	3,300
.75	G	VS2	2,700– 3,200	3,000
.75	G	SI1	2,300– 2,800	2,600
.75	H	VS1	2,600– 3,000	2,900
.75	H	VS2	2,300– 2,700	2,600
.75	H	SI1	2,100– 2,500	2,400
1.00	G	VS1	4,600– 4,600	4,600
1.00	G	VS2	4,100– 4,100	4,100
1.00	G	SI1	3,500– 3,500	3,500
1.00	H	VS1	4,100– 4,100	4,100
1.00	H	VS2	3,600– 3,600	3,600
1.00	H	SI1	3,200– 3,200	3,200

[1] Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; H-I—traces of color.
[2] Clarity: IF—no blemishes; VVS1—very, very slightly included; VS—very slightly included; VS2—very slightly included, but not visible; SI1—slightly included.
[3] Jeweler's Circular-Keystone. V. 161, No. 3, Feb. 1990.
[4] Jeweler's Circular-Keystone. V. 159, No. 2, Sept. 1989.

TABLE 6

PRICES OF U.S. CUT COLORED GEM STONES, BY SIZE[1]

Gem stones	Carat weight	Price range per carat in 1990[2]	Average price per carat[2] Jan. 1989	Jan. 1990
Amethyst	1	$6- $18	$8.00	$13.00
Aquamarine	1	100- 250	175.00	175.00
Emerald	1	1,900-3,500	2,400.00	2,750.00
Garnet, tsavorite	1	500- 800	950.00	650.00
Ruby	1	3,000-4,000	3,000.00	3,500.00
Sapphire	1	800-2,000	1,050.00	1,400.00
Tanzanite	1	250- 350	354.00	300.00
Topaz	1	6- 12	7.50	9.00
Tourmaline, red	1	60- 125	92.50	92.50

[1] Fine quality.

[2] Jewelers' Circular-Keystone. V. 161, No. 3, Mar. 1990, p. 190. These figures represent a sampling of net prices that wholesale colored stone dealers in various U.S. cities charged their cash customers during the month for fine-quality stones.

with an increase of 80% for the period. During the period, the value of imported uncut diamonds increased 42%, while the value of cut stones imported increased 89%.

The imports of cut diamonds decreased 29% in quantity and 11% in value to 6.3 million carats and $3,384.4 million, respectively. The average annual quantity of cut diamonds imported was 6.6 million carats, with a high of 8.9 million in 1989 and a low or 1.6 million carats in 1982. The trend for the quantity of cut diamond imports for the past 10 years was one of continued increases until the 1990 decline; the period still ended with imports 80% greater than at the beginning of the period. The average annual value of imported cut diamonds was $2,762.4 million, with a high of $3,805.5 in 1989 and a low of $1,641.0 million in 1982. The trend for the value of imported cut diamonds for the past 10 years was of strong growth and increases. The value at the end of the period was 88% greater than at the beginning.

The value of imports of other gem materials, led by emerald, ruby, and sapphire, was $558.9 million, an decrease of about 26% compared with that of 1989. Emerald imports decreased about 22% to $162.4 million. The average annual value of emerald imports for the past 10 years was $151.9 million, with a high of $207.5 million in 1989 and a low of $120.8 million in 1982. The 10-year trend for the value of emerald imports was one of fluctuating increases and decreases resulting in a 44% increase for the period.

The value of ruby imports increased 18% to $98.4 million, a record-high value for the past 10 years. The average annual value of imports for the past 10 years was $77.2 million, with a high of $98.4 in 1990 and a low of $58.7 in 1987. The 10-year trend for import values was one of extreme fluctuations. The period ended with values having increased 68% from the 10-year low and establishing a record high for the period.

The value of sapphire imports decreased 18% from the 1989 10-year high to $81.9 million. The average annual value of sapphire imports for the past 10 years was $81.8 million, with a high of $100.0 million in 1989 and a low of $63.3 million in 1982. The 10-year trend for the value of imports was one of extremely fluctuating increases and decreases. The period ended with the value slightly lower than at the beginning of the period.

The value of imported gem materials other than diamond, emerald, ruby, and sapphire decreased 41% to $216.2 million. The average annual value of imports was $325.3 million, with a high of $429.5 in 1988 and a low of $134.6 in 1981. The 10-year trend for the value of imports was one of fluctuating increases and decreases resulting in the period ending 61% higher than the period started.

World Review

De Beers, Centenary AG's diamond marketing arm, the CSO, reported 1990 sales of rough, uncut diamonds increased 2% over that of 1989 to $4.17 billion. Sales for the year were up, but sales for the second half of 1990 were 32% less than the sales for the first half of the year. Also, if the sales were adjusted for inflation, which was about 6% in the United States and higher in other leading consumer countries, the value of diamond sales actually decreased. The CSO markets from 80% to 85% of the total world production of natural diamonds. Sales of colored stones remained strong.

Natural diamond production occurs in Africa, Asia, Australia, and South America. The principal producing localities are as follows: in Africa—Angola, Botswana, Namibia, the Republic of South Africa, and Zaire; in Asia—U.S.S.R. (northeastern Siberia and in the Yakut A.S.S.R.); in Australia; and in South America—Venezuela and Brazil.

Foreign countries in which major gem stone deposits (other than diamond) occur are Afghanistan (beryl, kunzite, ruby, tourmaline); Australia (beryl, opal, sapphire); Brazil (agate, amethyst, beryl, kunzite, ruby, sapphire, tourmaline, topaz); Burma (beryl, jade, ruby, sapphire, topaz); Colombia (beryl, sapphire); Kenya (beryl, garnet, sapphire); Madagascar (beryl, rose quartz, sapphire, tourmaline); Mexico (agate, opal, topaz); Sri Lanka (beryl, ruby, sapphire, topaz); Tanzania (tanzanite, garnet, ruby, sapphire, tourmaline); and Zambia (amethyst, beryl).

Angola.—Endiama, the state diamond company, signed a two-part agreement with De Beers' CSO that reestablished a trading relationship that was ended in 1985. The first part of the agreement calls for De Beers to provide a $50 million loan to Endiama to be used to increase the production from the Cuango area. De Beers will market all of the production from the Cuango area; the area accounts for about 80% of Angola's production.

The second part of the agreement calls for De Beers to spend $50 million over 5 years on the evaluation of the Camutue kimberlite in northeastern Angola and on the search for additional kimberlite sources of diamonds.

Any mines resulting from this agreement will be jointly developed by De Beers and Endiama.

Endiama also signed an agreement with Steinmetz Evens Diamonds for the sale of diamonds produced in the Andrada and Lucapa areas. The alluvial deposits of these areas are about depleted and are of little interest to De Beers.[4]

Australia.—Diamond production in Australia decreased slightly because of a decrease in the production from Argyle. Argyle produced 33.8 million carats compared with 1989 production of 34.4 million, a decrease of about 2%. Estimates of 1990 Bow River production are about 900,000 carats.

In a move to increase the market for diamonds from the Argyle mine, Argyle Diamonds of Australia announced a multimillion dollar advertisement program to promote champagne colored diamonds. The multipart program will be directed primarily at the U.S. market.

More than 90 companies are involved in diamond projects in Australia, with another 23 companies exploring for diamonds on offshore projects. The success of the Argyle mine and reassessment of old information has led to the latest rush concentrated in New South Wales, with some companies in northern New South Wales claiming to have discovered pipes larger than that at Argyle.

Miners in Coober Pedy claimed to have found the world's biggest opal; the uncut opal weighed 5.27 kilograms and has an estimated worth of $3 million. The stone is 233.37 centimeters long and 12.19 centimeters wide. The opal is milky white in color.

Botswana.—Corona Corp. agreed to acquire control of Repadre Capital Corp. and the new firm will be named Corona Diamonds International Corp. Repadre had agreed to a joint venture with Ampal (Pty.) Ltd. to develop Ampal's diamond licenses in Botswana. Ampal holds multiple prospecting licenses covering about 20,700 square kilometers upon which a number of kimberlites have been identified. Exploration drilling is schedule to start on 30 to 50 of these targets. Corona Diamonds could earn a 40% interest in the properties by spending about $1.75 million before December 31, 1991. Additional interests can be earned by further expenditures.

The Government of Botswana and Lazare Kaplan International Inc. (LKI) signed a long-term agreement for a diamond cutting and polishing factory in Botswana. The agreement represent a major investment by a U.S. company in Botswana. The factory will be a state-of-the-art plant using automated and manual equipment. LKI will manage the plant and train Botswana workers as operators. It is anticipated that the plant will ultimately employ at least 500 skilled workers.

The Government of Botswana and Mabrodiamn, 85% owner of Diamond Manufacturing Botswana (DMB), signed a contract to expand DMB's 12-year-old cutting factory at Garabone. The agreement was to expand the plant from its current 55 workers to 200 workers. The factory manufactures low-quality 2 grainer sawn rough, but some 10-carat sawn is manufactured also. Cutting factory labor costs in Botswana are lower than in Belgium, but higher than in the Far East.

Canada.—Uranerz Exploration and Mining of Canada reported finding two diamonds, one two millimeters and the other four millimeters, near Melfort in the area of Fort a la Corne. These diamonds are significantly larger than the microdiamonds found in the past. Microdiamonds have been found in the area by other companies, including Claud Resources and Monopros Ltd., a subsidiary of De Beers. None of the companies exploring in the area has yet to discover a commercial deposit of diamonds, but these larger stones do increase the interest of the companies exploring the area. Uranerz plans to spend $2 million on exploration in the area in the next 2 years.

China.—The Mineral Resources Bureau reports that geologists discovered 13 diamond deposits along the Tanlu Fault Zone that stretches across several Provinces in the eastern part of the country. The Bureau claims to have found more than 100 kimberlites and 4 diamond placers in Shandong Province, while in Liaoning Province it found 3 large primary deposits and 3 smaller placer deposits.

Cook Islands.—The Cook Islands received $25 million in aid from the U.S. Agency for International Development for the development of a black pearl industry. The pearl industry would be started on the island of Suwarrow and possibly extended to the islands of Pen-

TABLE 7

U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY

Country	1989 Quantity (carats)	1989 Value[1] (millions)	1990 Quantity (carats)	1990 Value[1] (millions)
Exports and reexports:				
Belgium	279,682	$216.8	267,010	$269.4
Canada	25,722	31.1	35,837	23.7
France	5,577	11.4	8,388	13.2
Hong Kong	140,686	253.5	163,845	316.4
Israel	250,888	214.2	248,766	221.0
Japan	114,634	206.8	98,777	282.9
Singapore	3,274	10.1	4,766	20.2
Switzerland	42,201	180.7	82,800	131.3
Thailand	39,575	16.4	51,211	35.1
United Kingdom	10,451	60.6	14,180	45.8
Other	137,798	42.1	28,180	39.7
Total	1,050,488	1,243.7	1,003,760	1,398.7

[1] Customs value.

Source: Bureau of the Census.

TABLE 8

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY

Kind, range, and country of origin	1989 Quantity (carat)	1989 Value[1] (millions)	1990 Quantity (carat)	1990 Value[1] (millions)
Rough or uncut, natural:[2]				
Belgium	57,962	$18.0	104,544	$26.1
Brazil	33,709	5.7	10,547	1.2
Israel	12,979	7.1	11,769	5.4
Netherlands	24,424	11.7	5,552	12.1
South Africa, Republic of	9,130	13.8	458	.4
Switzerland	12,268	11.9	1,653	3.6
United Kingdom	747,397	254.0	300,579	287.1
Venezuela	7,275	.9	8,923	.5
Other	284,292	229.5	779,030	234.4
Total	1,189,436	552.6	1,223,055	570.8
Cut but unset, not more than 0.5 carat:				
Belgium	1,531,997	962.7	769,047	326.9
Brazil	39,200	16.2	17,168	6.1
Canada	7,754	5.5	7,232	1.0
Hong Kong	101,828	48.1	176,077	45.4
India	3,136,459	792.4	2,946,261	768.8
Israel	1,784,444	1,104.3	471,820	224.0
Netherlands	19,227	24.1	4,363	2.4
South Africa, Republic of	10,707	15.7	8,326	7.5
Switzerland	41,986	75.6	12,894	4.7
United Kingdom	37,581	37.3	5,593	1.9
Other	138,808	57.0	80,997	39.8
Total	6,849,991	3,138.9	4,499,778	1,428.5
Cut but unset, more than 0.5 carat:				
Belgium	266,164	99.0	516,109	651.1
Hong Kong	68,930	19.5	15,811	32.8
India	1,176,503	312.0	181,619	113.0
Israel	318,288	178.5	983,684	942.0
Netherlands	4,809	10.5	10,844	24.9
South Africa, Republic of	1,245	.4	5,792	11.5
Switzerland	21,420	13.4	14,484	70.3
United Kingdom	11,116	8.2	28,288	52.6
Other	151,614	25.1	48,550	57.7
Total	2,020,089	666.6	1,805,181	1,955.9

[1] Customs value.
[2] Includes some natural advanced diamond.
Source: Bureau of the Census.

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Guinea.—Currently, at least four companies are either exploring for or mining diamonds in Guinea. Aredor, the company with the longest history in diamond operations in the country, is experiencing a decline in production and in profits. The decline in production is because of decreasing ore grades. The decreasing profits is because of a combination of lower diamond production and a lower sales price for diamonds. The 1990 average sales price for Aredor's diamonds was down 19% to $245 per carat.

Star Diamonds has a prospection license area 30 kilometers to the south and east of the Aredor lease. The alluvial deposits that are of the most interest are those on the flats near Bouro and those at the headwaters of the Bouloumba.

Sidam-Minorex is exploring in an area for diamonds near Forecariah, east of Conakry, and Hydro Mineral Exploration is exploring for diamonds near Bounoudou.

Brigade Aurifere de Guinee has a concession to mine gold in an area north of the Aredor lease in which diamonds may be found also.

Hong Kong.—Less than 50% (42 of 98) of the jadeite jewelry lots were sold at Christie's Swire Ltd.'s auction in October. The 42 lots brought in $1.4 million. The sale was disappointing according to Christie's, but the jadeite market is and always has been extremely volatile. In November, buyers purchased about 75% (90 of 121 lots) of the jadeite jewelry sold at auction by Sotheby's Hong Kong Ltd. The total purchase price of the jewelry was $4.02 million. According to a Sotheby's representative, the market for top-quality jade is strong, but the market for decorative materials is very soft.

India.—Imports of rough diamonds fell in 1990 by 16% in value and 37% in volume to $1.97 billion and 38 million carats, respectively. Total exports of polished stones for the year also declined, caratage decreased 13% to 8.7 million carats, and value fell 9% to $2.7 billion. The decline in demand of cut goods resulted in the closing down of thousands of production units in the past 12 months and as many as 20,000 workers laid off by yearend. The decreases were blamed on the recession in the United States and the Persian Gulf war. Cut diamonds account for 90% by value of gem and jewelry exports, which in turn account for nearly 20% of the country's total exports.

Indonesia.—Development of the Danau Seran diamond project in South East Kalimantan began in late 1990. Dry mining and a conventional diamond recovery plant will be used in place of a dredge. This approach is cheaper and easier to finance. The Danau Seran contains about 2.9 million cubic meters of diamondiferous gravel with a grade of 0.1 carats per cubic meter. The deposit will be mined over the next 3 years at a production rate of 72,000 cubic meters per month. The group that put up the $2 million in financing will control a 25% equity interest. The interests of Indonesian Diamond Corp. (formerly Acorn Securities) and Keymead have been reduced to 44.7% and 10.3%, respectively, with PT Aneka Tambang (Indonesian Government) holding the remainder.[5]

Malaysia.—Boulders of nephrite jade were discovered in Sabah State in the northern part of Borneo. The boulders ranged in size from about 0.5 meters to 1.0 meters. The jade has a flawless area of good color that is suitable for jewelry. The source of the boulders and the commercial viability of the deposit are not known at this time.

Sierra Leone.—The Government of Sierra Leone granted a 20-year concession to Sunshine Mining Co. of the United States to mine and market diamonds from the Kono kimberlite deposit. Exploration and development work to date indicates the deposit contains about 2.4 million carats of recoverable gem-quality diamonds. Sunshine estimated the project capital costs at about $54 million.

The Government of Sierra Leone granted a lease to Intertarade Prospecting, a Swedish firm, to mine diamonds in an area north of Freetown. The firm announced plans to spend about $3 million dollars on deposits that are reported to be of marginal viability.

Wildcat Holdings PL, a wholly oned subsidiary of Pioneer Resources, entered into an agreement with Xerxes Ltd. to explore for diamonds in the Baoma district. The area is believed to contain both alluvial and kimberlite diamond deposits.

South Africa, Republic of.—The De Beers Mine, the smallest of the four mines De Beers Consolidated Mines Ltd. operates in Kimberley, is scheduled to close in October 1990. Treatment of surfaces stockpile ore at the mine will continue well into 1991. The mine was discovered in 1871 and operated as an open pit mine until 1885, at which time underground operations were started. The mine closed in 1908 and remained closed until opening once more in 1960 and operated until 1990.

TABLE 9

U.S. IMPORTS FOR CONSUMPTION OF GEM STONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY

Kind and country	1989		1990	
	Quantity (carats)	Value[1] (millions)	Quantity (carats)	Value[1] (millions)
Emerald:				
Belgium	10,605	$1.2	21,217	$1.1
Brazil	80,829	12.8	1,189,248	6.3
Colombia	429,390	73.1	382,051	58.2
France	5,345	4.0	10,202	2.5
Germany, Federal Republic of	23,902	3.2	44,811	2.1
Hong Kong	135,423	18.9	156,111	13.2
India	2,068,254	25.9	1,317,886	24.7
Israel	89,559	24.7	93,973	20.6
Japan	10,178	1.1	2,769	.2
South Africa, Republic of	146	(2)	52	(2)
Switzerland	60,265	28.6	144,394	18.9
Taiwan	1,681	.7	4,533	.2
Thailand	366,925	5.0	291,458	7.4
United Kingdom	6,187	2.5	9,722	2.6
Other	112,866	5.8	51,962	4.4
Total	3,401,555	207.5	3,720,389	162.4
Ruby:				
Belgium	7,760	1.1	4,250	.4
Brazil	8,093	(2)	1,562	.1
Colombia	337	(2)	346	.1
France	21,483	3.5	3,340	2.2
Germany, Federal Republic of	20,822	.8	11,580	.8
Hong Kong	79,583	6.1	49,175	5.3
India	455,954	1.6	313,583	2.3
Israel	26,326	3.8	12,857	1.1
Japan	796	0.4	13	(2)
Switzerland	70,098	19.7	190,056	26.6
Thailand	1,778,218	38.9	1,323,506	46.6
United Kingdom	3,596	2.9	66,831	6.5
Other	73,345	4.6	42,991	6.4
Total	2,546,411	83.4	2,020,090	98.4
Sapphire:				
Australia	30,439	.4	3,013	.2
Austria	377	(2)	202	(2)
Belgium	26,155	2.2	14,131	.5
Brazil	8,705	.2	2,827	.1
Canada	5,622	.6	2,126	.2
Colombia	358	.2	1,328	(2)
France	7,825	1.4	2,409	1.9
Germany, Federal Republic of	31,999	1.4	44,834	.9
Hong Kong	102,671	8.4	83,519	3.9
India	112,937	1.0	101,510	.8
Israel	29,535	4.7	26,140	1.5
Japan	2,532	.6	7,666	.1

See footnotes at end of table.

TABLE 9—Continued

U.S. IMPORTS FOR CONSUMPTION OF GEM STONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY

Kind and country	1989 Quantity (carats)	1989 Value[1] (millions)	1990 Quantity (carats)	1990 Value[1] (millions)
Sapphire—Continued				
Korea, Republic of	9,024	(2)	204	(2)
Singapore	481	(2)	4,931	.6
Sri Lanka	63,184	4.1	106,211	5.4
Switzerland	67,086	15.6	91,574	11.3
Thailand	3,576,666	55.1	3,248,891	51.2
United Kingdom	9,435	2.5	11,135	1.8
Other	34,348	1.6	44,113	1.5
Total	4,119,379	100.0	3,796,764	81.9
Other:				
Rough, uncut:				
Australia	NA	1.4	NA	1.7
Brazil		36.0		37.4
Colombia		10.5		2.4
Hong Kong		2.2		(2)
Nigeria		.7		.1
Pakistan		1.4		.4
South Africa, Republic of		.2		.4
Switzerland		1.3		3.5
United Kingdom		(2)		.4
Zambia		.5		1.2
Other		11.1		16.3
Total	NA	65.3	NA	63.3
Cut, set and unset:				
Australia	NA	10.7	NA	6.1
Brazil		5.0		12.7
Canada		.2		.5
China		1.1		1.9
Germany, Federal Republic of		12.2		19.6
Hong Kong		21.2		18.5
India		3.7		5.8
Japan		118.3		11.7
Switzerland		1.3		1.7
Taiwan		1.8		3.4
Thailand		10.0		41.1
United Kingdom		2.4		2.1
Other		15.7		21.4
Total	NA	203.6	NA	146.5

NA Not available.
[1] Customs value.
[2] Less than 1/10 unit.
Source: Bureau of the Census.

The Kim Diamond Cutting Works, a diamond cutting factory, was constructed in Kimberley. The factory will employ at least 1,280 workers and will process 30,000 carats of local rough per week. The plant will produce from 0.01- to 0.30-carats stones for the export market.

Sri Lanka.—The Government of Sri Lanka changed the regulations on the export of geuda three times during 1990. The first change was made at the end of July when the agreement to sell geuda only to Thailand was ended and the sale of geuda was opened to buyers from all countries. In August, the exports of geuda was restricted to milky corundum; therefore, only firms specializing in the heat treatment of this type of geuda could export materials. In October, the regulations were amended to include silky, yellow silky, ottu, ooral, diesel, and dalan geuda. The Government descriptions used for geuda based on appearance under reflected light include milky (white, blue or yellow with a milky or soapy appearance), silky (white or blue with a shiny effect over the entire stone caused by rutile inclusions), yellow silky (yellow with shiny effect), ottu (blue patches or bi-colored), coral (color concentrated in patches without a definite outline and difficult to locate color source), diesel (brownish with oily appearance similar to diesel), and dalan (loosely sued for two or more of the above varieties in small sizes, also for large stones with many cracks and bubbles). Under the new system the number of carats of geuda exported in-

TABLE 10

VALUE OF U.S. IMPORTS OF SYNTHETIC AND IMITATION GEM STONES, INCLUDING PEARLS, BY COUNTRY

(Million dollars[1])

Country	1989	1990
Synthetic, cut but unset:		
Austria	3.7	3.6
France	.4	.8
Germany, Federal Republic of	9.4	9.6
Japan	.4	.6
Korea, Republic of	4.3	5.5
Switzerland	3.8	3.1
Other	7.4	9.4
Total	29.4	32.6
Imitation:		
Austria	40.0	53.6
Czechoslovakia	3.1	1.9
Germany, Federal Republic of	1.6	1.6
Japan	.4	.3
Other	12.2	3.2
Total	57.3	60.6

[1] Customs value.
Source: Bureau of the Census.

TABLE 11

U.S. IMPORTS FOR CONSUMPTION OF GEM STONES

(Thousand carats and thousand dollars)

Stones	1989 Quantity	1989 Value[1]	1990 Quantity	1990 Value[1]
Diamonds:				
Rough or uncut	1,189	552,557	1,223	570,750
Cut but unset	8,870	3,805,590	6,305	3,384,472
Emeralds: Cut but unset	3,402	207,546	3,720	162,375
Rubies and sapphires: Cut but unset	6,666	183,344	5,817	180,375
Pearls:				
Natural	NA	4,382	NA	3,734
Cultured	NA	144,335	NA	19,097
Imitation	NA	5,456	NA	3,814
Other precious and semiprecious stones:				
Rough, uncut	NA	65,298	NA	63,751
Cut, set and unset	NA	55,909	NA	119,866
Other	NA	NA	NA	5,917
Synthetic:				
Cut but unset	99,292	29,368	113,367	32,649
Other	NA	3,441	NA	1,911
Imitation gem stone	NA	57,323	NA	60,594
Total	XX	5,114,549	XX	4,609,305

NA Not available. XX Not applicable.
[1] Customs value.

Source: Bureau of the Census.

creased, but the value of geuda exports decreased.[6]

Tanzania.—The Government of Tanzania and Tanex Ltd., a company associated with De Beers Centerary AG, concluded an agreement to explore for diamonds over a large area south of Lake Victoria and to the south and west of the Williamson Mine. Exploration in the past has discovered several kimberlites that contained diamonds, but none were economical to mine.

U.S.S.R.—The Soviet Government entered into an agreement with De Beers giving De Beers exclusive marketing right to the U.S.S.R. diamond production for the next 5 years. The agreement was with Glavalmazzoloto, the organization that administers the sale and export of rough diamonds. Under the terms of the contract, a De Beers' subsidiary will provide a $1 billion advance against future production, but secured by the Soviet stockpile. It is estimated that the contract calls for a purchase of $1 billion worth of diamonds per year.

It is estimated that the U.S.S.R.'s diamond cutting industry employs about 16,000 workers. The eight Krystall factories at Moscow, Smolensk, Kiev, Barnaul, Vinnitsa, Yerecvan, Kusa, and Gomel employ fewer than 8,000, with the Moscow plant having about 900 workers. The workers at the various factories may be paid by different methods.

The workers at the Moscow plant are paid by the piece according to its size and difficulty of the cut. At Kiev, those workers whose work is not subject to inspection receive a 50% higher salary. Some of the Krystall factories have an incentive program for workers producing stones of 0.3 carats and larger. The incentive is a bonus of 5% of the added value, which is paid to each 20-worker team and is shared by the team.

Annual cut diamond production is a function of the number of workers in the industry and their productivity. If it is assumed that the industry has a production rate of 20 carats of finished goods per month per worker and that polished yields are less than 40%, then the industry's consumptions of rough and yield of finished can be estimated.

It is estimated that during a year the U.S.S.R.'s diamond cutting industry processes about 3.8 million carats of rough that yields about 1.6 million carats of polished goods. The polished goods would be worth between $500 million and $550 million on the world market.

Reportedly, the U.S.S.R. is considering a joint venture with unnamed Western concerns to open a new diamond mine and cutting factory. The mine would be on a deposit about 100 kilometers north of Archngel. Reports indicate that the deposit contains 50% gem-quality diamonds.

Vietnam.—A new ruby mine in Hoang Lien Son district of Luc Yen, 270 kilometers west of Hanoi, produced about 1.12 million carats of ruby during 1990. It is estimated by company officials that about 30% of the rough or 336,000 carats is top quality faceting rough; 40%, or 448,000 carats, is medium quality for faceting and cabochons; and 30% is low quality for beads and cabochons. The mine is operated by a Thai-Vietnamese joint venture between B.H. Mining Co. Ltd. and the Vietnamese state gem enterprise, Vinagemco. It is planned for the production to be sold at auction in Hanoi.

Zaire.—It was reported that a 345.7-carat diamond was found in the Sediza Mine. The stone is said to be internally flawless with only a few minor surface blemishes. Early estimates of the stone's value are as high as $3.8 million.

Zambia.—The Government of Zambia reduced restrictions on the mining and marketing of gem stones. Miners can now retain 50% of foreign exchange earnings instead of 20%. Additionally, a gem stone board, run by miners, and an auction system will be established. The Government estimates that Zambia exported $200 million worth of gem stones in 1989, although only $10 million were officially reported.

Zimbabwe.—De Beers was unable to reach agreement with the Government of Zimbabwe on the development of the River Ranch Kimberlite deposit near the southern border at Beitbridge. The deposit was originally discovered in 1975. The Government of Zimbabwe was unwilling to grant De Beers' CSO an exclusive marketing agreement. The Government wanted to market the production through its Minerals Marketing Corp., which would also retain a portion of the production for domestic processing. The Government has initiated procedures for the forfeiture of the River Ranch claims held by De Beers.

Current Research

An oval jade cabochon in a ring offered to Sotheby's Hong Kong Ltd. for its 1990 jadeite jewelry auction was found to have been treated with a new procedure to improve its appearance. Testing by the Hong Kong Gems Laboratory discovered a coating that is a highly adhesive, colorless organic resin mixed with a chemical compound that makes it resistant to high temperatures. The Gemological Association of All Japan found an oval jade cabochon that had exceptionally good color, luster, and transparency that was poor quality white jadeite treated with a green resinous coating. The coatings can be identified by immersing the piece in methylene iodide and shining a bright light on the stone to display the thin transparent layer of the coating.[7]

OUTLOOK

World demand for gem diamond can be expected to rise because of increasing effective personal income of the population of the United States and other industrialized countries. Also demand will increase because of highly effective promotional efforts. These promotions are changing social customs in many eastern countries, particularly with the use of diamond engagement rings. The changes are resulting in significant growth in the diamond market. Demand for other precious gems will continue to grow as diamonds become more expensive and the popularity and acceptance of colored stone increases. Demand for synthetic and simulant gem materials for both personal and industrial consumption is expected to increase. The diversity of sizes, types, uses, and values of gem materials precludes any meaningful forecasting of future demand.

[1] Nassau, K. Gemstone Enhancement. Buttersworth, 1984, pp. 46-60

[2] Jewelry News Asia, No. 75, Nov. 1990, pp. 61-78.

[3] Pages 25-44 of work cited in footnote 2.

[4] Mining Journal. V. 316, No. 8103, Jan. 4, 1991, p. 1.

[5] Industry in Action Mining Journal. V. 315, No. 8096 Nov. 9, 1990, p. 357.

[6] Jewelry News Asia, No. 76, Dec. 1990, p. 28.

[7] Jewelry News Asia, No. 75, Nov. 1990, p. 90.

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Mineral Industry Surveys, Annual Advance Summary Supplement: Gem Stone Production In Arizona, Oregon, Maine, Utah, Nevada, and Tennessee.

TABLE 12

DIAMOND: WORLD PRODUCTION, BY TYPE AND COUNTRY[1]

(Thousand carats)

Country	1986			1987			1988				1989				1990[e]			
	Natural			Natural			Natural			Synthetic[3]	Natural			Synthetic[3]	Natural			Synthetic[3]
	Gem[2]	Industrial	Total	Gem[2]	Industrial	Total	Gem[2]	Industrial	Total		Gem[2]	Industrial	Total		Gem[2]	Industrial	Total	
Angola	240	10	[e]250	180	10	[e]190	950	50	[e]1,000	—	[r]1,165	[r]80	[r]1,245	—	1,200	80	1,280	—
Australia	13,145	16,066	29,211	13,650	16,683	30,333	[r]17,413	[r]17,413	[r]34,826	—	17,540	17,540	35,080	—	17,331	17,331	[4]34,662	—
Botswana	9,590	3,500	13,090	9,368	3,840	13,208	10,660	4,569	15,229	—	10,676	4,576	15,252	—	12,146	5,206	[4]17,352	—
Brazil	310	315	625	[r]300	[r]200	[r]500	353	180	533	—	350	[r]150	500	—	350	150	500	—
Central African Republic	259	99	358	304	108	412	284	59	343	—	[r]334	[r]81	[r]415	—	300	80	380	—
China[e]	200	800	1,000	200	800	1,000	200	800	1,000	15,000	200	800	1,000	15,000	200	800	1,000	15,000
Côte d'Ivoire[e] [5]	10	4	14	15	6	21	8	3	11	—	[r]9	[r]3	[r]12	—	9	3	12	—
Czechoslovakia[e]	—	—	—	—	—	—	—	—	—	5,000	—	—	—	5,000	—	—	—	5,000
France[e]	—	—	—	—	—	—	—	—	—	4,000	—	—	—	4,000	—	—	—	4,000
Ghana[6]	88	498	586	65	400	465	[r]155	[r]465	[r] [e]620	—	[r]124	[r]370	[r] [e]494	—	129	386	515	—
Greece[e]	—	—	—	—	—	—	—	—	—	1,000	—	—	—	1,000	—	—	—	1,000
Guinea[6]	190	14	204	163	12	175	136	10	146	—	138	10	148	—	130	5	135	—
Guyana	3	6	9	2	5	[e]7	1	3	4	—	[r]3	[r]5	[r]8	—	3	5	8	—
India	13	3	16	[r]16	3	[r]19	[r]11	3	14	—	3	[r]12	[r]15	—	3	12	15	—
Indonesia[e]	6	22	28	7	22	29	7	22	29	—	7	25	32	—	7	23	30	—
Ireland[e]	—	—	—	—	—	—	—	—	—	60,000	—	—	—	60,000	—	—	—	60,000
Japan[e]	—	—	—	—	—	—	—	—	—	25,000	—	—	—	25,000	—	—	—	25,000
Liberia	63	189	252	[r]112	[r]183	[r] [e]295	67	100	167	—	[r]62	[r]93	[r]155	—	40	60	100	—
Namibia	970	40	1,010	971	50	1,021	901	37	938	—	[r]910	[r]17	[r]927	—	735	13	[4]748	—
Romania[e]	—	—	—	—	—	—	—	—	—	5,000	—	—	—	4,500	—	—	—	4,500
Sierra Leone[5]	215	100	315	150	75	225	[r]12	[r]6	[r]18	—	[r]90	[r]39	[r]129	—	100	50	150	—
South Africa, Republic of:																		
Finsch Mine	1,821	3,208	5,029	1,455	2,701	4,156	1,372	2,548	3,920	—	1,613	2,997	4,610	—	1,462	2,716	[4]4,178	—
Premier Mine	882	1,977	2,859	772	1,713	2,485	696	1,543	2,239	—	689	1,526	2,215	—	724	1,604	[4]2,328	—
Other De Beers' properties[7]	1,428	529	1,957	1,427	546	1,973	1,388	531	1,919	—	1,360	520	1,880	—	1,240	474	[4]1,714	—
Other	342	41	383	409	30	439	361	65	426	—	348	63	411	—	400	74	[4]474	—
Total	4,473	5,755	10,228	4,063	4,990	9,053	3,817	4,687	8,504	[e]55,000	4,010	5,106	9,116	[e]60,000	3,826	4,868	[4]8,694	60,000
Swaziland	23	16	39	48	32	[e]80	44	29	73	—	33	22	55	—	19	13	32	—
Sweden[e]	—	—	—	—	—	—	—	—	—	25,000	—	—	—	25,000	—	—	—	25,000
Tanzania[e]	133	57	190	105	45	150	105	45	150	—	105	45	150	—	105	45	150	—
U.S.S.R.[e]	[r]7,400	[r]7,400	[r]14,800	[r]7,400	[r]7,400	[r]14,800	[r]7,500	[r]7,500	[r]15,000	41,500	[r]7,500	[r]7,500	[r]15,000	41,500	7,500	7,500	15,000	41,000
United States	—	—	—	—	—	—	—	—	—	W	—	—	—	W	—	—	—	W
Venezuela[8]	[r]46	[r]165	[r]212	[r]38	[r]68	[r]106	[r]54	[r]74	[r]128	—	[r]70	[r]185	[r]255	—	88	245	[4]333	—
Yugoslavia[e]	—	—	—	—	—	—	—	—	—	5,000	—	—	—	5,000	—	—	—	5,000
Zaire	4,661	18,643	23,304	3,885	15,540	19,425	[r]2,724	[r]15,439	[r]18,163	—	[r]2,663	[r]15,092	[r]17,755	—	2,700	15,300	18,000	—
Total[8]	[r]42,038	[r]53,702	[r]95,741	[r]41,042	[r]50,472	[r]91,514	[r]45,402	[r]51,494	[r]96,896	241,500	[r]45,992	[r]51,751	[r]97,743	246,000	46,921	52,175	99,096	245,500

[e] Estimated. [p] Preliminary. [r] Revised. W Withheld to avoid disclosing company proprietary data.

[1] Table includes data available through May 17, 1991. Total diamond output (gem plus industrial) for each country actually is reported except where indicated by a footnote to be estimated. In contrast, the detailed separate production data for gem diamond and industrial diamond are U.S. Bureau of Mines estimates in the case of every country except Australia (1986–87), Botswana (1987), Brazil (1987), Central African Republic (1986–89), Guinea (1986–89), and Liberia (1986), for which source publications give details on grade as well as totals. The estimated distribution of total output between gem and industrial diamond is conjectural, and for most countries, is based on the best available data at time of publication. Estimated distribution figures have been revised as necessary to correspond to reported total production figures.

[2] Includes near-gem and cheap-gem qualities.

[3] Includes all synthetic diamond production.

[4] Reported figure.

[5] Figures are estimates based on reported exports and do not include smuggled diamonds.

[6] Figures do not include smuggled artisanal production.

[7] Other De Beers' Group output from the Republic of South Africa includes Kimberley Pool, Koffiefontein Mine, Namaqualand Mines, and Venetia Mine.

[8] Data may not add to totals shown because of independent rounding.

GEMSTONES

By Gordon T. Austin

Mr. Austin, a physical scientist with more than 30 years industry and Government experience, has been the gemstones commodity specialist since 1986. Mr. William Field, statistical assistant, prepared the domestic production survey data.

Webster's defines a gem "as any jewel, whether stone, pearl or the like, having value and beauty that are intrinsic and not derived from its setting; a precious or, sometimes, a semiprecious stone cut and polished for ornament. A stone of value because it is carved or engraved, as a cameo or intaglio." Additionally, the dictionary states that gemstone or gem material is a stone or material from which a gem may be cut. In less formal or common terms a gem, gemstone, or gem material may be described as specimens of minerals or organic materials used for personal adornment, display, or to manufacture objects of art because they possess beauty, rarity, and durability.

In 1991, the value of natural gemstones from deposit in the United States was $84.4 million, an increase of 60% compared with that of 1990. Production of gemstones included faceting rough, lapidary rough, carving material, specimen material, natural and cultured freshwater pearls, mother of pearl, fossil ivory, amber, agatized coral, and coral.

Synthetic gemstones are grown in the laboratory but have essentially the same appearance, and optical, physical, and chemical properties as the natural material that they represent. Synthetic gemstones produced in the United States include alexandrite, coral, diamond, emerald, garnet, lapis lazuli, quartz, ruby, sapphire, spinel, and turquoise. Simulants are laboratory grown gem materials that have an appearance similar to that of a natural gem material but have different optical, physical, and chemical properties. The gemstone simulants produced in the United States include coral, cubic zirconia, lapis lazuli, malachite, and turquoise. Additionally, certain colors of synthetic sapphire and spinel, used to represent other gemstones, would be classed as simulants. Colored and colorless varieties of cubic zirconia are the major simulants produced. In 1991, the reported combined production value of U.S. synthetic and simulant materials was $17.9 million, about a 17% decrease from that of 1990.

Wholesale and retail outlets, gem and mineral shops, gem and mineral shows dealers, cutting factories, and jewelry manufacturers were the major purchasers of domestic gem materials.

DOMESTIC DATA COVERAGE

The U.S. Bureau of Mines estimates U.S. production from the "Natural and Synthetic Gem Material Survey," a voluntary survey of U.S. operations, and from Bureau estimates of unreported production. Of the approximately 400 operations surveyed, 82% responded, accounting for about 95% of the total production, 92% of the natural production, and 100% of the synthetic and simulant production.

The number of operations surveyed in 1991 was essentially the same as the number surveyed in 1990. The response rate was essentially the same also. The Bureau estimated the production by nonresponding operations, by professional collectors, and by amateur or hobbyist collectors. The basis for these estimates were information from published data, conversations with gem and mineral dealers, analyses of gem and mineral shows and sales statistics, and from information informally supplied by collectors. In the formal voluntary survey and the informal surveys, the Bureau is totally dependent upon the cooperation of the producers, brokers, dealers, and collectors. Individuals and companies have been very cooperative and forthcoming with information. The Bureau is very appreciative of this cooperation.

BACKGROUND

The history of production and preparation of gemstones begins with the wearing of items for personal adornment in prehistoric times; this preceded even the wearing of clothes. Amber was mined in the Baltic countries for use as a gem material before 25,000 B.C. Later, the Phoenicians in their writings described their trade routes to the Baltic for amber and to areas in Asia and Africa for other gemstones. The voyages of Columbus brought increased interest in gemstone deposits, especially emerald, in South America. The discovery of diamond in Africa in 1859 focused major interest on Africa. More recently, the discovery of diamond in Western Australia in 1967 resulted in the development of the largest known diamond deposit in the world.

Commercial mining of gemstones has never been extensive in the United States. Although more than 60 different gem materials have been produced commercially from domestic sources, most of the deposits are relatively small. In many instances, production rests in the hands of the numerous hobbyists and members of mineralogical and lapidary clubs. The Crater of Diamonds State Park near Murfreesboro, AR, is open to the public on a daily fee basis, as are many other gemstone deposits throughout the United States. Many gem-quality stones are found at these locations each year.

Definitions, Grades, and Specifications

Select rocks, certain varieties of mineral specimens, and some organic materials, such as pearl, amber, jet, and coral, are included in gemstones data. Customarily, diamond, ruby, sapphire, and emerald are considered the major gems.

The most important qualities of gemstones are beauty, durability, uniqueness, and rarity. Beauty, indicated as splendor, purity, or attractiveness, is judged mainly according to the taste of the beholder, and includes such appearances as luster, transparency, brilliance, and color. Luster of a mineral or stone is independent of color and is the surface appearance in reflected light. Apart from materials that have a metallic luster, the chief contributors to luster are transparency and refractive index. In cut gems, the perfection of the polish enhances the luster. Visible imperfections impair the luster of transparent stones. However, defects, described as "jardens" or "inclusions," may enhance the beauty and value of natural rubies, sapphires, and other gemstones. In some cases these inclusions may be used to identify the country and even the mine from which the stone was recovered. Durability is measured by the resistance of a stone to abrasion, pitting, chipping, or splitting. Resistance to abrasion is correlated with relative hardness, but intrinsic brittleness and toughness indicate resistance to wear in other aspects. Rarity is an essential qualification and is more important for some stones in determining their value than their physical characteristics.

Of the approximate 2,700 mineral species, only about 100 possess all of the attributes required of a gem. It must be noted that collectors of gems may not require that a gem be durable because the stone is destined for display and is not to be worn. Therefore, the number of species of gemstones may be greater than the 100 that meet all of the requirements. Silicates furnish the greatest number, including such minerals as beryl, topaz, tourmaline, and feldspar. Oxides such as corundum (ruby and sapphire) and quartz (amethyst, agate, etc.) comprise the second largest group. Sulfides, carbonates, and sulfates are of small importance; the phosphates yield only turquoise and variscite. An exception is pearl, essentially calcium carbonate, which is ranked high as a gem. Diamond, the best known gem, is an isometric crystalline form of the element carbon.

In general, gemstones are classified the same as minerals; that is, into group, species, and variety. Group refers to two or more gem materials that are similar in crystal structure and physical properties but have different chemical properties. Each individual member of the group is called a species. Varieties of species have similar crystal structure and chemical characteristics but differ in color. An example of this would be the hessonite variety of the grossular species of the garnet group.

Products for Trade and Industry

Cutting and polishing of gems from gemstones are done to obtain the most effective display of the material. No significant change is made in the fundamental properties, and the preparation is intended to enhance the desirable characteristics that are present initially. Gemstones are cut into gems in three main styles: cabochons, baroque, and faceted.

Cabochons are cut in four operations: sawing, grinding, sanding, and polishing. Sawing, the initial step in cutting, is customarily done with a diamond saw to obtain a slab or slice of the desired size and thickness from the rough gemstone. The cabochon outline is scribed onto a flat surface, most often using a template for making a standard size for jewelry mountings. Rough grinding of the stone may be by metal-bond diamond, electroplated diamond, silicon carbide, or aluminum oxide wheels or coated abrasive disks. In grinding, the hardness of the gemstone determines the grit and hardness of the abrasive used. Multiple grinding steps starting with 80- to 100-mesh (grit) through 600-mesh abrasives are normally used. The scratches left by grinding are removed by progressively finer grinding and sanding. Disk or belt sanders use bonded to cloth abrasives, waterproof reinforced paper abrasives, or cloth charged with abrasive pastes. The final polish is obtained by using hard felt, wood, or leather laps, with various polishing agents such as fine diamond compound, tin oxide, tripoli, chromium oxide, cerium oxide, alumina, or rouge.

Polished irregular shapes are called baroque gems. An inexpensive method of polishing baroque gems is to tumble them in rubber-lined drums, using a grinding and polishing medium with or without water.

Facet cutting usually is employed on transparent gemstones to increase brilliancy and appearance. It generally is confined to the harder materials. Softer materials may be faceted, but extreme care must be exercised in cutting and polishing the stones and in their use in jewelry. Often the softer gems are used only for display and not for making jewelry. The "round brilliant" cut, most commonly used in faceting, has 58 facets, 33 above the circle "girdle" and 25 below it, arranged in eightfold symmetry. The "round brilliant" and some other common cuts are illustrated in figure 1.

Industry Structure

The world market for rough diamonds is controlled to a degree by De Beers Centenary AG's marketing arm, the Central Sales Organization (CSO). It is by far the most controlled of the world's commodity markets. An estimated 80% to 85% of gem and natural industrial diamond is marketed by the CSO. The marketing is done through the CSO by the Diamond Trading Co. Ltd. and the Industrial Distributors Ltd. The CSO sells uncut gem diamonds on behalf of De Beers and most other major producers at sights (approved bidder viewings) in London, England, and Lucerne, Switzerland. There are 10 such sights each year.

Diamonds reach the CSO sights through three channels. De Beers owned and operated mines, contracts sales by mine owner and operators, and open-market competitive sales. The distribution of rough diamonds in the Republic of South Africa is determined by the South Africa Diamond Board. All categories of rough diamonds that can be processed economically in South Africa must first be offered to local manufacturers. Rough can be exported duty free only if it has first been offered to the local market, otherwise a 15% duty is charged. Different systems of offering rough on the local market apply to the different mine producers, but they must offer the rough to local manufacturers in a manner determined by the board.

The CSO has been extremely successful at maintaining the rough diamond market for about 50 years. In modern times there has never been a decrease in CSO's price of rough diamonds. Table 1 illustrates the timing and the amounts of the average CSO price increases for rough gem diamonds from 1949 until the present, while table 2 indicates the value of CSO's annual sales for the past 10 years. The compounded effect over 43 years of these increases is a price increase of about 1,800%. Thus, a piece of rough that sold for $100 in August 1949 would sell for about $1,800 in April 1991. *(See tables 1 and 2.)*

For more than 30 years, the major diamond cutting and polishing centers of the world were in Belgium and Israel, with a certain amount of the larger stones being cut in the United States. However, in the early 1980's, the development of a large cottage industry in India—today there is estimated to be more than 500,000 cutters—made a major impact on world diamond trade. India consumes most of the world's small-gem, cheap-gem, and near-gem rough material in the manufacture of small stones, which resulted in annual cut-stone exports worth billions of dollars. These small stones averaged less than one-fifth of a carat (0.20 carat). The availability of small inexpensive stones resulted in substantial changes in the design of jewelry. The utilization of small cut diamond stones (usually 0.07 to 0.14 carats each, called melee) to create a pavé effect (set close together to conceal the metal base) is but one example. Cutting and polishing of colored, synthetic, and simulant gemstones is centered in Thailand, India, Hong Kong, Korea, China, and Brazil, where cheap labor and favorable export laws ensure the lowest total costs for finished gems. It is estimated that the U.S.S.R.'s diamond cutting industry employs about 16,000 workers. The eight Krystall factories at Moscow, Smolensk, Kiev, Barnaul, Vinnitsa, Yerevan, Kusa, and Gomel employ fewer than 8,000, with the Moscow plant having about 900 workers. The workers at the various factories may be paid by different methods.

The workers at the Moscow plant are paid by the piece according to its size and difficulty of the cut. At Kiev, those workers whose work is not subject to inspection receive a 50% higher salary. Some of the Krystall factories have an incentive program for workers producing stones of 0.3 carats and larger. The incentive is a bonus of 5% of the added value that is paid to each 20-worker team that is shared by the team.

Annual cut diamond production is a function of the number of workers in the industry and their productivity. If it is assumed that the industry has a production rate of 20 carats of finished goods per month per worker and that polished yields are less than 40%, then the industry's consumption of rough and yield of finished goods can be estimated. It is estimated that during a year, the U.S.S.R.'s diamond cutting industry processes about 3.8 million carats of rough that yields about 1.6 million carats of polished goods. The polished goods would be worth between $500 million and $550 million on the world market.

During 1991, Leo and Schachter & Co. opened the United States' newest, largest, and most modern diamond polishing factory in New York. The factory is fully computerized to track every diamond from rough to finished stone. The computer predicts the cash return from each piece of rough based on estimates of the rough's color, clarity, yield, and make, estimates are reported to be within 2% of actuals. The factory employs 40 polishers.

Geology-Resources

Gemstones are found in a large variety of igneous, metamorphic, and sedimentary rocks and mineral deposits, usually as a small fraction of the total deposit. The origins are as varied as the deposits. Gemstones form primarily by precipitation from watery solutions, by crystallization from molten rock, and by metamorphic processes. Approximately one-third of gemstones is composed of silicate minerals, about one-fifth of alumina-silicates, and almost one-seventh of oxides. The remaining compositional groups include the sulfides, phosphates, borosilicates, carbonates, and, in the single case of diamond, an element. The composition of selected gem materials is included as one of the items in table 3. *(See table 3.)*

There are no large resources of major gem materials defined in the United States. Emerald deposits are known in North Carolina, as are ruby and sapphire. Historically, sapphires have been mined in Montana, and significant commercial mining once again is underway. Numerous other domestic deposits of gemstones are known and have been mined for many years. However, no systematic evaluations of the magnitude of these deposits have been made, and no positive statements can be made about their reserve or the size of the resource.

Occasional finds of diamond have been made, but no great diamond pipes or alluvial deposits similar to those of Africa have been reported. Several companies are involved in diamond exploration in the Colorado-Wyoming State line area, in Michigan, Minnesota, Wisconsin, and Arkansas. Diamond-bearing kimberlites have been located and bulk samples have been processed for diamond recovery. Results have not been made public.

World resources of gemstones are nearly all unevaluated. However, world gem diamond reserve is estimated to be about 300 million carats, including near-gem and cheap-gem qualities. Nearly all of the reserves are in Australia, Africa, and the U.S.S.R. (Siberia). The estimates for diamond reserves are of limited value because data needed for reliable estimates are not available from the producers. Reserve data on other gemstones are even less available than for diamond.

Technology

Synthetic Gems.—Synthetic gemstone production uses many different methods, but they can be grouped into one of three types of processes: melt growth, solution growth, or extremely high-temperature, high-pressure growth.

The year 1902 saw the first production of synthetic ruby using the Verneuil flame-fusion process. Later, sapphire, spinel, rutile, and strontium titanate were grown with this technique. In this process, a single crystal, called a boule, forms in the flame of a simple, downward-impinging oxygen-hydrogen blowtorch. Pure oxides of aluminum (in the cases of ruby, sapphire, and spinel) or titanium (rutile and strontium titanate) are poured into the top of a small furnace and melted. Other oxides are added as needed for process control and to obtain the specific color desired. The melted material solidifies as a boule on a rotating fire-clay peg as the peg is slowly withdrawn.

A boule has a very characteristic shape, with a rounded end; a long, cylindrical body; and a tapering end. It is usually about 13 to 25 millimeters in diameter, 50 to 100 millimeters long, and weighs 75 to 250 carats (a carat is 200 milligrams). Under controlled conditions, boule about 5 millimeters in diameter and more than 890 millimeters long can be produced for the manufacturing of jewel bearings.

Another melt technique is the Bridgman-Stockbarge solidification method, named for an American, P. W. Bridgman, and a German, D. C. Stockbarge, who, aided by three Russians, J. Obreimov, G. Tammann, and L. Shubnikov, discovered and perfected the process between 1924 and 1936. Currently, the method is used primarily for growing nongem halide, sulfide, and various metallic oxide crystals, one of the metallic oxides being aluminum oxide or sapphire.

The Bridgman-Stockbarge process uses a specially shaped crucible, which is a cylindrical tube open at one end and capped at the other by a small, pointed cone. The crucible is filled with the powdered chemicals necessary to grow a specific crystal and is lowered slowly through a furnace. The small, pointed end of the cone cools first because it is the first part of the crucible that moves from the hottest part of the furnace into cooler regions and it is the first part to emerge from the furnace. As the crucible cools, the molten materials solidify, hopefully in the structure of a single crystal, in the point of the crucible. The crystal then acts as a seed around which the remainder of the molten material solidifies until the entire melt has frozen, filling the container with a single crystal.

This process is simple, and crystals of various sizes can be grown. The crystals are typically about 51 millimeters in diameter and 15 millimeters in length, but large ones exceeding 890 millimeters in diameter and weighing more than 1 metric ton have been grown. The crystals have the same shape as the crucible.

The Czochralshi pulled-growth method is used for ruby, sapphire, spinel, yttrium-aluminum-garnet (YAG), gadolinium-gallium-garnet (GGG), and alexandrite. Czochralshi developed his method about 1917 while working with crystals of metallic nutrients.

In the Czochralshi method, ingredient powders--nutrients—are melted in a platinum, iridium, graphite, or ceramic crucible. A seed crystal is attached to one end of a rotating rod, then the rod is lowered into the crucible until the seed just touches the melt. Then the rod is slowly withdrawn. The crystal grows as the seed pulls materials from the melt, and the material cools and solidifies. Yet, because of surface tension of the melt, the growing crystal stays in contact with the molten material and continues to grow until the melt is depleted of the desired material.

Typically, the seed is pulled from the melt at a rate of 1 to 100 millimeters per hour. Crystals grown using this method can be very large, more than 51 millimeters in diameter and 1 meter in length, and of very high purity. Each year this method grows millions of carats of crystals for use as gems, laser rods, windows for special scientific or technical applications, and for other industrial applications.

Certain gemstones pose unique problems with regard to attempts to grow them. The problems arise because certain materials are either so reactive that they cannot be melted even in unreactive platinum and iridium crucibles or they melt at much higher temperatures than the crucible materials can endure. Therefore, another melting system must be used, called the skull melting system. Cubic zirconia, because of its high melting point (2,700° C), must be grown using the skull melting method.

The "skull" is a hollow-walled copper cup. Water is circulated through the hollow walls to cool the inside wall of the skull. The cup is filled with powdered ingredients and heated by radio frequency induction until the powders melt. Because the water cools the walls of the skull, the powdered materials next to the walls do not melt, and the molten material is contained within a shell of unmelted material. Therefore, the reactive or high-temperature melt is contained within itself. When the heat source is removed and the system is allowed to cool, crystals form by nucleation and grow until the entire melt solidifies. Crystals grown using this system vary in size, depending on the number of nucleations. In growing cubic zirconia, a single skull yields about 1 kilogram of material per cycle.

Solution techniques for making synthetic gems include flux methods for emerald, ruby, sapphire, spinel, YAG, GGG, and alexandrite. The other solution method is the hydrothermal method, often used for growing beryl (emerald, aquamarine, and morganite) and quartz.

Quartz crystals are grown in a hydrothermal solution in large pressure vessels known as autoclaves. Careful control of temperature and pressure in the different areas of the autoclave result in the feed material, known as lascas, dissolving in the hotter portion. The material redeposits on seed crystals, located in the cooler portion, forming synthetic quartz crystals. The process usually takes 30 to 60 days for the crystals to reach the desired size. The process can also produce rock crystal, amethyst, or citrine.

The same system is used to grow beryl crystals. Beryl seed crystals are suspended in the cooler upper portion of an autoclave. Nutrient materials dissolve in the hotter, lower portion of the autoclave and, because of the temperature and pressure gradients, migrate to the cooler seeds and are deposited. Other techniques involve solid- or liquid-state reactions and phase transformations for jade and lapis lazuli; vapor phase deposition for ruby and sapphire; ceramics for turquoise, lapis lazuli, and coral; and others for opal, glass, and plastics.

The Verneuil, Czochralski, and scull melting processes are the melt techniques most often used for gem materials. The various synthetics and the method of production are shown in table 4. *(See table 4.)*

Enhancement of Gemstones.—Enhancement of all types of gemstones through chemical and physical means has become much more commonplace and in the past few years has included a wider variety of materials. Irradiation by electromagnetic spectrum (X-rays, gamma rays, etc.) and by energetic particles (neutrons, electrons, alphas, etc.) is being used to enhance or change the color of diamonds, topaz, tourmaline, quartz, beryl, sapphire, zircon, scapolite, and pearls. Blue topaz is normally irradiated, but this does not imply that all of these gem materials are regularly irradiated.[1]

Many gemstones can be enhanced by chemical treatment or impregnations. The treatments may alter the bulk of the gem material or only penetrate the surface. This includes bleaching, oiling, waxing, plastic impregnations, color impregnations, and dying. The treatments that alter only the surface of the material include surface coatings of various types, interference filters, foil backings, surface decoration, and inscribing. Chemical treatment is more widespread than just the common dying of quartz, treatment of turquoise, and oiling of emeralds. Chemical treatment and impregnations have been used to enhance amber, beryl, chalcedony, coral, diamonds, emerald, ivory, jade, lapis lazuli, opal, pearl, quartz, ruby, sapphire, tiger's eye, and turquoise.[2]

Since about 1987, fractures, cleavages, and other void-type imperfections that reach the surface in diamonds have been filled using a process developed by Mr. Zvi Yehuda, of Ramat Gan, Israel. This treatment can enhance that apparent clarity of treated faceted diamonds; examples are available that show SI stones enhanced to VS and I1 improved to SI2. Recently, it was announced that Yehuda also had developed a similar treatment for emeralds.

The oldest and most common method of gemstone enhancement is heat treating. Heat treatment of gem materials was used in Greece and Rome well before the Christian Era. Heat treatment can cause color change, structural change, and improve clarity. In the past, heat treatment was common for quartz and gem corundum. Today, materials that are heat treated to enhance their appearance include amber, beryl, diamond, quartz, ruby, sapphire, topaz, tourmaline, zircon, and zoisite.[3]

Recently, an additional type of treatment for sapphire has appeared—diffusion treatment, a chemical-heat treatment. In this process a thin layer of color is diffused into the surface of the gem. The color may be diffused as little as 0.1 millimeter or as much as 0.4 millimeter into the gem. The treatment is a long process of heat treatment in a bath of chemicals containing the proper proportions of titanium and iron. The American Gem Trade Association (AGTA) adopted a policy for the disclosure of diffusion treated sapphires. The policy is "If the color of a gemstone is confined to an area near the surface so that the color of the stone would be visibly affected by recutting or repolishing then the following statement must also appear: Although the color induced in the diffusion treated sapphire is permanent, it remains confined to a shallow surface layer." Therefore, recutting or repolishing is not recommended.[4]

Mining.—Gemstone mining operations can range from the most primitive to the most sophisticated. In hard rock, at shallow depths, an operation by one, two, or three persons may be mined by prybar, pick, shovel, and buckets or baskets for carrying material; often drilling and blasting is employed. A larger operation includes drilling, blasting, and minimum timbering. Mechanized hauling and hoisting is done only at the larger mines.

Diamond mining in the kimberlite pipes of Africa and the U.S.S.R. and the lamproite pipes of Australia represent the ultimate in that huge quantities of ore must be mined to extract small quantities of diamond (20 to 30 carats per 100 tons of ore) produced at as low a cost as possible.

Placer mining for gemstones ranges from small-scale, simple procedures to huge, complicated operations. In some areas, digging is by hand, and sorting and recovery is by panning, screening, or sluicing. Diamond miners in the larger placer operations use bucket dredges and heavy-duty excavating equipment, as, for example, in Australia, Brazil, Namibia, the Republic of South Africa, and the U.S.S.R.

Processing.—Most gemstones are broken or crushed where necessary and concentrated by various combinations of hand picking, washing, screening, or jigging. In large-scale operations, mineral beneficiation methods are mechanized and employ the latest technology in each step from primary crushing and screening to the final recovery processes. Diamond recovery, in particular, makes use of standard gravity methods, grease belts, electrostatic separation, skin-flotation, magnetic separation, separation by X-ray luminescence, and separation by optical sorting.

ANNUAL REVIEW

Production

In 1991, all 50 States produced at least $1,000 worth of gem materials. Ten States accounted for 95% of the total value of production of natural gemstones. The States, in order of declining value of production, were Tennessee, California, Missouri, South Dakota, Arizona, Montana, Oregon, Texas, Arkansas, and Nevada. Certain States were known best for the production of a single gem material (i.e., Tennessee for freshwater pearls and Arkansas for quartz). Other States produced a variety of gemstones. Arizona produced the greatest variety. Production included agate, amethyst, antlerite, azurite, chrysocolla, fire agate, garnets, jade, malachite, obsidian, onyx, peridot, petrified wood, precious opal, shattuchite, smithsonite, and turquoise. California, Idaho, Montana, and North Carolina also produced a variety of gemstones. Historically, North Carolina is the only State to have produced all four of the major gems: diamond, emerald, ruby, and sapphire.

The average production value of natural gem materials for the past 10 years was $28.4 million per year, with a high of $84.4 million in 1991 and a low of $7.2 million in 1982. The value of production for the past 10 years must be separated into two trends. The first trend was the period between 1981 through 1985, during which time approximately 24 operations reported production. Production averaged $7.4 million per year and was generally level. In the second trend, 1986 to the present, production averaged $424 million and was the result of an increase of 1,567% in the number of producers surveyed. The reported value of synthetic and simulant gemstone production was $17.7 million in 1990. The reported value of production decreased 17%. The average value of production of these gem materials for the past 6 years was $16.5 million, with a high of $20.5 million in 1990 and a low of $10.3 million in 1986. Fifteen firms, five in California; four in Arizona; and one each in Massachusetts, Michigan, New Jersey, North Carolina, Ohio, and Washington, produce synthetic and simulant gem material. The eight States, in order of declining value of production, were Massachusetts, California, New Jersey, Michigan, Washington, North Carolina, Arizona, and Ohio.

Arizona is well known for the widest variety of gemstones produced by any State. In 1991, they included agate, amethyst, antlerite, azurite, chrysocolla, fire agate, fluorite, garnet, jade, jasper, malachite, obsidian (Apache tears), onyx, peridot, petrified wood, precious opal, shattuchite, smithsonite, and turquoise. Yet, turquoise, peridot, petrified wood, and azurite-malachite accounted for more than 90% of the total value of gem material produced. Production from Arizona of these gemstones was the largest in terms of dollar value in the United States and the world's largest for the first two. Additionally, four manufacturers of synthetic or simulant gem materials were in Arizona and produced about $100,000 worth of material.

Arkansas is famous for the production of quartz crystals. Yet, Arkansas is second in value of production of freshwater pearls and shells and the only State in the United States that has had any sustained diamond production.

Since 1972 hobbyists have found from 300 to 1,500 diamonds per year at the Crater of Diamonds State Park. From 1906 to the present, it is estimated that production from the deposit is 100,000 to 150,000 carats; this amount of diamond production is insufficient to classify the United States as a diamond-producing country. Still, the potential to become a diamond producer may be there, and efforts were underway to evaluate this potential more fully. The program to evaluate the diamond deposit was halted by legal actions after completing three exploratory drill holes. Although a Federal appellate court has cleared the way for the program to continue, the program is currently on hold.

Gemstone production from California includes a variety of materials. Tourmaline production from the State is the largest in the Nation, and California has the only producer of benitoite. Additionally, agate, alabaster, beryl, dumortierite, fire agate, freshwater mussel shell and pearls, garnet, gem feldspar, jade, jasper, kunzite, lepidolite, obsidian, quartz, rhodonite, topaz, and turquoise are produced from deposits in the State. Yet, even with this long list of gemstones, most people think of California in terms of its State gem benitoite, its high-quality tourmalines, and its fine orange spessartine garnets.

In May 1989, Pala International reported the discovery of the largest gem tourmaline pocket found in the Himalaya Mine during the past 13 years. The pocket yielded about 500 kilograms of tourmaline; 50% was carving or cabochon grade, less than 1% was faceting grade, and the remainder was specimen grade. The Himalaya continues to produce substantial quantities of fine-quality tourmaline.

As unusual as it may sound, the State also has a freshwater culture pearl farm at Marysville. The farm uses animals imported from Tennessee and other southeastern States. Productions includes pearls, shell, and finished nucleus for cultured pearl implants.

California also has four manufacturers of synthetic or simulant gemstones. The value of production from the State is the second largest for synthetics and simulants.

Colorado is not known as a gemstone-producing State, but it does hold some gemstone honors. For 4 or 5 years prior to 1988, Colorado had the only commercially operated amethyst mine in the United States. It has the only commercially mined deposit of lapis lazuli in the United States and one of the few fee-for-dig topaz deposits currently operating. Additionally, the State was the first to commercially produce turquoise and still has commercially operated turquoise mines. The State also produced the United State's finest gem-quality rhodochrosite and a quantity of high-quality rhodonite.

Many different locations in the State produce aquamarine, the Colorado State gemstone. The best known locations and the locations with the longest history of continued production (since about 1884) are Mount Antero and White Mountain in Chaffee County. Mount Antero, at 4,349 meters, may be the highest gemstone location in the United States. White Mountain, separated from Antero by a small saddle, is only slightly lower at 4,237 meters.

Star garnet, the Idaho State gemstone, leads the list of gemstones produced in the State. Idaho is one of two places that produce significant amounts of star garnet; India is the other. These almandite garnets are translucent, purplish-red stones that show four- or six-ray stars when cabochon cut or are transparent deep red stones that can be faceted. The primary sources of Idaho star garnet are the placer deposits on the East Fork of Emerald Creek and its tributary gulches in Benewah County. Additionally, the placers of Purdue Creek in Latah County yield star garnets. Currently, garnets that do not cut stars also are commercially mined from areas in Clearwater County. These garnets range from purplish rose-red to a highly prized "special pink." Gem-quality garnets are found at several other locations in Idaho and are mined periodically by hobbyists or professional collectors for the gemstone market.

Opal is the second largest contributor to the total value of gemstone production in Idaho. The varieties produced include precious, yellow, blue, pink, and common. The Spencer opal mine is the largest producer. At the Spencer Mine, precious opal occurs as one or more thin layers within common opal that have partially filled gas cavities within a rhyolite-obsidian flow. About 10% of the material is thick enough to cut into solid gems; the remainder is suitable for making doublets and triplets. The Spencer Mine is also the source of the pink opal, which occurs as either pink common opal or pink bodied precious opal.

In recent years, an increasing amount of gem material (smokey quartz, aquamarine, topaz, and garnets) was recovered from the Sawtooth batholith. A significant portion of the batholith lays within the Sawtooth National Recreation Area, administered by the Forest Service, U.S. Department of Agriculture. Herein lies a problem. The Forest Service prohibits the collection of gem and mineral specimens from the National Recreation Area under CFR Title 36, 269.9b, which prohibits the removal of "natural features of the land." Additionally, all mining is prohibited in a recreation area. It appears that material is still being collected from the area, but this may stop in the future.

In the U.S. gemstone industry, Maine and tourmaline are almost synonymous. In 1822, Maine's Mount Mica was the site of the first gemstone production in the United States. In 1991, Plumbago Mining Corp. was actively mining the Mount Mica pegmatite for gem material and mineral specimens. Over the years, production from Mount Mica has included hundreds of kilograms of fine-quality gem and mineral specimen tourmaline.

Mount Mica is not the only large producer of high-quality tourmalines. Dunton Mine of Newry Hill is the most prolific gem tourmaline producer in Maine. Since its discovery in 1898, the mine has produced tons of gem- and specimen-grade tourmaline. Other mines and quarries in a three county area produce gem- and mineral specimen-grade tourmalines. These include the Bennett, BB #7, Emmons, Harvard, Tomminen, Waisenen, Black Mountain and Red Hill Quarries, and Nevel Mine in Oxford County. It also includes the Mount Apatite Quarries in Androscoggin County and the Fisher and Porcupine Hill Quarries in Sagadahoc County.

Production from Maine deposits also includes fine-quality beryls—aquamarine, heliodor, and morganite. Pegmatites in Oxford, Androscoggin, and Sagadahoc Counties regularly produce fine-quality blue and blue-green aquamarine, rich yellow- and gold-colored heliodor, and rose- and peach-colored morganite. In 1989, the largest rose colored morganite on record was found at the Bennett Quarry near Buckfield in Oxford County.

In 1989, Plumbago Mining Corp. opened the most significant commercial amethyst mine in the United States near the town of Sweden in Oxford County. Reported production in the first year of operation was about 2,300 kilograms of gem-quality and specimen-grade amethyst. The gem material has good deep purple color, but is mostly small pieces. An officer of the company did report the cutting of a 12-carat stone from the material and that some material recovered would yield stones as large as 20 carats. The mine did not produce during 1991.

Montana produces many different gemstones, some suited for faceting, while others are better suited for the cutting of cabochons, carvings, or objects-of-art. Montana is noted for the production of sapphires, Montana moss agate, and Dryhead agates. Yet, amethyst, amazonite, azurite, covellite, cuprite, garnet, onyx, opal, petrified wood, rhodochrosite, rhodonite, smokey quartz, sphalerite, and wonderstone (banded rhyolite) are also produced or have been produced from deposit in the State for use as gemstones.

Sapphires have been produced from Montana deposits since 1865. In recent years, Montana sapphire has gained in popularity, and because of the improved popularity, production has increased significantly. Currently, commercial sapphire production is from deposits on the Missouri River in Lewis and Clark County, the Rock Creek area in Granite County, and from the Yogo Gulch area in Judith Basin County. Additionally, there are fee-for-dig sapphire operations on the Missouri River and Rock Creek.

Until 1989, the value of Nevada's gemstone production was essentially dependent upon the production of turquoise and opal, and the production of turquoise was, and still is, declining. In 1989, Nevada reported the first major production of nephrite jade.

The Nevada jade is from a deposit near Tonopah. The material varies in color from different shades of green to black and some is mottled with off-white to tan markings. The reported quality is from fine gem to carving-grade. Mine run jade is available from fist-size pieces to individual boulders that weigh more than 1 ton. The jade is very similar to good to fine Wyoming jade.

Nevada has been a major producer of turquoise since the 1930's, and until the early 1980's, the State was the largest turquoise producer in the United States. Estimates indicate that over the years, 75 to 100 different mines and/or prospects have produced sizable quantities of turquoise. Production varied from a few thousand dollars worth of material at some properties to more than $1 million at others. Estimates of total production to date are between $40 to $50 million.

Precious opal production from deposits in the Virgin Valley area began in about 1906. The opal from Virgin Valley is comparable to any in the world for its vivid play of color and is unsurpassed in terms of the size of material available. The material varies in color from deep pure black to brown to yellowish-white to white to colorless. The play of color includes all the colors common to precious opal—red, blue, green, yellow, orange, and so on. The opal is found primarily as replacement of wood, or sometimes, the replacement of cones of conifer trees. The use of the opal is greatly restricted because of a severe problem with crazing. Currently, two mines in Virgin Valley are open to individuals on a fee-for-dig basis during the summer months. The operators of these mines also mine the deposits for their own inventories.

North Carolina is the only State in the United States where all four major gem materials, diamond, ruby, sapphire and emerald, have been found. During 1988 was the last time all four major gemstones were found in the same year. The diamond was found in a gold placer mine, rubies and sapphires were recovered from the Cowee Valley, and emeralds were found near Hiddenite and Little Switzerland.

Production of ruby and sapphire from deposits along the Cowee Valley in Macon County began in 1895 when the American Prospecting and Mining Co. systematically mined and washed the gravels of Cowee Creek. Today ruby, sapphire, and fee-for-dig operations are in the Cowee Valley. Many people pay to dig or purchase buckets of gravel to wash to recover gem corundum, garnets, and other gemstones.

Every year there is publicity concerning the discovery of large and valuable rubies and sapphires at one or more of the mines in Cowee Valley. No doubt large corundum crystals and pieces of corundum are found each year. Similarly, valuable rubies and sapphires may be found, but the number of large and valuable gems and the values of these gems often are overstated. During the period when commercial mines operated in the area, gemstones were found that would cut fine-quality 3- to 4-carat stones. Today, the amount of quality gem material has greatly declined. Most of the rubies found are not of top color or clarity and on average are suitable for cutting stones of 1 carat or less. The sapphires tend to be larger than the rubies and high-quality sapphires are more abundant than high-quality rubies.

In 1875, emeralds were discovered near what is now Hiddenite, with the first attempts at commercial mining of emeralds in the Hiddenite area in 1881. Other attempts were made in the 1920's, the 1950's, the 1970's, and the latest attempt ended in 1990. At different times the emerald deposits in the Hiddenite area have produced large emerald crystals, and some significant stones have been cut from Hiddenite material. Yet, to date, it has not been possible to maintain an economically viable mine operation on any of the deposits. This includes the last attempt that would have mass mined the deposit and used a berylometer to sort the emerald from the waste rock. The berylometer worked well, but the amount of emerald present did not support the project.

Historically, Oregon has been known for the production of various picture and scenic jaspers, agates, thundereggs, petrified wood, and to a certain degree, gem labradorite. Oregon's State rock, the "thunderegg," may be the best known gem material from Oregon. Graveyard Point, Priday, and Polka Dot are names that are uniquely associated with beautiful Oregon agates. The same is true for the relationships between the names Biggs, Deschutes, and Sucker Creek and picture or scenic jasper. Yet, gem labradorite (sunstone) is currently the largest single contributor to the value of annual gemstone production in Oregon. At least seven firms or individuals currently are producing sunstone from three different geographic areas.

The other gemstone to contribute significantly to the value of production from Oregon is opal. During 1988, the first significant commercial mining and marketing of a variety of very fine quality opals from Opal Butte began. The varieties include hyalite, rainbow, contra luz, hydrophane, crystal, fire, blue, and dendritic. Exquisite stones as large as 315 carats have been cut from contra luz rough from this deposit.

Tennessee has the largest U.S. production of freshwater mussel shells and pearls of the 11 producing States. The fishing and marketing of freshwater mussel shells and pearls are not new in the United States or in Tennessee. There has been an established U.S. freshwater mussel fishing industry since the mid-1850's. The mussels are from the family Unioidae, of which about 20 different species are commercially harvested. During 1991 the value of U.S. mussel shell exports was more than $63 million.

To date, freshwater pearls from the United States have been a byproduct of the shell industry. Currently, the primary use of the shells is to make the bead nucleus used by the Japanese cultured pearl industry. Additionally, the shells are used in making cameos and as mother-of-pearl. With the coming of the freshwater cultured pearl farms in Tennessee and the increasing popularity of freshwater pearl jewelry with the U.S. consumer, this may change. In 1963, the first experimental U.S. freshwater cultured pearl farm was established. Since the technology for culturing freshwater pearls was proven in the late 1970's, six freshwater pearl farms have been established. These farms are the beginning of the U.S. freshwater cultured pearl industry, and the cultured pearl is the heart and future of the U.S. pearl industry.

The gemstone that Utah is best known for, topaz, is not well suited for use as a gem, but it does make a fine mineral specimen. Topaz crystals have been collected from certain rhyolite flows in the Thomas Mountains for more than 100 years. Similar crystals also are found in select rhyolites in the Wah Wah Mountains. The crystals from the Thomas Mountains are predominately small, 10 to 20 millimeters long and 4 to 6 millimeters across, and crystals from the Wah Wah Mountains are even smaller. Occasionally, large gem-quality crystals are found. The color of the topaz varies from colorless to light yellow, sherry brown, rose or light pink. Unfortunately, the light yellow to sherry brown color fades to colorless if exposed to sunlight or heat and rose- or light pink-colored crystals are rare. Because of the size of the crystals and problem with color fading, the material yields only small to very small colorless stones.

Another Utah gemstone with nearly a 100-year production history is variscite, first produced in about 1893 near Fairfield. The latest recorded commercial production was from near Lucin during the summer of 1991. Variscite is found as fracture fillings or as nodules. The nodules may be solid, almost geode in nature, or fractured solid nodules that have undergone alteration. The color of the variscite varies from deposit to deposit and from location to location within the same deposit. It is a shade of light to dark yellow-green, but can be a dark, nearly jade green and so pale as to appear almost white. It also can have black and brown spiderwebbing.

Another material from Utah is snowflake obsidian. Snowflake obsidian (also known as flower obsidian) earns its name from the bluish-white or grayish-white patterns of cristobalite included into the normally black obsidian. During 1991, two different firms produced this material commercially.

Topaz, variscite, and obsidian from Utah are well known and are nice materials. But, in the author's opinion, the red beryl from the Wah Wah Mountains is the most remarkable and desirable of Utah's gemstones. Bixbite, the variety name for red beryl (called red emerald by some) is found in rhyolites at several locations in the Thomas and Wah Wah Ranges. The beryl varies in color from a pink to bright red, with the bright red being what could be called strong raspberry-red. The material from most of the locations is not as spectacular, either in crystal size or color, as the crystals from the Violet claims in the Wah Wah's.

The Violet claims in the Wah Wah's are the only known location for commercial production of red beryl. In recent years, the claims have furnished a small but steady supply of materials for both mineral specimens and a few fine-quality gems. The crystals average about 10 millimeters in length, and most are flawed. Because of the size of the crystals and flaws, finished stones only average about 0.40 carat with few more than 1 carat. The largest finished stone to date is only 4.46 carats. The material is expensive, but justifiably so, because of its beauty and rarity.

Certain other States produce a single gem material of note, they are: Alaska with its two jade mines; Florida's agatized coral; Hawaii's black coral; Minnesota's thomsonite; New York's herkimer quartz; Ohio's flint; and South Dakota's rose quartz.

The value of 1991 production by individual gemstone can be reported for those materials that have three of more producers and if one of the three does not account for more than 75% of the total or two of the producers account for 95% or more of the production. *(See table 5.)*

Consumption and Uses

Consumption of domestic gemstones was in the commercial and amateur manufacture of jewelry, for exhibit in gem and mineral collections, and for decorative purposes in statuettes, vases, other art objects, and certain industrial applications.

Frequently, tourmaline is used as a standard for calibrating piezoelectric manometers and testing devices. It is also a control substance in boron experiments because it is itself an inert boron-containing compound. Tourmaline is the standard used in tests to check possible effects of water-soluble boron in fertilizers.

Many scientific and industrial instruments use tourmaline. One such use is tourmaline tongs, a simple laboratory instrument that shows the polarization of light. Because tourmaline is both pyroeletric and piezoelectric, meaning it generates electricity when heated or compressed, it is a component of instruments for measuring high pressures and fluid compressibility. Thermal dosimeters, which were early instruments that measured the intensity of radium emanations, depended upon tourmaline's pyroelectric properties.

Once the mark of a top-rated watch or timepiece was that it was Swissmade and had 18 or 21 ruby or sapphire jewel bearings. Originally, these jewel bearings were made from natural ruby and sapphire. Later, the availability of inexpensive synthetic gemstones allowed the natural materials to be replaced in the manufacture of jewel bearings.

Why are ruby and sapphire used as bearings? Because ruby and sapphire, color variations of the mineral corundum, are second only to diamond in hardness; they have no cleavage (cleavage being the tendency for a crystallized mineral to break in certain definite directions, indicates a minimum value of cohesion in the direction easy fracture) and thus they are very durable; they have a very low coefficient of friction when highly polished; they are chemically inert; and they can be cut and polished without great difficulty.

Watches were not the only instruments in which sapphire and ruby bearings were used. Most precision gauges in aircraft and boats depend upon jewel bearings, as do many gauges, meters, and other instruments in manufacturing and chemical plants. The military is still highly dependent on jewel bearings for many of its high-tech weapons systems. Recently, another use for one type of jewel bearing appeared—as connectors for optical fibers.

In recent years, technological advances allowed the growth of large, high-quality synthetic ruby crystals, called laser ruby, for the manufacture of laser rods. Several other synthetic gemstones also are being produced for lasers, including chromium-doped chrysoberyl (dope being a element added to the crystal growing nutrients to achieve a particular color), synthetic alexandrite, and varieties of doped yttrium-aluminum-garnet (YAG).

Lasers require high-purity, optically perfect crystals. The crystal must be large enough so that a laser rod can be cut from the raw crystal, and the mineral or material must have the correct physical properties to allow light amplification without the necessity of excessive energy. Synthetic ruby, sapphire, and YAG have all these characteristics.

Over the years, both natural and synthetic corundum have been ground and graded as an abrasive. Corundum was the major compound used in the polishing of eyeglass lenses. While industrial diamond has replaced much of the corundum used in the lens-polishing industry, some polishers still use corundum for specialized lenses.

Other gem materials have enjoyed limited uses in nongem applications. The abrasive and ceramic industries use topaz as a raw material because of its hardness and chemical features. Once, lenses for eyeglasses were made from gem-quality beryl—if the morganite variety of beryl were used, one would truly be looking at the world through rose-colored glasses. Mortar and pestle sets, knife edges for balances, textile rollers, and spatulas are some nongem uses of agate.

Some industrial applications requiring clean homogeneous stones used low-quality gem diamond. The quantity of natural and synthetic industrial-grade diamonds used in the United States each year is 12 to 15 times greater than the amount of diamonds consumed by the jewelry industry.

The 1991 estimated value of U.S. apparent consumption was $3,059 million, down about 18% for 1989's record high. The average annual estimated consumption for the past 10 years was $2,871 million, with a high of $3,711 in 1989 and a low of $1,642 in 1982. The trend for estimated consumption for the past 10 years was one of continued growth, with about 68% total increase.

In 1991, the value of U.S. estimated apparent consumption of diamonds was essentially unchanged from that of 1990 at $2.6 billion. The average annual value of apparent consumption of diamonds for the past 10 years was $2,419 million, with a high of $3,115 million in 1989 and a low of $1,279 million in 1982. The trend for the value of apparent consumption for the past 10 years was one of significant increase. The value of apparent consumption of diamonds increased 100% over the period.

The 1990 estimated apparent consumption of colored stones, led by emerald, ruby, and sapphire, was valued at $397.1 million, a decrease of 3%. The annual average value of consumption of colored stones for the past 9 years was $325.0 million, with a high of $406.9 million in 1989 and a low of $252.4 million in 1982. The trend for apparent consumption of colored stones for the past 9 years was one of fluctuating increases and decreases, but the general tread was one of increased consumption.

The estimated apparent consumption of pearls—natural, cultured, and imitations—was $19.5 million, an increase of about 18% from the 10-year low in 1990. The average annual consumption for the past 10 years was $163.0 million, with a high of $244.7 million in 1984 and a low of $16.5 million in 1990.

Estimated apparent consumption of synthetic and imitation gemstones decreased about 78% to $20.9 million. Average apparent consumption of these materials for the past 10 years was $51.8 million per year, with a high of $109.1 million in 1987 and a low of $13.9 million in 1982. The trend for apparent consumption for the past 10 years was one of generally strong growth except for the significant decrease in 1989 and 1991. Annual apparent consumption at the end of the period was 50% greater than at the beginning of the period. The U.S. Department of Commerce reported that jewelry store retail sales were $13.8 billion, a 3.6% decrease compared with those of 1990.

Prices

Demand, beauty, durability, rarity, freedom from defects, and perfection of cutting determine the value of a gem. In establishing the price of gem diamond, the CSO's control over output and prices also is a major factor.

The average U.S. wholesale asking price of the top 25 grades (D through H color and IF through VS2 clarity) of a 1-carat diamond fluctuated between $7,200 and $7,300, and was $7,300 at yearend. The average value per carat of all grades, sizes, and types of gem-quality diamond imports was $517, a slight decrease compared with that of 1990. The average value of diamond imports for the past 10 years was $405 per carat, with a high of $525 in 1990 and a low of $353 in 1984. The trend for the average annual value of diamonds imported for the past 10 years was one of general decline from the 10-year high in 1980 to stabile prices in 1986, 1987, and 1988, followed by the 1989 and 1990 increases.

The average yearend wholesale purchase price of a fine-quality 1-carat ruby, paid by retail jewelers on a per stone or memo basis, was $4,200, an increase of 20% from that of 1989. The average value of ruby imports decreased 39% to $29.80 per carat. The average annual value of ruby imports for the past 10 years was $37.12 per carat, with a high of $48.71 in 1990 and a low of $16.42 in 1984. The trend for the value of ruby imports for the past 10 years was one of rapid decline, 52% for the period from 1982 to 1984. This was followed by a steady, moderate increase until the 1991 decrease.

The average yearend wholesale purchase price of a fine-quality 1-carat sapphire, paid by retail jewelers on a per stone or memo basis, was $1,600, a 14% increase from that of 1989. The average value of sapphire imports increased 8% to $23.31 per carat. The average annual value of sapphire imports for the past 10 years was $23.23 per carat, with a high of $27.97 in 1987 and a low of $18.50 in 1984. The trend for the value of sapphire imports for the past 10 years was one of fluctuating increases and decreases. The 10-year period ended with the 1991 value 5% below the 1982 value.

The average yearend wholesale purchase price of a fine-quality 1-carat emerald, paid by retail jewelers on a per stone or memo basis, was $2,750, the same as for 1989. The average value of emerald imports decreased 4% to $42.01 per carat. The average annual value of emerald imports for the past 10 years was $55.65 per carat, with a high of $78.79 in 1988 and a low of $35.06 in 1984. The trend for the value of emerald imports for the past 10 years was one of fluctuating increases and decreases from 1982 through 1984. A steady moderate growth followed until the 3 years of decline in 1989, 1990, and 1991. The average value in 1990 being about 76% of the 1981 value. *(See tables 6 and 7.)*

Foreign Trade

The value of exported exports plus reexports increased 9% to $1,712 million, a record high. The quantity of cut diamonds exported and reexported increased slightly to 1,008,154 carats, and the value of diamond exported and reexported decreased slightly to $1,351.2 million. The average annual quantity of cut diamonds exported and reexported for the past 10 years was 577,581 carats, with a high of 1,008,154 in 1991 and a low of 184,871 in 1982. The trend for the quantity of cut diamonds exported and reexported for the past 10 years was one of significant growth, 445%, from 1982 to 1991. The average annual value of cut diamonds exported and reexported for the past 10 years was $734.6 million, with a high of $1,398.8 in 1990 and a low of $292.8 million in 1982. The trend for the value for the past 10 years was one of fluctuating increase and decline over 3 years, followed by 6 years of growth, 32%, and then 1 year of slight decline. The period ended with value of exports and reexports 361% greater than at the start of the period.

The value of other precious stones, cut but unset and other than diamonds and pearls, exported and reexported increased to $71.9 million. The 10-year trend for value of exports plus reexports of these types of gemstones was one of fluctuating increases and decreases, but one resulting in a significant overall total increase for the period. The value of exports and reexports of other precious stones not cut or set was $113.6 million. An additional $22.1 million worth of other gemstones was exported or reexported during 1991.

The value of synthetic gemstone exports plus reexports was $21.9 million. The 10-year trend for the value of exports plus reexports was one of extreme decline during the period between 1982 to 1988, followed by significant growth, 608%, during 1989-90, and then a significant decline in 1991.

The value of natural, cultured, and imitation pearls, not set or strung, exports and reexports of pearls increased significantly to more than $4.2 million.

The value of gems and gemstones imported increased slightly to $4,640.6 million compared with those of 1990, but still below the 1989 record high of $5,115 million. The value of imported gem diamonds accounted for about 86% of the total. The average annual value of gems and gemstones imports for the past 10 years was $4,027 million, with a high of $5,115 million in 1989 and a low of $2,384 million in 1982.

The value of imported gem diamonds increased slightly to $3992.0 million compared with that of 1990, but below the 1989 record high of $4,358 million. The 10-year trend for the value of diamond imports was one of generally steady continuous growth until the decline in 1990 and the small growth in 1991 that resulted in current value still being less than that of 1988. Even with the downward adjustment, total increase for the period was 108%. During the period the value of imported uncut diamonds increased 91%, while the value of cut stones imported increased 111%.

The imports of cut diamonds increased 6% in quantity and 2% in value to 6.7 million carats and $3,464.6 million, respectively. The average annual quantity of cut diamonds imported was 6.9 million carats, with a high of 8.9 million in 1989 and a low of 1.6 million carats in 1982. The trend for the quantity of cut diamond imports for the past 10 years was one of continued increases until the 1990 decline; the period still ended with imports 79% greater than at the beginning of the period. The average annual value of cut diamond imports was $2,929.2 million, with a high of $3,805.5 in 1989 and a low of $1,641.0 million in 1982. The trend for the value of cut diamond imports for the past 10 years was of strong growth and increases. The value at the end of the period was 111% greater than at the beginning.

The value of imports of other gem and gemstones, led by emerald, ruby, and sapphire, was $531.1 million, a decrease of about 5% compared with that of 1990. Emerald imports increased slightly to $165.5 million. The average annual value of emerald imports for the past 10 years was $155.3 million, with a high of $207.5 million in 1989 and a low of $120.8 million in 1982. The 10-year trend for the value of emerald imports was one of fluctuating increases and decreases resulting in a 37% increase for the period.

The value of ruby imports decreased 28% to $70.9 million from 1990's record-high value for the past 10 years of $98.4 million. The average annual value of imports for the past 10 years was $74.9 million, with a high of $98.4 in 1990 and a low of $58.7 in 1987. The 10-year trend for import values was one of extreme fluctuations. The period ended with values having increased 21% from the 10-year low for the period.

The value of sapphire imports was $81.6, essentially unchanged from that of 1990. The average annual value of sapphire imports for the past 10 years was $81.7 million, with a high of $100.0

million in 1989 and a low of $63.3 million in 1982. The 10-year trend for the value of imports was one of extremely fluctuating increases and decreases. The period ended with the value 29% greater than that at the beginning of the period.

The value of imported gem materials other than diamond, emerald, ruby, and sapphire increased slightly to $213.1 million. The average annual value of imports was $332.5 million, with a high of $429.5 in 1988 and a low of $210.3 in 1990. The 10-year trend for the value of imports was one of fluctuating increases and decreases resulting in the period ending essentially at the same level that the period started. *(See tables 8, 9, 10, 11, and 12.)*

World Review

Diamond sales by De Beers Centenary AG was $3.93 billion in 1991, a decrease of 6% compared with 1990 sales of $4.17 billion. Sales during the second half of 1991 were only $1.84 billion, 11% less than the $2.08 billion sales for the second half of 1990. A De Beers official stated that the reduction in sales was the result of the Persian Gulf war and the economic turndown in the United States. De Beers controls about 80% of the rough, uncut diamonds sold in the world. Sales of colored stones remained strong.

In May, De Beers unveiled the 273-carat Centenary diamond, reportedly the largest top-colored, flawless diamond outside of the British Crown Jewels. The Centenary was cut from a 599-carat piece of rough recovered at the Premier Mine in the Republic of South Africa in 1986. Three years were spent in preparing, cutting, and polishing the modified heart-shaped stone. The Centenary is insured for more than $100 million.

Natural diamond production occurs in Africa, Asia, Australia, and South America. The principal producing localities are as follows: in Africa—Angola, Botswana, Namibia, the Republic of South Africa, and Zaire; in Asia—U.S.S.R. (northeastern Siberia and in the Yakut A.S.S.R.); in Australia; and in South America—Venezuela and Brazil. *(See table 13.)*

Foreign countries in which major gemstone deposits (other than diamond) occur are Afghanistan (beryl, kunzite, ruby, tourmaline); Australia (beryl, opal, sapphire); Brazil (agate, amethyst, beryl, kunzite, ruby, sapphire, tourmaline, topaz); Burma (beryl, jade, ruby, sapphire, topaz); Colombia (beryl, sapphire); Kenya (beryl, garnet, sapphire); Madagascar (beryl, rose quartz, sapphire, tourmaline); Mexico (agate, opal, topaz); Sri Lanka (beryl, ruby, sapphire, topaz); Tanzania (tanzanite, garnet, ruby, sapphire, tourmaline); and Zambia (amethyst, beryl).

Angola.—The Government of Angola's diamonds company, Endiama, entered into a prospecting agreement with a Portuguese-Zairian consortium. The consortium is Sociedade Portuguesa de Envestimentos and SAICAN; both firms are privately held. It is reported that the Zairian firm may have links with President Mobutu Sese Seko of Zaire. The prospecting rights are along the Cuango River near the Angola-Zaire border, the same area included in the April diamond sales agreement between Angola and De Beers Centenary.[5]

Australia.—Stirling Resources NL has entered into a joint venture with Sabminco NL on Stirling's Boab Creek exploration license in West Kimberleys of Western Australia. Stirling has identified what is interpreted to be a potential kimberlite pipe and buried alluvial channel. The license is adjacent to Sabminco's Diamond Mountain project area where Sabminco has recovered gem-quality diamonds from drill holes in a buried alluvial channel.

Brazil.—The Director of the Brazilian Gem and Precious Metal Institute announced that he expected that exports of cut gems and uncut gemstones would be about $200 million for 1991. This would be an increase of 18% compared with 1990's $170 million worth of exports. He is hopeful that exports will increase to as much as $500 million within 2 years. One reason for the increase in exports is that the domestic market is weak; in 1980 domestic purchases of gemstones was $800 million, in 1990 they were $360 million, and only $300 million in 1991.

Canada.—Uranerz Exploration, operator of its joint venture with Cameco, announced the recovery of additional diamonds from drill samples from the Fort a la Corne property. The latest stones recovered averaged 0.04 carat with the largest at 0.6 carat. Some on the stones recovered were of gem quality.

Uranerz's exploration program has identified 70 potential kimberlite pipes in a corridor that is 50 kilometers by 20 kilometers from Price Albert to Nipawin in Saskatchewan. The first 15 sites tested proved to be kimberlites, and to date a total of 160 diamonds have been recovered from drill cores. Uranerz is playing down the exploration results, but experts are speculating on the possibility of a diamond mine in Saskatchewan by the end of the decade. Normally, geologists search for indicator minerals, minerals that form under the same conditions as diamonds, but at the Fort a la Corne property they found the actual diamonds in the drill samples.

Dia Met Minerals Ltd. announced the results of the analysis of one drill hole on the Dia Met and BHP-Utah Mines Point Lake prospect, a 800-square-kilometer joint venture in the Northwest Territories. Analysis of a 59-kilogram sample of core taken from between 140 and 180 meters yielded 81 diamonds each less than 2 millimeters in diameter. The drill hole was in a kimberlite pipe that is estimated to have a surface area of between 162,000 and 324,000 square meters and to have a depth of 1 kilometer. The Point Lake prospect is about 480 kilometers north of Yellowknife, the capital of Northwest Territories. The announcement has set off a rush to stake claims around the Point Lake prospect.

China.—A 60.5-carat diamond was unearthed from the Wafangdian Mine in

Dalian city in northeast Liaoning Province. Since the Wafangdian Mine went into production in 1990 many diamonds more than 10 carats have been found.[6]

Argyle Diamonds has opened a diamond cutting and polishing factory in China. The factory is a joint project between the Australian International Development Assistance Bureau and the China Pearl, Diamond, Gem, and Jewelry Import and Export Corp.

The factory, about 30 kilometers from the center of Beijing, is one of the most modern and best equipped training factories in the world. It is planned for the factory to train about 900 cutters by the end of 1992. The factory began training with five Australian trained Chinese cutters and nine skilled international trainers recruited by Argyle.[7]

Cook Islands.—In June, about two-thirds of the 39,000 black pearls offered in the first full auction by Cook Islands Pearls Ltd. was sold. A total of 54 lots, with a reserve price of $2.7 million, was expected to bring more than $4.5 million. The highest successful bid for a single lot was $114,000 by Kikuchi Pearl Co. Ltd. of Japan.[8]

Ghana.—The Government of Ghana, Lazare Kaplan of the United States, and Inco Ltd. of Canada have entered into an agreement to mine and market Ghanaian diamonds. This is the first privatization of the diamond industry under the current Government. The agreement was 2 years in the making.

The agreement calls for a two-phased mining plan, the first of which will take 7 to 11 years to complete. The mine will be brought to a production level of about 0.5 million carats per year. The second phase will bring the mine to a production level of about 1 million carats per year. Currently, the mine production is between 0.1 and 0.2 million carats per year.

Murtob Mining Co. Ltd. of Akwatia purchased a diamond concentrating plant from Somerville Engineering Associates of England. The plant is trommel and jig-grease tables style.

Guinea.—Bridge Oil Inc.'s Aredor Mine recovered another 100-plus carat stone. Since 1986 the Aredor Mine has produced more than five stones more than 100 carats. The latest stone was 192.9 carats and estimated to be worth more than $2.0 million. The other large stones were; 100 carats sold in 1986 for $1.56 million, 143 carats sold in 1987 for $3.65 million, 181.77 carats sold in 1988 for $8.62 million, and a 255.6 carat sold for more than $10 million in 1989. The largest stone on record for the Aredor Mine was a nongem-quality 460-carat stone.[9]

India.—Total rough diamond imports for 1991 increased 57% in volume to 59,990,000 carats compared with those of 1990, while the value decreased 0.5% to $1,990 million. The net polished diamond exports for 1991 totaled 8,817,000 carats valued at $2,564 million, an increase of 0.2% and a decrease of 5%, respectively, compared with those of the previous year. This reflected the demand for cheaper goods for most of the year.

Ashton Mining, an Australian company, negotiated an agreement with the Indian National Mineral Development Corp. to assist in the modernization of the Panna Mine. The mine produced about 20,000 carats of diamonds in 1991, and the modernization is intended to increase production by increasing the amount of ore processed.

Indonesia.—Indonesian Diamond Corp. was delayed in the construction of its diamond plant in South East Kalimantan. The plant was ready for production in December 1991. The pilot plant, capable of running about 30 cubic meters per hour, processed material from the mine until the commercial plant was completed. The delay and cost overruns resulted in the plant costing about $1.1 million more than the original estimate of $2 million. The first diamonds from the commercial operation, 2,200 carats, were sold for an average price of $191 per carat. It is planned to operate both plants in the coming year to process about 54,000 cubic meters of ore per month and recover about 5,400 carats of diamonds each month.

Israel.—Israel has established a joint venture involving the U.S.S.R. and Panama to polish and market emeralds from the Ural area of the U.S.S.R. The joint venture will operate under the name Emural and have exclusive right on the U.S.S.R. emeralds for the next 50 years.

Two Israeli companies, Hargem and Izumrud, will supply the company with training as well as the polishing equipment and technology. Two factories were opened in the U.S.S.R. with about 200 workers and 4 Israeli experts. The joint venture is expected to eventually supply about 20% of the world emeralds.

The 1991 exports of polished diamonds from Israel were valued at $2,472 million, an 11% decrease compared with those of 1990. During the year, 630 diamond cutting factories employed more than 9,500 workers.

Namibia.—Consolidated Diamond Mines (CDM) began production at the open pit Elizabeth Bay Mine in June. It is planned that the mine will produce about 4 million tons of ore per year that will result in the recovery of about 250,000 carats of diamonds. The production from the Elizabeth Bay Mine will increase CDM's annual production to about 1 million carats per year. During the expected 10-year life of the mine, the mine should produce about 2.5 million carats of diamonds.

Monarch Minerals and Mining, Inc., a U.S. firm, announced production began at its new diamond mine in southeastern Namibia in July. The mine is located on Monarch's 50-square-kilometer mining concession at the mouth of the Fish River.

Tahiti.—Sales of black pearls at the 14th International Pearls Sale in Papeete, Tahiti, were 48,771 pearls for $4.97 million. These sales represented an increase of 19% in the number of pearls sold, but the total value of sales decreased 17% and the average price per pearl decreased 30% compared with those of 1990. The pearls ranged in size from 8.5 to 18 millimeters in diameter and were of much better quality than in recent years. There were 40 overseas buyers at the auction representing companies from 6 different countries.

Tanzania.—Late in the year the Government of Tanzania urgently invited tenders from competent companies for mineral rights at the Merelani tanzanite area, Arusha region. The tender areas are nine 200-meter by 300-meter blocks. The applicants must be experienced gemstone miners, processors, and marketers. Additionally, they must indicate the prospecting methods they intend to use, the availability of equipment, the method of drilling, a detailed work program, security arrangement for the mine, and the financial commitment to the program. The successful applicants will be required to post a $25,000 bond.

U.S.S.R.—Reports on Radio Moscow indicate the discovery of a major diamond field in Buryatskaya on the Soviet side of the Mongolian border. It is reported that more than 10 diamond-bearing sites in the eastern part of the Sayany Mountains were found. The discovery comes after 50 years of small-scale prospecting in the region, during which small quantities of diamonds were found.

The world's biggest new source of diamonds in this century may be the five kimberlite diamond pipes near the village of Pomorie at Lamonsov in the North Russian oblast of Archangelsk. Development plans for the pipes are for two shafts to a depth of about 1,000 meters, one on each side of the pipe. The cost to develop the five pipes, including the infrastructure and power station, is estimated to be $4 billion. Funds of the project will have to come from foreign sources or joint ventures.

Tokyo Maruichi Shoji Co. (Maruichi) of Japan entered into a joint venture with the Yakut Autonomous Soviet Socialist Republic for Maruichi to produce an unspecified amount of diamonds from the Republic for export to Japan. According to the agreement, approximately 10% of the diamonds will be cut and polished prior to export. This appears to be one step in the Yakut authorities taking control of the Republic's diamond production from the central U.S.S.R. Government.

Zimbabwe.—Auridium Consolidated NL of Australia has acquired the exploration license for the Ranch River diamond project that was forfeited by De Beers early in 1991. Kimberlitic Searches Ltd., a De Beers subsidiary, evaluated the project in the early 1980's and found the diamond project was uneconomical at that time. Auridium and its partner, Cornerstone Investments, Ltd., believe that given the current diamond market the project may be economical during the 1990's. Evaluations will be undertaken to determine if the deposit is economical at this time.

Delta Gold NL of Australia has applied for exploration rights in eight diamond-bearing areas totaling about 4,600 square kilometers. The company already has completed a great deal of fieldwork in the selected areas.

Current Research

An oval jade cabochon in a ring offered to Sotheby's Hong Kong Ltd. from its 1990 jadeite jewelry auction was found to have been treated with a new procedure to improve its appearance. Testing by the Hong Kong Gems Laboratory discovered a coating that is a highly adhesive, colorless organic resin mixed with a chemical compound that makes it resistant to high temperatures. The Gemological Association of All Japan found an oval jade cabochon that had exceptionally good color, luster, and transparency that was poor-quality, white jadeite treated with a green resinous coating. The coatings can be identified by immersing the piece in methylene iodide and shining a bright light on the stone to display the thin transparent layer of the coating.[10]

OUTLOOK

World demand for gem diamond can be expected to rise because of increasing effective personal incomes and the populations of the United States and other industrialized countries. Also, demand will increase because of highly effective promotional efforts. These promotions are changing social customs in many eastern countries, particularly the use of diamond engagement rings. The changes are resulting in significant growth in the diamond market. Demand for other precious gems will continue to grow as diamonds become more expensive and the popularity and acceptance of colored gemstones increase. Demand for synthetic and simulant gemstones for both personal and industrial consumption is expected to increase. The diversity of sizes, types, uses, and values of gems and gemstones precludes any meaningful forecasting of future demand.

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[1] Nassau, K. Gemstone Enhancement. Buttersworth, 1984, pp. 46-60.

[2] CRA Gazette. July 1991, pp. 61-78.

[3] Pages 25-44 of work cited in footnote 2.

[4] Rapaport Diamond Report. Colored Stones Section. V. 15, No 9, Mar. 6, 1992, p. 26.

[5] Diamond Registry Bulletin. V. 23, No. 7, July 21, 1991, p. 3.

[6] Mining Journal. V. 316, No. 8128, June 28, 1991, p. 491.

[7] Page 6 of work cited in footnote 2.

[8] Business. Pacific Islands Monthly, v. 61, No. 7, July 1991, p. 48.

[9] Mining Journal. V. 317, No. 8132, July 26, 1991, p. 67.

[10] Jewellery News Asia. No. 75, Nov. 1990, p. 90.

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Gem Stones. Ch. in Mineral Commodity Summaries, 1992.

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TABLE 1

DE BEERS' CSO ROUGH DIAMOND PRICE INCREASES, BY PERCENTAGE

Sept. 1949	25.0	Nov. 1967	16.0	Aug. 1973	10.2	Sept. 1982	2.5
Mar. 1951	15.0	Sept. 1968	2.5	Dec. 1974	1.5	Apr. 1983	3.5
Sept. 1952	2.5	July 1969	4.0	Jan. 1976	3.0	Aug. 1986	7.5
Jan. 1954	2.0	Nov. 1971	5.0	Sept. 1976	5.8	Nov. 1986	7.0
Jan. 1957	5.7	Jan. 1972	5.4	Mar. 1977	15.0	Sept. 1987	10.0
May 1960	2.5	Sept. 1972	6.0	Dec. 1977	17.0	Apr. 1988	13.5
Mar. 1963	5.0	Feb. 1973	11.0	Aug. 1978	30.0	Mar. 1989	15.5
Feb. 1964	7.5	Mar. 1973	7.0	Sept. 1979	13.0	Mar. 1990	5.5
Aug. 1966	7.5	May 1973	10.0	Feb. 1980	12.0		

TABLE 2

DE BEERS' CSO ROUGH DIAMOND SALES AND STOCKS

(Billions of dollars)

Year	Sales	Stocks
1982	1.30	1.71
1983	1.50	1.85
1984	1.61	1.95
1985	1.80	1.90
1986	2.56	1.85
1987	3.07	2.30
1988	4.17	2.00
1989	4.09	2.47
1990	4.17	2.68
1991	3.93	3.03

TABLE 3
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0-2.5	1.0-1.1	Single	1.54	Synthetic or pressed, plastics	Fossil resin, soft.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5-8.0	2.63-2.80	Double	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Emerald	do.	Green	Medium	Very high	7.5	2.63-2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet, doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5-8.0	2.63-2.80	do.	1.58	Genuine emerald	Flaws, brilliant, fluorescence in ultraviolet light.
Golden	do.	Yellow to golden	Any	Low to medium	7.5-8.0	2.63-2.80	do.	1.58	Citrine, topaz, glass, doublets	
Morganite	do.	Pink to rose	Any	do.	7.5-8.0	2.63-2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Refractive index.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	Any	Low	3.0	2.72	Double (strong)	1.49-1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	Any	Low	3.0	2.72	do.	1.6	do.	Banded, translucent.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day, red by artificial light	U.S.S.R. (small), Sri Lanka (medium)	High	8.5	3.50-3.84	Double	1.75	Synthetic	Dichroism, inclusions in synthetic sapphire.

See footnotes at end of table.

TABLE 3—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Chrysoberyl—Continued:										
Catseye	Beryllium aluminate	Greenish to brownish	Small to large	High	8.5	3.50-3.84	Double	1.75	Synthetic, shell	Gravity and translucence.
Chrysolite	do.	Yellow, green, and/or brown	Medium	Medium	8.5	3.50-3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Coral	Calcium carbonate	Orange, red, white, black, or green	Branching, medium	Low	3.5-4.0	2.6-2.7	do.	1.49-1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95-4.10	do.	1.78	Synthetics, including spinel	Inclusions, fluorescence.
Sapphire	do.	Blue	Medium	High	9.0	3.95-4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, white, orange, green, or violet	Medium to large	Medium	9.0	3.95-4.10	do.	1.78	Synthetics, glass and doublets	Inclusions, double refraction, refractive index.
Sapphire and ruby stars	do.	Red, pink, violet blue, or gray	do.	High to low	9.0	3.95-4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color on side view.
Sapphire or ruby synthetic	do.	Yellow, pink, or blue	Up to 20 carats	Low	9.0	3.95-4.10	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Diamond	Carbon	White, blue-white, yellow, brown, green, pink, blue	Any	Very high	10.0	3.516-3.525	Single	2.42	Zircon, titania, cubic zirconia	High index, dispersion, single refraction, hardness, cut, luster.

See footnotes at end of table.

TABLE 3—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Feldspar:										
Amazonstone	Alkali aluminum-silicate	Green	Large	Low	6.0-6.5	2.56	—	1.52	Jade	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	Alkali aluminum-silicate	Gray with blue and bronze sheen color play	Large	Low	6.0-6.5	2.56	—	1.56	Jade	Cleavage, sheen, vitreous to pearly opaque, grid.
Moonstone	do.	White	do.	Low	6.0-6.5	2.77	—	1.52-1.54	Glass or white onyx	Blue sheen, opalescent.
Garnet	Complex silicate	Brown, black, yellow, green, ruby red, or orange	Small to medium	Low to high	6.5-7.5	3.15-4.30	Single strained	1.79-1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Jade:										
Jadeite	do.	Green, yellow, black, white, or mauve	Large	Low to very high	6.5-7.0	3.3-3.5	Cryptocrystalline	1.65-1.68	Onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0-6.5	2.96-3.10	do.	1.61-1.63	do.	Do.
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5-7.0	3.27-3.37	Double (strong)	1.65-1.69	Tourmaline chrysoberyl	Strong double refraction, low dichroism.
Opal	Hydrous silica	Colors flash in white gray, black, red, or yellow	Large	Low to high	5.5-6.5	1.9-2.3	Isotropic	1.45	Glass, synthetics, triplets	Play of color.
Pearl	Calcium carbonate	White, pink, or black	Small	do.	2.5-4.0	2.6-2.85	—	—	Cultured and imitation	Luster, structure, X-ray.

See footnotes at end of table.

TABLE 3—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Quartz:										
Agate	Silica	Any color	Large	Low	7.0	2.58-2.64	—	—	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65-2.66	Double	1.55	do.	Refractive index, double refraction, transparent.
Cairngorm	do.	Smoky	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Citrine	do.	Yellow	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Crystal, rock	do.	Colorless	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Jasper	do.	Uniform or spotted red, yellow, or green	do.	Low	7.0	2.58-2.66	—	—	do.	Opaque, vitreous.
Onyx	do.	Many colors	do.	Low	7.0	2.58-2.64	—	—	do.	Uniformly banded.
Rose	do.	Pink, rose red	do.	Low	7.0	2.65-2.66	Double	1.55	do.	Refractive index, double refraction, translucent.
Spinel	Magnesuim aluminum oxide.	Any	Small to medium	Medium	8.0	3.5-3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	Any	Up to 40 carats	Low	8.0	3.5-3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Kunzite	Lithium aluminum silicate	Pink to lilac	Medium	Medium	6.5-7.0	3.13-3.20	Double	1.66	Amethyst, morganite	Refractive index.

See footnotes at end of table.

TABLE 3—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Spudumene—Continued:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5-7.0	3.13-3.20	Double.	—	Synthetic spinel	Refractive index.
Tanzanite	Complex silicate	Blue	Small	High	6.0-7.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism.
Topaz	do.	White, blue, green	Medium	Low to medium	8.0	3.4-3.6	do.	1.62	Beryl, quartz	Refractive index.
Tourmaline	do.	All, including mixed	do.	do.	7.0-7.5	2.98-3.20	do.	1.63	Glass, plastics	Difficult if matrix not present, matrix usually limonitic.
Turquoise	Copper aluminum phosphate	Blue to green phosphate	Large	Low	6.0	2.60-2.83	do.	1.63	Glass, plastics	Difficult if matrix not present, matrix usually limonitic.
Zircon	Zirconium silicate	White, blue, or brown, yellow, or green	Small to medium	Low to medium	6.0-7.5	4.0-4.8	Double (strong)	1.79-1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

[1]Small—up to 5 carats; medium—up to 50 carats; large—more than 50 carats.
[2]Low—up to $25 per carat; medium—up to $200 per carat; high—more than $200 per carat.

TABLE 4
SYNTHETIC GEMSTONE PRODUCTION METHODS

Gemstone	Production methods	Company	Date of first production
Ruby	Flux	Chatham	1950's
Do.	do.	Kashan	1960's
Do.	do.	Knischka	1980's
Do.	do.	J.O. Crystal (Ramaura)	1980's
Do.	Zone melt	Seiko	1980's
Do.	Melt pulling	Kyocera (Inamori)	1970's
Do.	Verneuil	Various producers	1900's
Star ruby	do.	Linde (Div. of Union Carbide)	1940's
Do.	Melt pulling	Kyocera	1980's
Do.	do.	Nakazumi	1980's
Sapphire	Flux	Chatham	1970's
Do.	Zone melt	Seiko	1980's
Do.	Melt pulling	Kyocera	1980's
Do.	Verneuil	Various producers	1900's
Star sapphire	Verneuil	Linde	1940's
Emerald	Flux	Chatham	1930's
Do.	do.	Gilson	1960's
Do.	do.	Kyocera	1970's
Do.	do.	Seiko	1980's
Do.	do.	Lennix	1980's
Do.	do.	U.S.S.R.	1980's
Do.	Hydrothermal	Lechleitner	1960's
Do.	do.	Regency	1980's
Do.	do.	Biron	1980's
Do.	do.	U.S.S.R.	1980's
Alexandrite	Flux	Creative crystals	1970's
Do.	Melt pulling	Kyocera	1980's
Do.	Zone melt	Seiko	1980's
Cubic zirconia	Skull melt	Various producers	1970's

TABLE 5
VALUE OF 1991 U.S. GEMSTONE PRODUCTION, BY GEM MATERIALS

Gem materials	Value
Agate	$535,000
Beryl	450,000
Coral (all types)	63,000
Garnet	251,000
Gem feldspar	1,485,750
Geode/nodules	769,640
Fire agate	194,100
Jasper	236,300
Obsidian	18,000
Opal	579,300
Peridot	1,757,000
Petrified wood	462,500
Quartz	5,197,300
Sapphire/ruby	3,282,000
Topaz	126,600
Tourmaline	629,000
Turquoise	610,800
Total	16,647,290

TABLE 6

PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Price range per carat[3] Jan. 1990-Jan. 1991	Average[4] July 1991
0.25	G	VS1	$1,400 -$1,400	$1,400
.25	G	VS2	1,200 -1,200	1,200
.25	G	SI1	970 -970	970
.25	H	VS1	1,200 -1,200	1,200
.25	H	VS2	1,100 -1,100	1,100
.25	H	SI1	950 -950	950
.50	G	VS1	2,700 -2,700	2,700
.50	G	VS2	2,500 -2,500	2,500
.50	G	SI1	2,300 -2,300	2,300
.50	H	VS1	2,600 -2,600	2,600
.50	H	VS2	2,400 -2,400	2,400
.50	H	SI1	2,100 -2,100	2,100
.75	G	VS1	3,500 -3,500	3,500
.75	G	VS2	3,200 -3,200	3,200
.75	G	SI1	2,800 -2,800	2,800
.75	H	VS1	3,000 -3,000	3,000
.75	H	VS2	2,700 -2,700	2,700
.75	H	SI1	2,500 -2,500	2,500
1.00	G	VS1	4,600 -4,600	4,600
1.00	G	VS2	4,100 -4,100	4,100
1.00	G	SI1	3,500 -3,500	3,500
1.00	H	VS1	4,100 -4,100	4,100
1.00	H	VS2	3,600 -3,600	3,600
1.00	H	SI1	3,200 -3,200	3,200

[1]Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; G-H-I—traces of color.
[2]Clarity: IF—no blemishes; VVS1—very, very slightly included; VS—very slightly included; VS2—very slightly included, but not visible; SI1—slightly included.
[3]Jeweler's Circular-Keystone, V. 163, No. 3, Feb. 1991.
[4]Jeweler's Circular-Keystone, V. 162, No. 9, Sept. 1991.

TABLE 7

PRICES OF U.S. CUT COLORED GEMSTONES, BY SIZE[1]

Gemstone	Carat weight	Price range per carat in 1991[2]	Average price per carat[2] Oct. 1990	Average price per carat[2] Oct. 1991
Amethyst	1	$6 -$18	$13.00	$13.00
Aquamarine	1	100 -250	175.00	175.00
Emerald	1	1,900 -3,500	2,750.00	2,750.00
Garnet, tsavorite	1	500 -800	750.00	750.00
Ruby	1	3,000 -4,000	3,500.00	3,900.00
Sapphire	1	800 -2,000	1,400.00	1,400.00
Tanzanite	1	250 -350	262.50	210.00
Topaz	1	6 -12	9.00	9.00
Tourmaline, red	1	60 -125	92.50	92.50

[1]Fine quality.
[2]Jewelers' Circular-Keystone. V. 162, No. 12, Oct. 1991, p. 119. These figures represent a sampling of net prices that wholesale colored stone dealers in various U.S. cities charged their cash customers during the month for fine-quality stones.

TABLE 8
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY

Country	1990[r]		1991	
	Quantity (carats)	Value[1] (millions)	Quantity (carats)	Value[1] (millions)
Exports and reexports:				
Belgium	305,621	$274.0	787,290	$341.7
Canada	81,072	40.8	303,492	32.0
France	9,280	14.7	8,746	23.7
Hong Kong	163,591	316.5	118,966	267.6
Israel	254,240	222.3	260,924	238.3
Japan	110,024	283.6	107,285	195.5
Singapore	4,766	20.2	19,550	27.5
Switzerland	82,937	131.6	43,456	143.3
Thailand	53,327	45.5	35,019	39.3
United Kingdom	83,358	47.2	12,682	37.6
Other	67,204	36.2	142,173	36.1
Total	1,215,420	1,432.6	1,839,583	[2]1,382.7

[r]Revised.
[1]Customs value.
[2]Data do not add to total shown because of independent rounding.

Source: Bureau of the Census.

TABLE 9
U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY

Kind, range, and country of origin	1990 Quantity (carat)	1990 Value[1] (millions)	1991 Quantity (carat)	1991 Value[1] (millions)
Rough or uncut, natural:[2]				
Belgium	104,544	$26.1	455,621	$40.7
Brazil	10,547	1.2	106,396	9.8
Israel	11,769	5.4	17,097	10.3
Netherlands	5,552	12.1	18,334	9.2
South Africa, Republic of	458	[r].3	13,787	7.6
Switzerland	1,653	3.6	64,717	18.9
United Kingdom	300,579	287.1	625,965	249.5
Venezuela	[r]8,423	.5	20,580	.3
Other	[r]779,530	234.4	460,339	181.1
Total	1,223,055	[r]570.7	1,782,836	527.4
Cut but unset, not more than 0.5 carat:				
Belgium	769,047	326.9	789,422	280.1
Brazil	17,168	6.1	41,626	17.6
Canada	7,232	1.0	4,419	1.2
Hong Kong	176,077	45.4	132,735	29.0
India	2,946,261	768.8	3,373,905	825.4
Israel	471,820	224.0	727,175	357.9
Netherlands	4,363	2.4	5,612	1.7
South Africa, Republic of	8,326	7.5	16,517	10.0
Switzerland	12,894	4.7	21,237	6.2
United Kingdom	5,593	1.9	1,424	.7
Other	80,997	39.8	86,601	20.9
Total	4,499,778	1,428.5	5,200,673	1,550.7
Cut but unset, more than 0.5 carat:				
Belgium	516,109	651.1	592,530	793.9
Hong Kong	15,811	32.8	14,196	34.5
India	181,619	113.0	41,316	33.8
Israel	983,684	942.0	783,799	834.4
Netherlands	10,844	24.9	4,491	13.8
South Africa, Republic of	5,792	11.5	5,291	12.2
Switzerland	14,484	70.3	23,766	115.2
United Kingdom	28,288	52.6	9,018	34.8
Other	48,550	57.7	23,553	41.3
Total	1,805,181	1,955.9	1,497,960	1,913.9

[r]Revised.
[1]Customs value.
[2]Includes some natural advanced diamond.

Source: Bureau of the Census.

TABLE 10

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY

Kind and country	1990 Quantity (carats)	1990 Value[1] (millions)	1991 Quantity (carats)	1991 Value[1] (millions)
Emerald:				
Belgium	21,217	$1.1	10,782	$1.6
Brazil	1,189,248	6.3	1,554,717	6.7
Colombia	382,051	58.2	212,818	51.5
France	10,202	2.5	7,456	3.0
Germany, Federal Republic of	44,811	2.1	19,828	2.2
Hong Kong	156,111	13.2	114,521	13.4
India	1,317,886	24.7	1,298,384	22.7
Israel	93,973	20.6	134,178	21.3
Japan	2,769	.2	2,946	.7
South Africa, Republic of	52	(2)	206	0.3
Switzerland	144,394	18.9	66,283	23.3
Taiwan	4,533	.2	414	.1
Thailand	291,458	7.4	483,037	12.6
United Kingdom	9,722	2.6	8,755	.9
Other	51,962	[r]4.3	24,980	5.1
Total[3]	3,720,389	162.4	3,939,305	165.5
Ruby:				
Belgium	4,250	.4	8,127	1.3
Brazil	1,562	.1	11,517	.5
Colombia	346	.1	145	(2)
France	3,340	2.2	4,686	.9
Germany, Federal Republic of	11,580	.8	15,438	1.6
Hong Kong	49,175	5.3	38,030	4.4
India	313,583	2.3	455,938	1.9
Israel	12,857	1.1	10,736	.8
Japan	13	(2)	647	.1
Switzerland	190,056	26.6	72,979	16.5
Thailand	1,323,506	46.6	1,715,511	37.3
United Kingdom	66,831	6.5	12,089	3.2
Other	42,991	[r]6.3	32,128	2.4
Total[3]	2,020,090	98.4	2,377,971	70.9
Sapphire:				
Australia	3,013	.2	3,963	.3
Austria	202	(2)	603	(2)
Belgium	14,131	.5	5,044	1.3
Brazil	2,827	.1	7,932	.4
Canada	2,126	.2	8,109	.4
Colombia	1,328	(2)	111	(2)
France	2,409	1.9	4,695	1.3
Germany, Federal Republic of	44,834	.9	21,882	.8
Hong Kong	83,519	3.9	141,486	6.2
India	101,510	.8	59,588	.6
Israel	26,140	1.5	10,723	.8
Japan	7,666	.1	6,536	.5
Korea, Republic of	204	(2)	1,980	(2)

See footnotes at end of table.

TABLE 10—Continued

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY

Kind and country	1990 Quantity (carats)	1990 Value[1] (millions)	1991 Quantity (carats)	1991 Value[1] (millions)
Sapphire—Continued:				
Singapore	4,931	$0.6	833	$0.4
Thailand	3,248,891	51.2	3,122,987	46.1
United Kingdom	11,135	1.8	15,895	1.4
Other	44,113	r1.6	14,062	.9
Total[3]	3,796,764	81.9	3,501,548	81.5
Other:				
Rough, uncut:				
Australia		1.7		1.1
Brazil		r41.5		35.2
Colombia		2.4		1.4
Hong Kong		r2.0		2.0
Nigeria		.1		.2
Pakistan	NA	.4	NA	.7
South Africa, Republic of		.4		.6
Switzerland		3.5		1.0
United Kingdom		.4		1.2
Zambia		r1.3		.8
Other		r15.9		11.8
Total	NA	r67.9	NA	56.0
Cut, set and unset:				
Australia		6.1		3.2
Brazil		r8.6		9.3
Canada		r.4		.2
China		r1.4		.8
Germany, Federal Republic of		r19.5		15.2
Hong Kong		r17.6		16.4
India	NA	r5.6	NA	7.4
Japan		r10.0		9.3
Switzerland		1.7		1.1
Taiwan		r3.1		2.8
Thailand		r40.9		72.3
United Kingdom		2.1		2.1
Other		r19.8		14.4
Total[3]	NA	r136.8	NA	154.7

rRevised. NA Not available.
[1]Customs value.
[2]Less than 1/10 unit.
[3]Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census.

TABLE 11

VALUE OF U.S. IMPORTS OF SYNTHETIC AND IMITATION GEMSTONES, INCLUDING PEARLS, BY COUNTRY

(Million dollars[1])

Country	1990	1991
Synthetic, cut but unset:		
Austria	3.6	3.4
France	.8	1.9
Germany, Federal Republic of	9.6	8.7
Japan	.6	.7
Korea, Republic of	5.5	4.9
Switzerland	3.1	2.8
Thailand	7.0	16.0
Other	2.4	4.4
Total	32.6	42.8
Imitation:		
Austria	[r]53.9	58.7
Czechoslovakia	1.9	4.1
Germany, Federal Republic of	1.6	1.8
Japan	[r]2.0	1.5
Other	[r]5.0	3.0
Total	[r]64.4	69.1

[r]Revised.
[1]Customs value.

Source: Bureau of the Census.

TABLE 12

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES

(Thousand carats and thousand dollars)

Stones	1990 Quantity	1990 Value[1]	1991 Quantity	1991 Value[1]
Diamonds:				
Rough or uncut	1,223	570,750	1,783	527,424
Cut but unset	6,305	3,384,472	6,699	3,464,599
Emeralds: Cut but unset	3,720	162,375	3,939	165,508
Coral and similar materials, unworked	2,792	7,504	2,556	6,746
Rubies and sapphires: Cut but unset	5,817	180,375	5,880	152,475
Pearls:				
Natural	NA	3,734	NA	4,525
Cultured	NA	19,097	NA	16,753
Imitation	NA	3,814	NA	2,459
Other precious and semiprecious stones:				
Rough, uncut	NA	[r]55,436	NA	43,825
Cut, set and unset	NA	[r]113,949	NA	133,376
Other	NA	[r]6,727	NA	5,404
Synthetic:				
Cut but unset	113,367	32,649	148,173	42,820
Other	NA	1,911	NA	2,094
Imitation gemstone	NA	60,594	NA	66,649
Total[2]	XX	[r]4,603,388	XX	4,634,656

[r]Revised. NA Not available. XX Not applicable.
[1]Customs value.
[2]Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census.

TABLE 13

DIAMOND: WORLD PRODUCTION, BY TYPE AND COUNTRY[1]

(Thousand carats)

Country	1987 Gem[2]	1987 Natural industrial	1987 Total	1988 Gem[2]	1988 Natural industrial	1988 Total	1988 Synthetic	1989 Gem[2]	1989 Natural industrial	1989 Total	1989 Synthetic
Angola[e]	180	10	190	950	50	1,000	—	1,165	80	1,245	—
Australia	13,650	16,683	30,333	17,413	17,413	34,826	—	17,540	17,540	35,080	—
Botswana	9,368	3,840	13,208	10,660	4,569	15,229	—	10,676	4,576	15,252	—
Brazil	300	200	500	353	180	533	—	350	150	500	—
Central African Republic	304	108	412	284	59	343	—	334	81	415	—
China[e]	200	800	1,000	200	800	1,000	15,000	200	800	1,000	15,000
Côte d'Ivoire[e] [5]	15	6	21	8	3	11	—	9	3	12	—
Czechoslovakia[e]	—	—	—	—	—	—	5,000	—	—	—	5,000
France[e]	—	—	—	—	—	—	4,000	—	—	—	4,000
Ghana[6]	65	400	465	[r]78	[r]181	[r]259	—	[r]86	[r]201	[r]287	—
Greece[e]	—	—	—	—	—	—	1,000	—	—	—	1,000
Guinea[6]	163	12	175	136	10	146	—	138	10	148	—
Guyana	2	5	[e]7	1	3	4	—	3	5	8	—
India	16	3	19	11	3	4	—	3	12	15	—
Indonesia[e]	7	22	29	7	22	29	—	7	25	32	—
Ireland[e]	—	—	—	—	—	—	60,000	—	—	—	[e]60,000
Japan[e]	—	—	—	—	—	—	25,000	—	—	—	25,000
Liberia	112	183	[e]295	67	100	167	—	62	93	155	—
Namibia	971	50	1,021	[r]890	[r]48	938	—	910	17	927	—
Romania[e]	—	—	—	—	—	—	5,000	—	—	—	4,500
Sierra Leone[5]	150	75	225	12	6	18	—	90	39	129	—
South Africa, Republic of:											
Finsch Mine	1,455	2,701	4,156	1,372	2,548	3,920	—	1,613	2,997	4,610	—
Premier Mine	772	1,713	2,485	696	1,543	2,239	—	689	1,526	2,215	—
Other De Beers' properties[7]	1,427	546	1,973	1,388	531	1,919	—	1,360	520	1,880	—
Other	409	30	439	361	65	426	—	348	63	411	—
Total	4,063	4,990	9,053	3,817	4,687	8,504	[e]55,000	4,010	5,106	9,116	60,000
Swaziland	48	32	[e]80	44	29	73	—	33	22	55	—
Sweden[e]	—	—	—	—	—	—	25,000	—	—	—	25,000
Tanzania	[r]87	[r]37	[r]124	[r]60	[r]26	[r]86	—	[r]53	[r]23	[r]76	—
U.S.S.R.[e]	7,400	7,400	14,800	7,500	7,500	15,000	41,500	7,500	7,500	15,000	41,500
United States	—	—	—	—	—	—	W	—	—	—	W
Venezuela	38	68	106	54	74	128	—	70	185	255	—
Yugoslavia[e]	—	—	—	—	—	—	5,000	—	—	—	5,000
Zaire	3,885	15,540	19,425	2,724	15,439	18,163	—	2,663	15,092	17,755	—
Total	[r]41,024	[r]50,464	[r]91,488	[r]45,269	[r]51,202	[r]96,471	241,500	[r]45,902	[r]51,560	[r]97,462	246,000

See footnotes at the end of table

TABLE 13—Continued

DIAMOND: WORLD PRODUCTION, BY TYPE AND COUNTRY[1]

(Thousand carats)

Country	1990				1991[e]			
	Gem[2]	Natural industrial	Total	Synthetic	Gem[2]	Natural industrial	Total	Synthetic
Angola[e]	[r]1,215	[r]85	[r]1,300	—	1,215	85	1,300	—
Australia	17,331	17,331	34,662	—	17,978	17,978	[4]35,956	—
Botswana	12,146	5,206	17,352	—	12,000	6,000	18,000	—
Brazil	[r]600	[r]900	[r]1,500	—	600	900	1,500	—
Central African Republic	[r]303	[r]78	[r]381	—	300	70	370	—
China[e]	200	800	1,000	15,000	200	800	1,000	15,000
Côte d'Ivoire[e 5]	9	3	12	—	11	4	15	—
Czechoslovakia[e]	—	—	—	5,000	—	—	—	5,000
France[e]	—	—	—	4,000	—	—	—	4,000
Ghana[6]	[r]191	[r]446	[r]637	—	210	490	700	—
Greece[e]	—	—	—	1,000	—	—	—	1,000
Guinea[6]	130	5	[e]135	—	85	6	[4]91	—
Guyana	3	5	8	—	3	5	8	—
India	3	12	[e]15	—	3	12	15	—
Indonesia[e]	7	23	[r]30	—	8	24	32	—
Ireland[e]	—	—	—	60,000	—	—	—	60,000
Japan[e]	—	—	—	25,000	—	—	—	30,000
Liberia	40	60	[e]100	—	40	60	100	—
Namibia	[r]745	[r]16	[r]761	—	1,170	24	[4]1,194	—
Romania[e]	—	—	—	4,500	—	—	—	4,500
Sierra Leone[5]	[r]66	[r]12	[r]78	—	175	68	[4]243	—
South Africa, Republic of:								
Finsch Mine	1,462	2,716	4,178	—	1,500	2,500	4,000	—
Premier Mine	724	1,604	2,328	—	700	1,500	2,200	—
Other De Beers' properties[7]	1,240	474	1,714	—	1,200	500	1,700	—
Other	400	[r]88	[r]488	—	400	112	512	—
Total	3,826	[r]4,882	[r]8,708	[e]60,000	3,800	[r]4,612	[r]8,412	60,000
Swaziland	[r]25	[r]17	[r]42	—	18	12	30	—
Sweden[e]	—	—	—	25,000	—	—	—	25,000
Tanzania	[r]59	[r]26	[r]85	—	56	24	80	—
U.S.S.R.[e]	7,500	7,500	15,000	41,000	7,500	7,500	15,000	60,000
United States	—	—	—	W	—	—	—	90,000
Venezuela	88	245	333	—	90	250	340	—
Yugoslavia[e]	—	—	—	5,000	—	—	—	5,000
Zaire	[r]2,914	[r]16,513	[r]19,427	—	3,000	17,000	20,000	—
Total	[r]47,401	[r]54,165	[r]101,566	245,500	48,462	55,924	104,386	359,500

[e]Estimated. [r]Revised. W Withheld to avoid disclosing company proprietary data.

[1]Table includes data available through May 19, 1992. Total diamond output (gem plus industrial) for each country actually is reported, except where indicated by a footnote to be estimated. In contrast, the detailed separate production data for gem diamond and industrial diamond are U.S. Bureau of Mines estimates except for Australia (1987), Brazil (1987-90), and Central African Republic (1987-90), for which source publications give details on grade as well as totals. The estimated distribution of total output between gem and industrial diamond is conjectural, and for most countries, is based on the best available data at time of publication.

[2]Includes near-gem and cheap-gem qualities.

[3]Includes all synthetic diamond production.

[4]Reported figure.

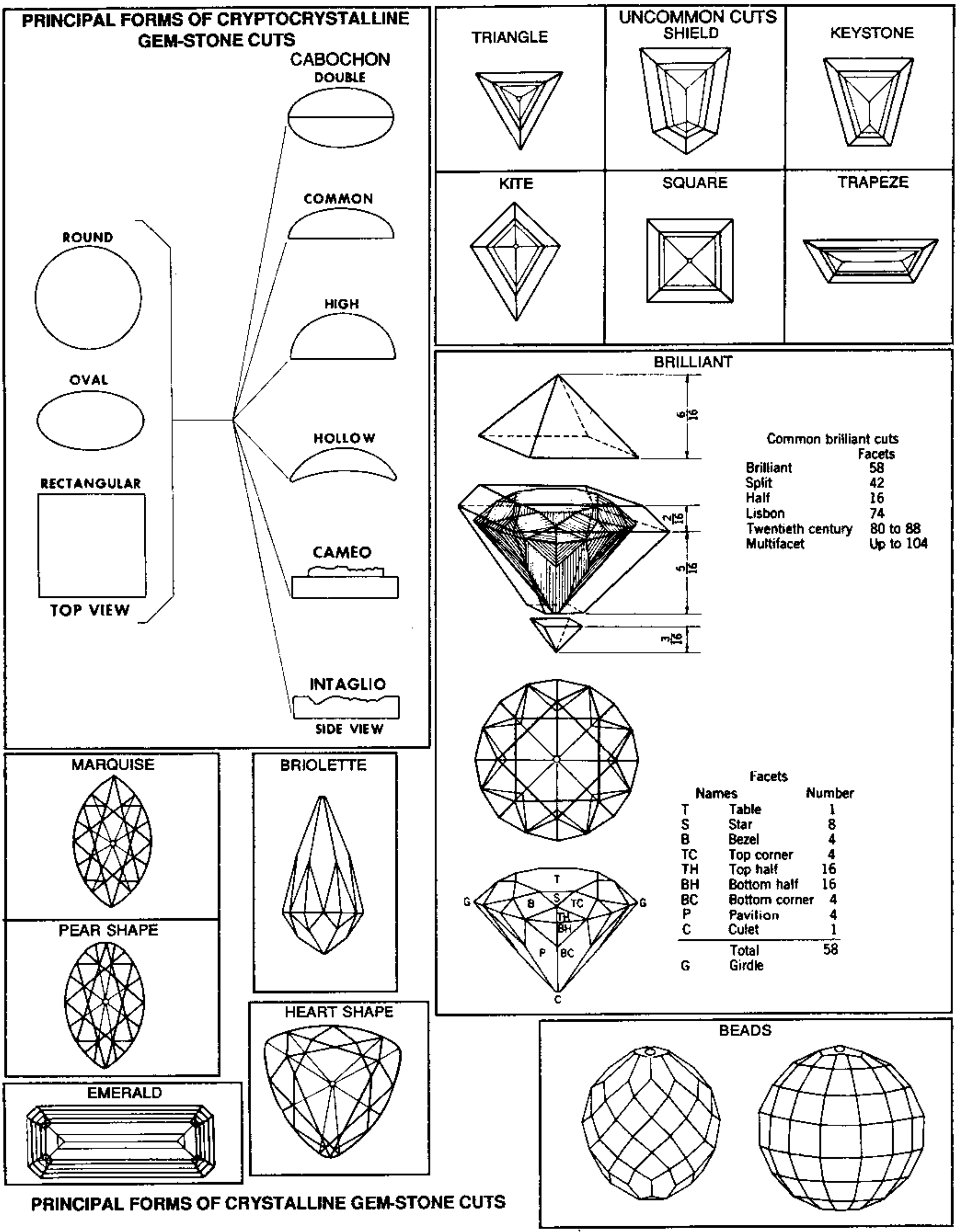
[5]Figures are estimates based on reported exports and do not include smuggled diamonds.

[6]Figures do not include smuggled artisanal production.

[7]"Other De Beers' Group output from the Republic of South Africa includes Kimberley Pool, Koffiefontein Mine, Namaqualand mines, and Venetia mines.

FIGURE 1

PRINCIPAL FORMS OF CRYPTOCRYSTALLINE AND CRYSTALLINE GEMSTONE CUTS



GEMSTONES

By Gordon T. Austin

Mr. Austin, a physical scientist with more than 30 years of industry and Government experience, has been the gemstones commodity specialist since 1986. Ms. Kelly Dorney of the Branch of Data Collection and Coordination prepared the domestic production survey data.

Webster's dictionary defines a gem "as any jewel, whether stone, pearl or the like, having value and beauty that are intrinsic and not derived from its setting; a precious or, sometimes, a semiprecious stone cut and polished for ornament. A stone of value because it is carved or engraved, as a cameo or intaglio." Additionally, the dictionary states that gemstone or gem material is a stone or material from which a gem may be cut. In less formal or common terms a gem, gemstone, or gem material may be described as specimens of minerals or organic materials used for personal adornment, display, or to manufacture objects of art because they possess beauty, rarity, and durability.

In 1992, the value of natural gemstones from deposits in the United States was $66.2 million, a decrease of 22% compared with that of 1991. Production of gemstones included faceting rough, lapidary rough, carving material, specimen material, natural and cultured freshwater pearls, mother of pearl, fossil ivory, amber, and coral.

Synthetic gemstones are grown in the laboratory but have essentially the same appearance and optical, physical, and chemical properties as the natural material that they represent. Synthetic gemstones produced in the United States include alexandrite, coral, diamond, emerald, garnet, lapis lazuli, quartz, ruby, sapphire, spinel, and turquoise. Simulants are laboratory grown gem materials that have an appearance similar to that of a natural gem material but have different optical, physical, and chemical properties. The gemstone simulants produced in the United States include coral, cubic zirconia, lapis lazuli, malachite, and turquoise. Additionally, certain colors of synthetic sapphire and spinel, used to represent other gem stones, would be classed as simulants. Colored and colorless varieties of cubic zirconia are the major simulants produced. In 1992, the reported combined production value of U.S. synthetic and simulant materials was $18.9 million, about a 6% increase from that of 1991.

Wholesale and retail outlets, gem and mineral shops, gem and mineral shows dealers, cutting factories, and jewelry manufacturers were the major purchasers of domestic gem materials.

DOMESTIC DATA COVERAGE

The U.S. Bureau of Mines estimates U.S. production from the "Natural and Synthetic Gem Material Survey," a voluntary survey of U.S. operations, and from Bureau estimates of unreported production. Of the 380 operations surveyed, 94% responded, accounting for about 96% of the total production, 93% of the natural production, and 99% of the synthetic and simulant production.

The number of operations surveyed in 1992 was essentially the same as the number surveyed in 1991. The response rate was slightly better. The Bureau estimated the production by nonresponding operations, by professional collectors, and by amateur or hobbyist collectors. The basis for these estimates were information from published data, conversations with gem and mineral dealers, analyses of gem and mineral shows and sales statistics, and from information informally supplied by collectors.

BACKGROUND

The history of production and preparation of gemstones begins with the wearing of items for personal adornment in prehistoric times; this preceded even the wearing of clothes. Amber was mined in the Baltic countries for use as a gem material before 25000 B.C. Later, the Phoenicians in their writings described their trade routes to the Baltic for amber and to areas in Asia and Africa for other gemstones. The voyages of Columbus brought increased interest in gemstone deposits, especially emerald, in South America. The discovery of diamond in Africa in 1859 focused major interest on Africa. More recently, the discovery of diamond in Western Australia in 1967 resulted in the development of the largest known diamond deposit in the world.

Commercial mining of gemstones is extensive in the United States but not as large-scale operations. More than 60 different gemstones have been produced commercially from relatively small domestic sources. In many instances, production rests in the hands of the numerous hobbyists and members of mineralogical and lapidary clubs. The Crater of Diamonds State Park near Murfreesboro, AR, is open to the public on a daily-fee basis, as are many other gemstone deposits throughout the United States. Many gem-quality stones are found at these locations each year.

Definitions, Grades, and Specifications

Select rocks, certain varieties of mineral specimens, and some organic materials, such as pearl, amber, jet, and coral, are included in gemstones data.

Customarily, diamond, ruby, sapphire, and emerald are considered the major gems.

The most important qualities of gemstones are beauty, durability, uniqueness, and rarity. Beauty, indicated as splendor, purity, or attractiveness, is judged mainly according to the taste of the beholder and includes such appearances as luster, transparency, brilliance, and color. Luster of a mineral or stone is independent of color and is the surface appearance in reflected light. Apart from materials that have a metallic luster, the chief contributors to luster are transparency and refractive index. In cut gems, the perfection of the polish enhances the luster. Visible imperfections impair the luster of transparent stones. However, defects, described as "jardens" or "inclusions," may enhance the beauty and value of natural rubies, emeralds, and other gemstones. In some cases these inclusions may be used to identify the country and even the mine from which the stone was recovered. Durability is measured by the resistance of a stone to abrasion, pitting, chipping, or splitting. Resistance to abrasion is correlated with relative hardness, but intrinsic brittleness and toughness indicate resistance to wear in other aspects. Rarity is an essential qualification and is more important for some stones in determining their value than their physical characteristics.

Of the approximate 2,700 mineral species, only about 100 possess all of the attributes required of a gem. Collectors of gems may not require that a gem be durable because the stone is destined for display and is not to be worn. Therefore, the number of species of gemstones may be greater than the 100 that meet all of the requirements. Silicates furnish the greatest number, including such minerals as beryl, topaz, tourmaline, and feldspar. Oxides such as corundum (ruby and sapphire) and quartz (amethyst, agate, etc.) comprise the second largest group. Sulfides, carbonates, and sulfates are of small importance; the phosphates yield primarily turquoise and variscite. An exception is pearl, essentially calcium carbonate, which is ranked high as a gem. Diamond, the best known gem, is an isometric crystalline form of the element carbon.

Gemstones are classified the same as minerals; that is, into group, species, and variety. Group refers to two or more gem materials that are similar in crystal structure and physical properties but have different chemical properties. Each individual member of the group is called a species. Varieties of species have similar crystal structure and chemical characteristics but differ in color. An example of this would be the hessonite variety of the grossular species of the garnet group.

Products for Trade and Industry

Cutting and polishing of gems from gemstones are done to obtain the most effective display of the material. No significant change is made in the fundamental properties, and the preparation is intended to enhance the desirable characteristics that are present initially. Gemstones are cut into gems in three main styles: faceted, cabochons, and baroque.

Facet cutting usually is employed on transparent gemstones to increase brilliancy and appearance. It generally is confined to the harder materials. Softer materials may be faceted, but extreme care must be exercised in cutting and polishing the stones and in their use in jewelry. Often the softer gems are used only for display and not for making jewelry. The "round brilliant" cut, most commonly used in faceting, has 58 facets, 33 above the circle "girdle" and 25 below it, arranged in eightfold symmetry. The "round brilliant" and some other common cuts are illustrated in figure 1. *(See figure 1.)*

Cabochons are cut in four operations: sawing, grinding, sanding, and polishing. Sawing, the initial step in cutting, is customarily done with a diamond saw to obtain a slab or slice of the desired size and thickness from the rough gemstone. The cabochon outline is scribed onto a flat surface, most often using a template for making a standard size for jewelry mountings. Rough grinding of the stone may be by metal-bond diamond, electroplated diamond, silicon carbide, or aluminum oxide wheels or coated abrasive disks. In grinding, the hardness of the gemstone determines the grit and hardness of the abrasive used. Multiple grinding steps starting with 80- to 100-mesh (grit) through 600-mesh abrasives are normally used. The scratches left by grinding are removed by progressively finer grinding and sanding. Disk or belt sanders use abrasives bonded to cloth, waterproof reinforced paper abrasives, or cloth charged with abrasive pastes. The final polish is obtained by using hard felt, wood, or leather laps, with various polishing agents such as fine diamond compound, tin oxide, tripoli, chromium oxide, cerium oxide, alumina, or rouge.

Polished irregular shapes are called baroque gems. An inexpensive method of polishing baroque gems is to tumble them in rubber-lined drums, using a grinding and polishing medium with or without water.

Industry Structure

The world market for rough diamonds is controlled to a high degree by De Beers Centenary AG's marketing arm, the Central Sales Organization (CSO). It is by far the most controlled of the world's commodity markets. An estimated 80% of gem and natural industrial diamond is marketed by the CSO. The marketing is done through the CSO by the Diamond Trading Co. Ltd. and Industrial Distributors Ltd. The CSO sells uncut gem diamonds on behalf of De Beers and most other major producers at sights (approved bidder viewings) in London, England, and Lucerne, Switzerland. There are 10 such sights each year.

Diamonds reach the CSO sights through three channels—De Beers owned and operated mines, contract sales by mine owner and operators, and open-market competitive sales.

The distribution of rough diamonds in the Republic of South Africa is determined by the South Africa Diamond Board. A new agreement was reached between De Beers Consolidated Mines

Ltd., its customer, and the Government of South Africa on the method of domestic rough diamond distribution. In the past, all categories of rough diamonds that could be processed economically in South Africa must first be offered to local manufacturers. Rough could be exported duty free only if it had first been offered to the local market, otherwise a 15% duty is charged. Now, all rough will be shipped to London and mixed with diamonds from the other producers. Rough for South African cutters is then drawn from the world rough supply.

The CSO has been extremely successful at maintaining the rough diamond market for more than 50 years. In modern times there has never been a decrease in CSO's price of rough diamonds. Table 1 illustrates the timing and the amounts of the average CSO price increases for rough gem diamonds from 1949 until the present, while table 2 indicates the value of CSO's annual sales for the past 10 years. The compounded effect over 44 years of these increases is a price increase of about 1,800%. Thus, a piece of rough that sold for $100 in August 1949 would sell for about $1,800 in April 1991. *(See tables 1 and 2.)*

For more than 30 years, the major diamond cutting and polishing centers of the world were in Belgium and Israel, with a certain amount of the larger stones being cut in the United States. In the early 1980's, the development of a large cottage industry in India—today there is estimated to be more than 500,000 cutters—made a major impact on world diamond trade. India consumes most of the world's small-gem, cheap-gem, and near-gem rough material in the manufacture of small stones, which resulted in annual cut-stone exports worth billions of dollars. These small stones averaged less than one-fifth of a carat (0.20 carat). The availability of small inexpensive stones resulted in substantial changes in the design of jewelry. The utilization of small cut diamond stones (usually 0.07 to 0.14 carats each, called melee) to create a pavè effect (set close together to conceal the metal base) is but one example.

It is estimated that the Russian's diamond cutting industry employs about 16,000 workers. The eight Krystall factories at Moscow, Smolensk, Kiev, Barnaul, Vinnitsa, Yerevan, Kusa, and Gomel employ fewer than 8,000, with the Moscow plant having about 900 workers. The workers at the various factories may be paid by different methods.

The workers at the Moscow plant are paid by the piece according to its size and difficulty of the cut. At Kiev, those workers whose work is not subject to inspection receive a 50% higher salary. Some of the Krystall factories have an incentive program for workers producing stones of 0.3 carats and larger. The incentive is a bonus of 5% of the added value that is paid to each 20-worker team and is shared by the team.

Annual cut diamond production is a function of the number of workers in the industry and their productivity. If it is assumed that the industry has a production rate of 20 carats of finished goods per month per worker and that polished yields are less than 40%, then the industry's consumption of rough and yield of finished goods can be estimated. It is estimated that during a year, the Russian diamond cutting industry processes about 3.8 million carats of rough that yields about 1.6 million carats of polished goods. The polished goods would be worth between $500 million and $550 million on the world market.

During 1991, Leo and Schachter & Co. opened the United States' newest, largest, and most modern diamond polishing factory in New York. The factory is fully computerized to track every diamond from rough to finished stone. The computer predicts the cash return from each piece of rough based on estimates of the rough's color, clarity, yield, and make; estimates are reported to be within 2% of actuals. The factory employs 40 polishers.

Cutting and polishing of colored, synthetic, and simulant gemstones is centered in, listed according to importance, Thailand, India, Hong Kong, Republic of Korea, China, and Brazil, where cheap labor and favorable export laws ensure the lowest total costs for finished gems.

Geology-Resources

Gemstones are found in a large variety of igneous, metamorphic, and sedimentary deposits, usually as a small fraction of the total deposit. The origins are as varied as the deposits. Gemstones form primarily by precipitation from watery solutions, by crystallization from molten rock, and by metamorphic processes. Approximately one-third of gemstones is composed of silicate minerals, about one-fifth of alumina-silicates, and almost one-seventh of oxides. The remaining compositional groups include the sulfides, phosphates, borosilicates, carbonates, and, in the single case of diamond, an element. The composition of selected gem materials is included as one of the items in table 3. *(See table 3.)*

There are no large resources of major gem materials defined in the United States. Emerald deposits are known in North Carolina, as are ruby and sapphire. Historically, sapphires have been mined in Montana, and significant commercial mining once again is underway. Numerous other domestic deposits of gemstones are known and have been mined for many years. However, no systematic evaluations of the magnitude of these deposits have been made, and no positive statements can be made about their reserve or the size of the resource.

Occasional finds of diamond have been made, but no great diamond pipes or alluvial deposits similar to those of Africa have been reported. Several companies are involved in diamond exploration in the Colorado-Wyoming State line area, in Michigan, Minnesota, Wisconsin, and Arkansas. Diamond-bearing kimberlites have been located and bulk samples have been processed for diamond recovery. Results have not been made public.

World resources of gemstones are nearly all unevaluated. However, world gem diamond reserves are estimated to be about 300 million carats, including near-gem and cheap-gem qualities. Nearly all of the reserves are in, listed in order of size, Australia, Africa, and Russia (Siberia). The estimates for diamond reserves are of limited value because data needed for reliable estimates are not available from the producers. Reserve data on other gemstones are even less available than for diamond.

Technology

Synthetic Gems.—Synthetic gemstone production uses many different methods, but they can be grouped into one of three types of processes: melt growth, solution growth, or extremely high-temperature, high-pressure growth.

The year 1902 saw the first production of synthetic ruby using the Verneuil flame-fusion process. Later, sapphire, spinel, rutile, and strontium titanate were grown with this technique. In this process, a single crystal, called a boule, forms in the flame of a simple, downward-impinging oxygen-hydrogen blowtorch. Pure oxides of aluminum (in the cases of ruby, sapphire, and spinel) or titanium (rutile and strontium titanate) are poured into the top of a small furnace and melted. Other oxides are added as needed for process control and to obtain the specific color desired. The melted material solidifies as a boule on a rotating fire-clay peg as the peg is slowly withdrawn.

A boule has a very characteristic shape, with a rounded end, a long, cylindrical body, and a tapering end. It is usually about 13 to 25 millimeters in diameter, 50 to 100 millimeters long, and weighs 75 to 250 carats (a carat is 200 milligrams). Under controlled conditions, a boule about 5 millimeters in diameter and more than 890 millimeters long can be produced for the manufacturing of jewel bearings.

Another melt technique is the Bridgman-Stockbarge solidification method, named for an American, P.W. Bridgman, and a German, D.C. Stockbarge, who, aided by three Russians, J. Obreimov, G. Tammann, and L. Shubnikov, discovered and perfected the process between 1924 and 1936. Currently, the method is used primarily for growing nongem halide, sulfide, and various metallic oxide crystals, one of the metallic oxides being aluminum oxide or sapphire.

The Bridgman-Stockbarge process uses a specially shaped crucible, which is a cylindrical tube open at one end and capped at the other by a small, pointed cone. The crucible is filled with the powdered chemicals necessary to grow a specific crystal and is lowered slowly through a furnace. The small, pointed end of the cone cools first because it is the first part of the crucible that moves from the hottest part of the furnace into cooler regions and it is the first part to emerge from the furnace. As the crucible cools, the molten materials solidify, hopefully in the structure of a single crystal, in the point of the crucible. The crystal then acts as a seed around which the remainder of the molten material solidifies until the entire melt has frozen, filling the container with a single crystal.

This process is simple, and crystals of various sizes can be grown. The crystals are typically about 51 millimeters in diameter and 15 millimeters in length, but large ones exceeding 890 millimeters diameter and weighing more than 1 metric ton have been grown. The crystals have the same shape as the crucible.

The Czochralshi pulled-growth method is used for ruby, sapphire, spinel, yttrium-aluminum-garnet (YAG), gadolinium-gallium-garnet (GGG), and alexandrite. Czochralshi developed his method about 1917 while working with crystals of metallic nutrients.

In the Czochralshi method, ingredient powders—nutrients—are melted in a platinum, iridium, graphite, or ceramic crucible. A seed crystal is attached to one end of a rotating rod, then the rod is lowered into the crucible until the seed just touches the melt. Then the rod is slowly withdrawn. The crystal grows as the seed pulls materials from the melt, and the material cools and solidifies. Yet, because of surface tension of the melt, the growing crystal stays in contact with the molten material and continues to grow until the melt is depleted of the desired material.

Typically, the seed is pulled from the melt at a rate of 1 to 100 millimeters per hour. Crystals grown using this method can be very large, more than 51 millimeters in diameter and 1 meter in length, and of very high purity. Each year this method grows millions of carats of crystals for use as gems, laser rods, windows for special scientific or technical applications, and for other industrial applications.

Certain gemstones pose unique problems with regard to attempts to grow them. The problems arise because certain materials are either so reactive that they cannot be melted even in unreactive platinum and iridium crucibles or they melt at much higher temperatures than the crucible materials can endure. Therefore, another melting system must be used, called the skull melting system. Cubic zirconia, because of its high melting point (2,700° C) must be grown using the skull melting method.

The "skull" is a hollow-walled copper cup. Water is circulated through the hollow walls to cool the inside wall of the skull. The cup is filled with powdered ingredients and heated by radio frequency induction until the powders melt. Because the water cools the walls of the skull, the powdered materials next to the walls do not melt, and the molten material is contained within a shell of unmelted material. Therefore, the reactive or high-temperature melt is contained within itself. When the heat source is removed and the system is allowed to cool, crystals form by nucleation and grow until the entire melt solidifies. Crystals grown using this system vary in size, depending on the number of nucleations. In growing cubic zirconia, a single skull yields about 1 kilogram of material per cycle.

Solution techniques for making synthetic gems include flux methods for emerald, ruby, sapphire, spinel, YAG, GGG, and alexandrite. The other solution method is the hydrothermal method, often used for growing beryl (emerald, aquamarine, and morganite) and quartz.

Quartz crystals are grown in a hydrothermal solution in large pressure vessels known as autoclaves. Careful control of temperature and pressure in the different areas of the autoclave result in the feed material, known as lascas, dissolving in the hotter portion. The material redeposits on seed crystals, located in the cooler portion, forming synthetic quartz crystals. The process usually takes 30 to 60 days for the crystals to reach the desired size. The process can also produce rock crystal, amethyst, or citrine.

The same system is used to grow beryl crystals. Beryl seed crystals are suspended in the cooler upper portion of an autoclave. Nutrient materials dissolve in the hotter, lower portion of the autoclave and, because of the temperature and pressure gradients, migrate to the cooler seeds and are deposited.

Other techniques involve solid- or liquid-state reactions and phase transformations for jade and lapis lazuli; vapor phase deposition for ruby and sapphire; ceramics for turquoise, lapis lazuli, and coral; and others for opal, glass, and plastics.

The Verneuil, Czochralshi, and skull melting processes are the melt techniques most often used for gem materials. The various synthetics and the method of production are shown in table 4. *(See table 4.)*

Enhancement of Gemstones.—Enhancement of all types of gemstones through chemical and physical means has become much more commonplace and in the past few years has included a wider variety of materials. Irradiation by electromagnetic spectrum (X-rays, gamma rays, etc.) and by energetic particles (neutrons, electrons, alphas, etc.) is being used to enhance or change the color of diamonds, topaz, tourmaline, quartz, beryl, sapphire, zircon, scapolite, and pearls. Blue topaz is normally irradiated, but this does not imply that all of these gem materials are regularly irradiated.[1]

Many gemstones can be enhanced by chemical treatment or impregnations. The treatments may alter the bulk of the gem material or only penetrate the surface. This includes bleaching, oiling, waxing, plastic impregnations, color impregnations, and dyeing. The treatments that alter only the surface of the material include surface coatings of various types, interference filters, foil backings, surface decoration, and inscribing. Chemical treatment is more widespread than just the common dyeing of quartz, treatment of turquoise, and oiling of emeralds. Chemical treatment and impregnations have been used to enhance amber, beryl, chalcedony, coral, diamonds, emerald, ivory, jade, lapis lazuli, opal, pearl, quartz, ruby, sapphire, tiger's eye, and turquoise.[2]

Since about 1987, fractures, cleavages, and other void-type imperfections that reach the surface in diamonds have been filled using a process developed by Mr. Zvi Yehuda, of Ramat Gan, Israel. This treatment can enhance that apparent clarity of treated faceted diamonds; examples are available that show SI stones enhanced to VS and I_1 improved to SI_2. Yehuda also has developed a similar treatment for emeralds.

The oldest and most common method of gemstone enhancement is heat treating. Heat treatment of gem materials was used in Greece and Rome well before the Christian Era. Heat treatment can cause color change, structural change, and improve clarity. In the past, heat treatment was common for quartz and gem corundum. Today, materials that are heat treated to enhance their appearance include amber, beryl, diamond, quartz, ruby, sapphire, topaz, tourmaline, zircon, and zoisite.[3]

Recently, an additional type of treatment for sapphire has appeared—diffusion treatment, a chemical-heat treatment. In this process a thin layer of color is diffused into the surface of the gem. The color may be diffused as little as 0.1 millimeter or as much as 0.4 millimeter into the gem. The treatment is a long process of heat treatment in a bath of chemicals containing the proper proportions of titanium and iron. The American Gem Trade Association (AGTA) adopted a policy for the disclosure of diffusion treated sapphires. The policy is "If the color of a gemstone is confined to an area near the surface so that the color of the stone would be visibly affected by recutting or repolishing then the following statement must also appear: Although the color induced in the diffusion treated sapphire is permanent, it remains confined to a shallow surface layer." Therefore, recutting or repolishing is not recommended.[4]

Mining.—Gemstone mining operations can range from the most primitive to the most sophisticated. In hard rock, at shallow depths, an operation by one, two, or three persons may be mined by prybar, pick, shovel, and buckets or baskets for carrying material; often drilling and blasting is employed. A larger operation includes drilling, blasting, and minimum timbering. Mechanized hauling and hoisting is done only at the larger mines.

Diamond mining in the kimberlite pipes of Africa and Russia and the lamproite pipes of Australia represent the ultimate in that huge quantities of ore must be mined to extract small quantities of diamond (20 to 30 carats per 100 tons of ore) produced at as low a cost as possible.

Placer mining for gemstones ranges from small-scale, simple procedures to huge, complicated operations. In some areas, digging is by hand, and sorting and recovery is by panning, screening, or sluicing. Diamond miners in the larger placer operations use bucket dredges and heavy-duty excavating equipment, as, for example, in Australia, Brazil, Namibia, the Republic of South Africa, and Russia.

Processing.—Most gemstone ores are broken or crushed where necessary and concentrated by various combinations of hand picking, washing, screening, or jigging. In large-scale operations, mineral beneficiation methods are mechanized and employ the latest technology in each step from primary crushing and screening to the final recovery processes. Diamond recovery, in particular, makes use of standard gravity methods, grease belts, electrostatic separation, skin-flotation, magnetic separation, separation by X-ray luminescence, and separation by optical sorting.

ANNUAL REVIEW

Production

In 1992, all 50 States produced at least $1,000 worth of gem materials. Ten States accounted for 83% of the total value of production of natural gemstones. The States, in order of declining value of production, were Tennessee, California, Arizona, Louisiana, Texas, Oregon, Oklahoma, Iowa, Arkansas, and North Carolina. Certain States were known best for the production of a single gem material (i.e., Tennessee for freshwater pearls and Arkansas for quartz). Other States produced a variety of gemstones. Arizona produced the greatest variety. Production included agate, amethyst, antlerite, azurite, chrysocolla, fire agate, garnets, jade, malachite, obsidian, onyx, peridot, petrified wood, precious opal, shattuchite, smithsonite, and turquoise. California, Idaho, Montana, and North Carolina also produced a variety of gemstones. Historically, North Carolina is the only State to have produced all four of the major gems: diamond, emerald, ruby, and sapphire.

The average production value of natural gem materials for the past 10 years was $34.9 million per year, with a high of $84.4 million in 1991 and a low of $7.4 million in 1983. The value of production for the past 10 years must be separated into two trends. The first trend was the period between 1981 through 1985, during which time approximately 24 operations reported production. Production averaged $7.4 million per year and was generally level. In the second trend, 1986 to the present, production averaged $45.7 million and was the result of an increase of 1,567% in the number of producers surveyed.

The reported value of synthetic and simulant gemstone production was $18.9 million in 1992, an increase of 6% over that of 1991. The average value of production of these gem materials for the past 7 years was $16.9 million, with a high of $20.5 million in 1990 and a low of $10.3 million in 1986. Fourteen firms, four in California, four in Arizona, and one each in Massachusetts, Michigan, New Jersey, North Carolina, Ohio, and Washington, produced synthetic and simulant gem material. The eight States, in order of declining value of production, were California, Massachusetts, Arizona, New Jersey, Washington, North Carolina, Michigan, and Ohio.

Arizona is well known for the widest variety of gemstones produced by any State. In 1992, these included agate, amethyst, antlerite, azurite, chrysocolla, fire agate, fluorite, garnet, jade, jasper, malachite, obsidian (Apache tears), onyx, peridot, petrified wood, precious opal, shattuchite, smithsonite, and turquoise. Yet, turquoise, peridot, petrified wood, and azurite-malachite accounted for more than 90% of the total value of gem material produced. Production from Arizona of these gemstones was the largest in terms of dollar value in the United States and the world's largest for the first two. Additionally, four manufacturers of synthetic or simulant gem materials were in Arizona and produced about $1.8 million worth of material.

Arkansas is famous for the production of quartz crystals, but it appears that the fads that have supported the production of quartz crystals for the past few years has ended. It is second in value of production of freshwater pearls and shells and the only State in the United States that has had any sustained diamond production.

Since 1972, hobbyists have found from 300 to 1,500 diamonds per year at the Crater of Diamonds State Park. From 1906 to the present, it is estimated that production from the deposit is 100,000 to 150,000 carats; this amount of diamond production is insufficient to classify the United States as a diamond-producing country. Still, the potential to become a diamond producer may be there, and efforts were underway to evaluate this potential more fully. A four phased program to evaluate the diamond deposit was halted by legal actions after completing three exploratory drill holes in 1990. After a Federal appellate court cleared the way for the program to continue, phase 1, the drilling of 26 core holes totaling 2,600 meters, was completed during 1992.

Gemstone production from California includes a variety of materials. Tourmaline production from the State is the largest in the Nation, and California has the only producer of benitoite. Additionally, agate, alabaster, beryl, dumortierite, fire agate, freshwater mussel shell and pearls, garnet, gem feldspar, jade, jasper, kunzite, lepidolite, obsidian, quartz, rhodonite, topaz, and turquoise are produced from deposits in the State. Yet, even with this long list of gemstones, most people think of California in terms of its State gem benitoite, its high-quality tourmalines, and its fine orange spessartine garnets.

The State also has a freshwater culture pearl farm at Marysville. The farm uses animals imported from Tennessee and other southeastern States. Production includes pearls, shell, and finished nucleus for cultured pearl implants.

California also has four manufacturers of synthetic or simulant gemstones. The value of production from the State is the largest of any State for synthetics and simulants.

Colorado is not known as a gemstone-producing State, but it does hold some gemstone honors. It has the only commercially mined deposit of lapis lazuli in the United States and one of the few fee-for-dig topaz deposits currently operating. Additionally, the State was the first to commercially produce turquoise and still has commercially operated turquoise mines. It also produced the United States' finest gem-quality rhodochrosite and a quantity of high-quality rhodonite.

Many different locations in the State produce aquamarine, the Colorado State gemstone. The best known locations and the locations with the longest history of continued production (since about 1884) are Mount Antero and White Mountain in Chaffee County. Mount Antero, at 4,349 meters, may be the highest gemstone location in the United States. White Mountain, separated from Antero by a small saddle, is only slightly lower at 4,237 meters.

Star garnet, the Idaho State gemstone, leads the list of gemstones produced in the State. Idaho is one of two places that produce significant amounts of star garnet; India is the other. These almandite garnets are translucent, purplish-red stones that show four- or six-ray stars when cabochon cut or are transparent deep red stones that can be faceted. The primary sources of Idaho star garnet are the placer deposits on the East Fork of Emerald Creek and its tributary gulches in Benewah County. Additionally, the placers of Purdue Creek in Latah County yield star garnets. Currently, garnets that do not cut stars also are commercially mined from areas in Clearwater County. These garnets range from purplish rose-red to a highly prized "special pink." Gem-quality garnets are found at several other locations in Idaho and are mined periodically by hobbyists or professional collectors for the gemstone market.

Opal is the second largest contributor to the total value of gemstone production in Idaho. The varieties produced include precious, yellow, blue, pink, and common. The Spencer opal mine is the largest producer. At the Spencer Mine, precious opal occurs as one or more thin layers within common opal that have partially filled gas cavities within a rhyolite-obsidian flow. About 10% of the material is thick enough to cut into solid gems; the remainder is suitable for making doublets and triplets. The Spencer Mine is also the source of the pink opal, which occurs as either pink common opal or pink bodied precious opal.

In the U.S. gemstone industry, Maine and tourmaline are almost synonymous. In 1822, Maine's Mount Mica was the site of the first gemstone production in the United States. In 1992, Plumbago Mining Corp. was actively mining the Mount Mica pegmatite for gem material and mineral specimens. Over the years, production from Mount Mica has included hundreds of kilograms of fine-quality gem and mineral specimen tourmaline.

Mount Mica is not the only large producer of high-quality tourmalines. Dunton Mine of Newry Hill is the most prolific gem tourmaline producer in Maine. Since its discovery in 1898, the mine has produced tons of gem- and specimen-grade tourmaline. Other mines and quarries in a three county area produce gem- and mineral specimen-grade tourmalines. These include the Bennett, BB #7, Emmons, Harvard, Tomminen, Waisenen, Black Mountain and Red Hill Quarries, and Nevel Mine in Oxford County. It also includes the Mount Apatite Quarries in Androscoggin County and the Fisher and Porcupine Hill Quarries in Sagadahoc County.

Production from Maine deposits also includes fine-quality beryls—aquamarine, heliodor, and morganite. Pegmatites in Oxford, Androscoggin, and Sagadahoc Counties regularly produce fine-quality blue and blue-green aquamarine, rich yellow- and gold-colored heliodor, and rose- and peach-colored morganite.

Montana produces many different gemstones, some suited for faceting, while others are better suited for the cutting of cabochons, carvings, or objects-of-art. Montana is noted for the production of sapphires, Montana moss agate, and Dryhead agates. Yet, amethyst, amazonite, azurite, covellite, cuprite, garnet, onyx, opal, petrified wood, rhodochrosite, rhodonite, smokey quartz, sphalerite, and wonderstone (banded rhyolite) also are produced or have been produced from deposit in the State for use as gemstones.

Sapphires have been produced from Montana deposits since 1865. In recent years, Montana sapphire has gained in popularity, and because of the improved popularity, production has increased significantly. Currently, commercial sapphire production is from deposits on the Missouri River in Lewis and Clark County, the Rock Creek area in Granite County, and from the Yogo Gulch area in Judith Basin County. Additionally, there are fee-for-dig sapphire operations on the Missouri River and Rock Creek.

Nevada has been a major producer of turquoise since the 1930's, and until the early 1980's, the State was the largest turquoise producer in the United States. Estimates indicate that over the years, 75 to 100 different mines and/or prospects have produced sizable quantities of turquoise. Production varied from a few thousand dollars worth of material at some properties to more than $1 million at others. Estimates of total production to date are between $40 to $50 million.

Precious opal production from deposits in the Virgin Valley area began in about 1906. The opal from Virgin Valley is comparable to any in the world for its vivid play of color and is unsurpassed in terms of the size of material available. The material varies in color from deep pure black to brown to yellowish-white to white to colorless. The play of color includes all the colors common to precious opal—red, blue, green, yellow, orange, and so on. The opal is found primarily as replacement of wood, or sometimes, the replacement of cones of conifer trees. The use of the opal is greatly restricted because of a severe problem with crazing. Currently, two mines in Virgin Valley are open to individuals on a fee-for-dig basis during the summer months. The operators of these mines also mine the deposits for their own inventories.

North Carolina is the only State in the United States where all four major gem materials, diamond, ruby, sapphire, and emerald, have been found. During 1988 was the last time all four major gemstones were found in the same year. The diamond was found in a gold placer mine, rubies and sapphires were recovered from the Cowee Valley, and emeralds were found near Hiddenite and Little Switzerland.

Production of ruby and sapphire from deposits along the Cowee Valley in Macon County began in 1895 when the American Prospecting and Mining Co. systematically mined and washed the gravels of Cowee Creek. Today ruby, sapphire, and fee-for-dig operations are in the Cowee Valley. Many people pay to dig or purchase buckets of gravel to wash to recover gem corundum, garnets, and other gemstones.

Historically, Oregon has been known for the production of various picture and scenic jaspers, agates, thundereggs, petrified wood, and to a certain degree, gem labradorite. Oregon's State rock, the "thunderegg," may be the best known gem material from Oregon. Graveyard Point, Priday, and Polka Dot are names that are uniquely associated with beautiful Oregon agates. The same is true for the relationships between the names Biggs, Deschutes, and Sucker Creek and picture or scenic jasper. Yet, gem labradorite (sunstone) is currently the largest single contributor to the value of annual gemstone production in Oregon. At least seven firms or individuals currently are producing sunstone from three different geographic areas.

The other gemstone to contribute significantly to the value of production from Oregon is opal. During 1988, the first significant commercial mining and marketing of a variety of very fine quality opals from Opal Butte began. The varieties include hyalite, rainbow, contra luz, hydrophane, crystal, fire, blue, and dendritic. Exquisite stones as large as 315 carats have been cut from contra luz rough from this deposit.

Tennessee has the largest U.S. production of freshwater mussel shells and pearls of the 11 producing States. There has been an established U.S. freshwater mussel fishing industry since the mid-1850's. The mussels are from the family Unioidae, of which about 20 different species are commercially harvested. During 1992 the value of U.S. mussel shell exports was more than $43 million.

To date, freshwater pearls from the United States have been a byproduct of the shell industry. With the coming of the freshwater cultured pearl farms in Tennessee and the increasing popularity of freshwater pearl jewelry with the U.S. consumer, this may change. Since the technology for culturing freshwater pearls was proven in the late 1970's, six freshwater pearl farms have been established. These farms are the beginning and heart of the U.S. pearl industry.

In Wisconsin and Michigan, 12 kimberlite pipes have been identified on exploration holdings, 7 have yielded microdiamonds, and 3 have not been tested.

Utah topaz is not well suited for use as a gem, but it does make a fine mineral specimen. Topaz crystals have been collected from certain rhyolite flows in the Thomas Mountains and the Wah Wah Mountains. The crystals from the Thomas Mountains are predominately small, 10 to 20 millimeters long and 4 to 6 millimeters across, and crystals from the Wah Wah Mountains are even smaller. Occasionally, large gem-quality crystals are found. The color of the topaz varies from colorless, to light yellow, sherry brown, rose, or light pink. The light yellow to sherry brown color fades to colorless if exposed to sunlight or heat and rose or light pink colored crystals are rare. Because of the size of the crystals and problem with color fading, the material yields only small to very small colorless stones.

Another Utah gemstone is variscite, first produced in about 1893 near Fairfield. The latest recorded commercial production was from near Lucin during the summer of 1992. Variscite is found as fracture fillings or as nodules. The nodules may be solid, almost geode in nature, or fractured solid nodules that have undergone alteration. The color of the variscite varies from a shade of light to dark yellow-green, but can be a dark, nearly jade green and so pale as to appear almost white. It also can have black and brown spiderwebbing.

Another material from Utah is snowflake obsidian. Snowflake obsidian (also known as flower obsidian) earns its name from the bluish-white or grayish-white patterns of cristobalite included in the normally black obsidian. During 1992, two different firms produced this material commercially.

The red beryl from the Wah Wah Mountains is the most remarkable and desirable of Utah's gemstones. Bixbite, the variety name for red beryl, is found in rhyolites at several locations in the Thomas and Wah Wah Ranges. The beryl varies in color from a pink to bright red, with the bright red being what could be called strong raspberry-red. The material from most of the locations is not as spectacular, either in crystal size or color, as the crystals from the Violet claims in the Wah Wah's.

The Violet claims in the Wah Wah's are the only known location for commercial production of red beryl. In recent years, the claims have furnished a small but steady supply of materials for both mineral specimens and a few fine-quality gems. The crystals average about 10 millimeters in length, and most are flawed. Because of the size of the crystals and flaws, finished stones only average about 0.40 carats with few more than 1 carat. The largest finished stone to date is only 4.46 carats. The material is expensive, but justifiably so, because of its beauty and rarity.

Certain other States that produce a single gem material of note are: Alaska with its two jade mines; Florida's agatized coral; Hawaii's black coral; Minnesota's thomsonite; New York's herkimer quartz; Ohio's flint; and South Dakota's rose quartz.

The value of 1992 production by individual gemstone can be reported for those materials that have three or more producers and if one of the three does not account for more than 75% of the total or two of the producers account for 95% or more of the production. *(See table 5).*

Consumption and Uses

Consumption of domestic gemstones was in the commercial and amateur manufacture of jewelry, for exhibit in gem and mineral collections, and for decorative purposes in statuettes, vases, other art objects, and certain industrial applications.

Frequently, tourmaline is used as a standard for calibrating piezoelectric manometers and testing devices. It is also a control substance in boron experiments because it is itself an inert boron-containing compound. Tourmaline is the standard used in tests to check possible effects of water-soluble boron in fertilizers.

Many scientific and industrial instruments use tourmaline. One such use is tourmaline tongs, a simple laboratory instrument that shows the polarization of light. Because tourmaline is both pyroeletric and piezoelectric, meaning it generates electricity when heated or compressed, it is a component of instruments for measuring high pressures and fluid compressibility. Thermal dosimeters, which were early instruments that measured the intensity of radium emanations, depended upon tourmaline's pyroelectric properties.

Once the mark of a top-rated watch or timepiece was that it was Swissmade and had 18 or 21 ruby or sapphire jewel bearings. Originally, these jewel bearings were made from natural ruby and sapphire. Later, the availability of inexpensive synthetic gemstones allowed the natural materials to be replaced in the manufacture of jewel bearings.

Why are ruby and sapphire used as bearings? Because ruby and sapphire, color variations of the mineral corundum, are second only to diamond in hardness; they have no cleavage (cleavage being the tendency for a crystallized mineral to break in certain definite directions, indicating a minimum value of cohesion in the direction easy fracture) and thus they are very durable; they have a very low coefficient of friction when highly polished; they are chemically inert; and they can be cut and polished without great difficulty.

Watches were not the only instruments in which sapphire and ruby bearings were used. Most precision gauges in aircraft and boats depend upon jewel bearings, as do many gauges, meters, and other instruments in manufacturing and chemical plants. The military is still highly dependent on jewel bearings for many of its high-tech weapons systems. Recently, another use for one type of jewel bearing appeared—as connectors for optical fibers.

In recent years, technological advances allowed the growth of large, high-quality synthetic ruby crystals, called laser ruby, for the manufacture of laser rods. Several other synthetic gemstones also are being produced for lasers, including chromium-doped chrysoberyl (dope being an element added to the crystal growing nutrients to achieve a particular color), synthetic alexandrite, and varieties of doped yttrium-aluminum-garnet (YAG).

Lasers require high-purity, optically perfect crystals. The crystal must be large enough so that a laser rod can be cut from the raw crystal, and the mineral or material must have the correct physical properties to allow light amplification without the necessity of excessive energy. Synthetic ruby, sapphire, and YAG have all these characteristics.

Over the years, both natural and synthetic corundum has been ground and graded as an abrasive. Corundum was the major compound used in the polishing of eyeglass lenses. While industrial diamond has replaced much of the corundum used in the lens-polishing industry, some polishers still use corundum for specialized lenses.

Other gem materials have enjoyed limited uses in nongem applications. The abrasive and ceramic industries use topaz as a raw material because of its hardness and chemical features. Once, lenses for eyeglasses were made from gem-quality beryl—if the morganite variety of beryl were used, one would truly be looking at the world through rose-colored glasses. Mortar and pestle sets, knife edges for balances, textile rollers, and spatulas are some nongem uses of agate.

Some industrial applications requiring clean homogeneous stones used low-quality gem diamond. The quantity of natural and synthetic industrial-grade diamonds used in the United States each year is 12 to 15 times greater than the amount of diamonds consumed by the jewelry industry.

The 1992, estimated value of U.S. apparent consumption was $3,226 million, down about 13% from 1989's record high. The average annual estimated consumption for the past 10 years was $3,148 million, with a high of $3,705 in 1988 and a low of $2,132 in 1983. The trend for estimated consumption for the past 10 years was one of continued growth with some downward adjustments related to economic conditions.

In 1992, the value of U.S. estimated apparent consumption of diamonds increased about 8% to $2.8 billion. The average annual value of apparent consumption of diamonds for the past 10 years was $2.6 billion, with a high of $3.1 billion in 1989 and a low of $2.1 billion in 1983.

The 1992 estimated apparent consumption of colored stones, led by emerald, ruby, and sapphire, was valued at $392.0 million, a decrease of 3%. The estimated apparent consumption of pearls—natural, cultured, and imitations—was $19.1 million, a slight decrease. The average annual consumption for the past 10 years was $155.3 million, with a high of $244.7 million in 1984 and a low of $16.5 million in 1990. Estimated apparent consumption of synthetic and imitation gemstones increased about 464% to $117.9 million. Average apparent consumption of these materials for the past 10 years was $62.6 million per year, with a high of $117.9 million in 1992 and a low of $17.2 million in 1983. During 1992, sales in retail jewelry stores increased about 4% to $14.4 billion, according to the U.S. Department of Commerce.

Prices

Demand, beauty, durability, rarity, freedom from defects, and perfection of cutting determine the value of a gem. In establishing the price of gem diamond, the CSO's control over output and prices of diamond rough also is a major factor.

The average U.S. wholesale asking price of the top 25 grades (D through H color and IF through VS2 clarity) of a 1-carat diamond fluctuated between $7,208 and $7,256, and was $7,208 at yearend. The average value per carat of all grades, sizes, and types of gem-quality diamond imports was $443, a 14% decrease compared to that of 1991. The average value of diamond imports for the past 10 years was $408 per carat, with a high of $525 in 1990 and a low of $353 in 1984.

The average yearend wholesale purchase price of a fine-quality 1-carat ruby, paid by retail jewelers on a per stone or memo basis, was $3,900, the same as that of 1991. The average value of ruby imports decreased slightly to $29.53 per carat. The average annual value of ruby imports for the past 10 years was $36.67 per carat, with a high of \$48.71 in 1990 and a low of \$16.42 in 1984.

The average yearend wholesale purchase price of a fine-quality 1-carat sapphire, paid by retail jewelers on a per stone or memo basis, was \$1,400, the same as that of 1991. The average value of sapphire imports decreased 30% to \$16.29 per carat. The average annual value of sapphire imports for the past 10 years was \$22.40 per carat, with a high of \$27.97 in 1987 and a low of \$16.29 in 1992.

The average yearend wholesale purchase price of a fine-quality 1-carat emerald, paid by retail jewelers on a per stone or memo basis, was \$2,750, the same as for 1991. The average value of emerald imports increased 72% to \$72.23 per carat. The average annual value of emerald imports for the past 10 years was \$57.30 per carat, with a high of \$78.79 in 1988 and a low of \$35.06 in 1984. *(See tables 6 and 7).*

Foreign Trade

The value of diamond exports plus reexports decreased 5% to \$1.45 billion. The quantity of cut diamonds exported and reexported decreased 10% to 911,419 carats, and the value of diamond exported and reexported decreased slightly to \$1.32 billion.

The value of other precious stones, cut but unset or rough other than diamonds, pearls, and synthetics, exported and reexported increased from \$105.5 million to \$241.2 million. The value of synthetic gemstone exports plus reexports decreased slightly to \$21.2 million.

The value of natural, cultured, and imitation pearls, not set or strung, exports and reexports of pearls increased 62% to more than \$6.7 million.

The value of gems and gemstones imported increased 4% to \$4,839.4 million compared to those of 1991, but was still below the 1989 record high of \$5,115 million. The value of imported gem diamonds accounted for about 86% of the total. The average annual value of gems and gemstones imports for the past 10 years was \$4,272 million, with a high of \$5,115 million in 1989 and a low of \$2,856 million in 1983.

The value of imported gem diamonds increased 4% to \$4,143.6 million, but was below the 1989 record high of \$4,358 million. The imports of cut diamonds increased 15% in quantity and 5% in value to 7.7 million carats and \$3,648.6 million, respectively. The average annual quantity of cut diamonds imported for the past 10 years was 7.3 million carats, with a high of 8.9 million in 1989 and a low of 5.2 million carats in 1983. The average annual value of cut diamond imports was \$3,130.0 million, with a high of \$3,805.5 in 1989 and a low of \$1,982.7 million in 1983.

The value of imports of other gem and gemstones, led by emerald, ruby, and sapphire, was \$668.2 million, a decrease of about 26% compared to that of 1991. Emerald imports increased 29% to \$213.5 million. The average annual value of emerald imports for the past 10 years was \$164.6 million, with a high of \$213.5 million in 1992 and a low of \$134.1 million in 1983.

The value of ruby imports increased 10% to \$77.8 million, but was less than the record-high value for the past 10 years of \$98.4 million in 1990. The average annual value of imports for the past 10 years was \$76.1 million, with a high of \$98.4 in 1990 and a low of \$58.7 in 1987. The value of sapphire imports was \$75.1, a decrease of 8% compared to those of 1991. The average annual value of sapphire imports for the past 10 years was \$82.9 million, with a high of \$100.0 million in 1989 and a low of \$70.8 million in 1985.

The value of imported gem materials other than diamond, emerald, ruby, and sapphire increased 35% to \$327.7 million. The average annual value of imports was \$338.9 million, with a high of \$429.5 in 1988 and a low of \$210.3 in 1990. *(See tables 8, 9, 10, 11, and 12).*

World Review

Diamond sales by De Beers Centenary AG was \$3.4 billion in 1992, a decrease of 13% compared with 1991 sales of \$3.94 billion. Sales during the second half of 1992 were only \$1.63 billion, 12% less than the \$1.84 billion sales for the second half of 1991. A De Beers official stated that the reduction in sales was the result of the world economic conditions. De Beers controls about 80% of the rough, uncut diamonds sold in the world. Sales of colored stones remained strong.

Natural diamond production occurs in Africa, Asia, Australia, and South America. The principal producing localities are as follows: in Africa—Angola, Botswana, Namibia, the Republic of South Africa, and Zaire; in Asia—Russia (northeastern Siberia and in the Yakutia); in Australia; and in South America—Venezuela and Brazil.

Foreign countries in which major gemstone deposits (other than diamond) occur are Afghanistan (beryl, kunzite, ruby, tourmaline); Australia (beryl, opal, sapphire); Brazil (agate, amethyst, beryl, kunzite, ruby, sapphire, tourmaline, topaz); Burma (beryl, jade, ruby, sapphire, topaz); Colombia (beryl, sapphire); Kenya (beryl, garnet, sapphire); Madagascar (beryl, rose quartz, sapphire, tourmaline); Mexico (agate, opal, topaz); Sri Lanka (beryl, ruby, sapphire, topaz); Tanzania (tanzanite, garnet, ruby, sapphire, tourmaline); and Zambia (amethyst, beryl).

Angola.—Odebrecht, a Brazilian company, purchased modular diamond recovery plants from Van Eck & Lurie for use on its diamond projects in Angola. Odebrecht is undertaking projects in Quango Province on behalf of Endiama, the Angolan state mining corporation.

Armenia.—The diamond cutting and polishing factory at Nur Adjen produced about \$60 million of income during the year, despite cutbacks of rough diamonds from Yakutia. The factory worked at full capacity even in the winter because of its priority for electricity and heat. The factory's 1,800 workers are not allowed to drink at lunch (unlike Russian and Ukrainian diamond factory workers), have high moral, and comparatively high salaries; these factors resulted in high-quality production.

Australia.—Argyle's diamond production of 39.0 million carats was a record for the mine. The Argyle partners stated that the installation of a new heavy-media separation circuit in the alluvial plant and the 2-million-ton expansion in the AK-1 treatment plant would increase production and efficiency. The largest gem-quality diamond recovered from the Argyle mine to date, a 41.7-carat elongated octahedron, was discovered in May. The peanut shell-sized diamond has not been evaluated to establish a price. However, it is not as valuable as the highly prized Argyle pink diamonds. Since the start of mining in 1983, more than 265 million carats of diamonds has been recovered from the AK 1 pipe and alluvial operations.

Ashton Mining Ltd. reported that the Australian Diamond Exploration Joint Venture had discovered 20 commercial-sized stones in the Northern Territory. The stones were from work on the Merlin anomaly.

Redfire Resources NL announced it appeared its opal mining would start in early 1993 on their Coocoran opal project in New South Wales 20 kilometers west of Lighting Ridge. Initial company estimations are that the deposit has potential for a bonanza of economic-grade opals from two separate zones.

Centenary International Mining is spending $373,000 to earn a 70% interest in the Lila Springs Claims, a boulder opal deposit in New South Wales. The company plans to raise funds for the purchase of equipment to start recovering opal to quickly establish a cash-flow. Additionally, Centenary has claims that cover about 200 kilometers of strike length along the Giralia Fault. These claims cover a fossil beach sand deposit suspected to contain diamonds.

Canada.—Sudbury Contact Mines announced the discovery of six more microdiamonds from its Diamond Lake property east of Kirkland Lake, Ontario. This brings to 14 the number of diamonds recovered from cores from 3 holes drilled during the winter of 1991-92. Sudbury drilled eight additional targets during the summer. The targets were drilled to an average depth of 150 meters.

Dia Met Minerals announced additional results from the testing of its kimberlite discovery in the Lac De Gras area of the Northwest Territories. The most recent information disclosed the recovery of 101 carats of diamonds from a 160-ton bulk sample from core drilling. About 25% of the diamonds was gem quality, and some of the stones were in the 1- to 3-carat size range.

Thermal Exploration Co. of California acquired a 70% interest in about 390,000 hectares in the Lac de Gras area of the Northwest Territories. The claims are on the same trend as Dia Met Minerals' and BHP-Utah's holdings. Kennecott Canada Ltd. can earn a 70% interest in Thermal's holding by providing 100% of the exploration costs.

Sudbury Contact Mines, which continued to explore in the Kirkland Lake mining district of northern Ontario, they sampled a second kimberlite pipe and commenced drilling late in the year.

Celtic Gold and Claude Resources secured funding to continued exploration of their joint-venture diamond project at Sturgeon Lake in Saskatchewan. Drilling is underway to examine a ring structure.

China.—Everay Jewellery Ltd. opened its sixth diamond cutting factory in Guangdong Province. The new factory is the company's largest in China and has a capacity for 1,000 workers. The factory produced round brilliants of five points and less. Everay's production of finished goods from China is just over 100,000 pieces per month.

Russia.—The Siberian Republic of Sakha (formerly Yakutia), an autonomous republic with the Russian Federation, signed an agreement with De Beers Centenary AG to exclusively market diamonds through the CSO. Under the agreement, the Republic has the right to retain up to 10% of its rough diamonds for cutting or independent sales. Sakha is responsible for 99.8% of the rough diamond production from the Commonwealth of Independent States. Additionally, De Beers agreed to furnish equipment and training to establish a cutting factory in Sakha. Called Polar Star, the plant will cut about 100,000 carats per year and produce jewelry for the domestic market.

Sakha also signed an agreement with Reichbart Arye, an Israeli firm, which will supply diamond cutting equipment, technology, and training. Diamonds will be cut in the town of Barnaul and in Israel. Additionally, Sakha entered into an agreement with Arda Co., a Japanese jewelry firm, for diamond cutting plants in Sakha. Arda plans to cut 50,000 to 100,000 carats per year for sale in Japan, the Republic of Korea, and Taiwan.

Smolensk Gems NV is a venture between Antwerp-based PHP Diamond, Smolensk Cutting Factory, the Antwerp office of Russalmaz, and Almazjuvelierexport in Moscow. The venture will cut Russian rough into fancy cuts, mainly triangles and princess cuts. The finished goods will be sold in Antwerp.

A recent government decree created the Severoalmaz joint stock company to mine the diamond deposits discovered in the 1980's at Lomonosov in the Archangel region. The decree provides for creating a production complex to mine, sort, and cut diamonds and to make diamond instruments. Severoalmaz will include the Russian corporation Almazzoloto, the Finance Ministry, Archangel Regional Administration, and the Arkhangelskgeologiya enterprise. It is expected that foreign firms will join in providing technical and economic expertise, and assistance in construction of the mining and recovery plants.

Sierra Leone.—The National Provisional Ruling Council of Sierra Leone (which overthrew the President in April 1992) rendered invalid all diamond export licenses issued by the former regime. All sales of diamonds after July were by tender.

Sunshine Mining settled a legal dispute with Boulle Group, its former partner, and gained 100% control of the Koidu Kemberlite project, believed to contain reserves of 2.5 million carats of diamonds. Sunshine announced plans for a two phase approach to developing the project. Phase 1 would be an approximate 2-year bulk sampling project to substantiate the reserves. Phase 2 would be the construction of a full-scale mine and recovery plant at a cost of about $37 million. The project is anticipated to have a 15-year life.

South Africa, Republic of.—De Beers Consolidated Mines Ltd. brought its new Venetia Mine to full production late in the year. It is reported that the mine will produce about 5.9 million carats per year. Venetia, located in the northern Transvaal near Messina, is a low-cost, high-grade (137 carats per 100 tons) open pit mine. Production from the mine is reported to be 50% to 60% gem-quality stones. Production from the mine is equal to 70% of the country's total production in 1991.

Agreement was reached between De Beers Consolidated Mines Ltd., its customers, and the Government of South Africa on the method of domestic rough diamond distribution. In the past, rough mined in South Africa was offered to domestic cutters before being exported. Now, all rough will be shipped to London and mixed with diamonds from the other producers. Rough for South African cutters is then drawn from the world rough supply.

Three Canadian partners, Stow Resources, Dryden Resources, and Southerera Resources, commissioned the treatment plant for the Leicester diamond mine near Kimberly. A dozen clear white gem-quality diamonds were recovered during startup, including two that are slightly more than 1 carat and one of about 6.5 carats. Previous production from the mine yielded 32,000 carats, with about 50% gem-quality and about 10% larger than 10 carats.

Tanzania.—De Beers' subsidiary Willcroft Co. Ltd. entered into a prospecting and mining agreement with the Ministry of Water, Energy and Minerals. The agreement is for prospecting and mining rights on an area of more than 22,000 square kilometers in the Mwanza, Shinyanga, and Tabora regions. The Ministry also has signed diamond exploration agreements with Reunion Mining Plc. and RZT.

In May, the Tanzania Mineral Dealers Association and the Ministry of Water, Energy, and Minerals of Tanzania held the first gemstone auction in Arusha. Sixty dealers offered goods for sale at the auction attended by 28 buyers from 9 countries. About $200,000 worth of mostly rough tanzanite, ruby, rhodolite garnet, green garnet, chrome tourmaline, and sapphire were sold.

Uruguay.—It is estimated that annual exports of amethyst are about 80 tons valued at more than $500,000. The amethyst is used as mineral specimens, decorator pieces, and as gemstones.

Uzbekistan.—A deposit of industrial diamonds was opened in Tyan-Shan near Tashkent. The diamonds are up to 2 millimeters in diameter, but the deposit also may contain larger gem diamonds. It does allow the republic to enter the ranks of diamond-producing countries.

Zaire.—The volume and value of diamonds marketed through unofficial channels increased after the mutiny in September 1991. The value of diamonds marketed through these channels was estimated to be more than $200 million in 1991, two to five times greater than before the mutiny. The problem seems to have abated somewhat during 1992.

Zimbabwe.—Australian-based Auridiam Consolidated Ltd. recovered about 5,000 carats of diamonds, including a 17-carat gem-quality stone, from the 3-month pilot plant testwork on its Rive Ranch concession. The concession, near the Limpopo River, in southern Zimbabwe, was acquired in the past year after De Beers Consolidated Mines Ltd. and the Government of Zimbabwe could not come to terms. Based on these encouraging results, Auridiam is planning a 200,000-cubic-meter-per-year production plant that would produce about 500,000 carats per year for 10 to 15 years. The diamonds recovered to date were offered for tender in Antwerp.

Reunion Mining Plc. discovered two kimberlites on its concession near Lake Kariba, 300 kilometers west of Harare. Other anomalies in the same area lead the company to believe a group or cluster of pipes may be present. Reunion has 6 additional concessions for diamond exploration in Zimbabwe.

See table 13 for world diamond production by country. *(See table 13.)*

OUTLOOK

World demand for gem diamond can be expected to rise because of increasing effective personal incomes in the populations of the United States and other industrialized countries. Also, demand will increase because of highly effective promotional efforts. These promotions are changing social customs in many eastern countries, particularly in the use of diamond engagement rings. The changes are resulting in significant growth in the diamond market. Demand for other precious gems will continue to grow as diamonds become more expensive and the popularity and acceptance of colored gemstones increase. Demand for synthetic and simulant gemstones for both personal and industrial consumption is expected to increase. The diversity of sizes, types, uses, and values of gems and gemstones precludes any meaningful forecasting of future demand.

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[1]Nassau, K. Gemstone Enhancement. Butterworth, 1984, pp. 46-60.
[2]Pages 61-78 of work cited in footnote 1.
[3]Pages 25-44 of work cited in footnote 1.
[4]Rapaport Diamond Report. Mar. 6, 1992, Colored Stones Section. V. 15, No 9., p. 26.

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Mineral Industry Surveys, Annual Advance Summary Supplement: Directory of Principal Gem Stone Producers in the United, 1990.

Mineral Industry Surveys, Annual Advance Summary Supplement: Gemstone Production In Arizona, Arkansas, California, Colorado, Idaho, Montana, North Carolina, Oregon, Maine, New Hampshire, South Dakota, Utah, Nevada, and Tennessee.

TABLE 1
DE BEERS' CSO ROUGH DIAMOND PRICE INCREASES, BY PERCENTAGE

Sept. 1949	25.0	Nov. 1967	16.0	Aug. 1973	10.2	Sept. 1982	2.5
Mar. 1951	15.0	Sept. 1968	2.5	Dec. 1974	1.5	Apr. 1983	3.5
Sept. 1952	2.5	July 1969	4.0	Jan. 1976	3.0	Aug. 1986	7.5
Jan. 1954	2.0	Nov. 1971	5.0	Sept. 1976	5.8	Nov. 1986	7.0
Jan. 1957	5.7	Jan. 1972	5.4	Mar. 1977	15.0	Sept. 1987	10.0
May 1960	2.5	Sept. 1972	6.0	Dec. 1977	17.0	Apr. 1988	13.5
Mar. 1963	5.0	Feb. 1973	11.0	Aug. 1978	30.0	Mar. 1989	15.5
Feb. 1964	7.5	Mar. 1973	7.0	Sept. 1979	13.0	Mar. 1990	5.5
Aug. 1966	7.5	May 1973	10.0	Feb. 1980	12.0	Feb.1993	1.5

TABLE 2
DE BEERS' CSO ROUGH DIAMOND SALES AND STOCKS

(Billions of dollars)

Year	Sales	Stocks
1983	1.50	1.85
1984	1.61	1.95
1985	1.80	1.90
1986	2.56	1.85
1987	3.07	2.30
1988	4.17	2.00
1989	4.09	2.47
1990	4.17	2.68
1991	3.93	3.03
1992	3.42	3.36

TABLE 3
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0-2.5	1.0-1.1	Single	1.54	Synthetic or pressed, plastics	Fossil resin, soft.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5-8.0	2.63-2.80	Double	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	do.	Small	Very high	7.5-8.0	2.63-2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald	do.	Green	Medium	do.	7.5	2.63-2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet, doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5-8.0	2.63-2.80	do.	1.58	Genuine emerald	Flaws, brilliant, fluorescence in ultra violet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5-8.0	2.63-2.80	do.	1.58	Citrine, topaz, glass, doublets	
Goshenite	do.	do.	Any	Low	7.5-8.0	2.63-2.80	do.	1.58	Quartz, glass, white sapphire, white topaz	Refractive index.
Morganite	do.	Pink to rose	Any	do.	7.5-8.0	2.63-2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Refractive index.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	Any	Low	3.0	2.72	Double (strong)	1.49-1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	Any	Low	3.0	2.72	do.	1.6	do.	Banded, translucent.

See footnotes at end of table.

TABLE 3—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day, red by artificial light	Former U.S.S.R. (small), Sri Lanka (medium)	High	8.5	3.50-3.84	Double	1.75	Synthetic	Dichroism, inclusions in synthetic sapphire.
Catseye	do.	Greenish to brownish	Small to large	do.	8.5	3.50-3.84	do.	1.75	Synthetic, shell	Gravity and translucence.
Chrysolte	do.	Yellow, green, and/or brown	Medium	Medium	8.5	3.50-3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Coral	Calcium carbonate	Orange, red, white, black, or green	Branching, medium	Low	3.5-4.0	2.6-2.7	do.	1.49-1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95-4.10	do.	1.78	Synthetics, including spinel	Inclusions, fluorescence.
Sapphire	do.	Blue	Medium	High	9.0	3.95-4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, white, orange, green, or violet	Medium to large	Medium	9.0	3.95-4.10	do.	1.78	Synthetics, glass and doublets	Inclusions, double refraction, refractive index.
Sapphire and ruby stars	do.	Red, pink, violet blue, or gray	do.	High to low	9.0	3.95-4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color on side view.
Sapphire or ruby synthetic	do.	Yellow, pink, or blue	Up to 20 carats	Low	9.0	3.95-4.10	do.	1.78	Synthetic spinel, glass	Curved strae, bubble inclusions.

See footnotes at end of table.

TABLE 3—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Diamond	Carbon	White, blue-white, yellow, brown, green, pink, blue	Any	Very high	10.0	3.516-3.525	Single	2.42	Zircon, titania, cubic zirconia	High index, dispersion, single refraction, hardness, cut, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green	Large	Low	6.0-6.5	2.56	—	1.52	Jade	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play	do.	Low	6.0-6.5	2.56	—	1.56	do.	Cleavage, sheen, vitreous to pearly opaque, grid.
Moonstone	do.	White	do.	Low	6.0-6.5	2.77	—	1.52-1.54	Glass or white onyx	Blue sheen, opalescent.
Garnet	Complex silicate	Brown, black, yellow, green, ruby red, or orange	Small to medium	Low to high	6.5-7.5	3.15-4.30	Single strained	1.79-1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Jade:										
Jadeite	do.	Green, yellow, black, white, or mauve	Large	Low to very high	6.5-7.0	3.3-3.5	Cryptocrystalline	1.65-1.68	Onyx, bowenite, vesu vianite, grossularite	Luster, spectrum, translucent, to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0-6.5	2.96-3.10	do.	1.61-1.63	do.	Do.
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5-7.0	3.27-3.37	Double (strong)	1.65-1.69	Tourmaline chrysoberyl	Strong double refraction, low dichroism.
Opal	Hydrous silica	Colors flash in white gray, black, red, or yellow	Large	Low to high	5.5-6.5	1.9-2.3	Isotropic	1.45	Glass, synthetics, triplets	Play of color.

See footnotes at end of table.

TABLE 3—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Pearl	Calcium carbonate	White, pink, or black	Small	do.	2.5-4.0	2.6-2.85	—	—	Cultured and imitation	Luster, structure, X-ray.
Quartz:										
Agate	Silica	Any color	Large	Low	7.0	2.58-2.64	—	—	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65-2.66	Double	1.55	do.	Refractive index, double refraction, transparent.
Cairngorm	do.	Smoky	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Citrine	do.	Yellow	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Crystal, rock	do.	Colorless	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Jasper	do.	Uniform or spotted red, yellow, or green	do.	Low	7.0	2.58-2.66	—	—	do.	Opaque, vitreous.
Onyx	do.	Many colors	do.	Low	7.0	2.58-2.64	—	—	do.	Uniformly banded.
Rose	do.	Pink, rose red	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Refractive index, double refraction, translucent.
Spinel	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5-3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	Any	Up to 40 carats	Low	8.0	3.5-3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.

See footnotes at end of table.

TABLE 3—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Spodumene:										
Kunzite	Lithium aluminum silicate	Pink to lilac	Medium	Medium	6.5-7.0	3.13-3.20	Double	1.66	Amethyst, morganite	Refractive index.
Hiddenite	do.	Yellow to green	do.	do.	6.5-7.0	do.	do.		Synthetic spinel	Do.
Tanzanite	Complex silicate	Blue	Small	High	6.0-7.0	3.30	do.	1.69	Sapphire, synthetics.	Strong trichroism.
Topaz	do.	White, blue, green	Medium	Low to medium	8.0	3.4-3.6	do.	1.62	Beryl, quartz	Refractive index.
Tourmaline	do.	All, including mixed	do.	do.	7.0-7.5	2.98-3.20	do.	1.63	Peridot, beryl, corundum, glass	Double refraction, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green phosphate	Large	Low	6.0	2.60-2.83	do.	1.63	Glass, plastics	Difficult if matrix not present, matrix usually limonitic.
Zircon	Zirconium silicate	White, blue, or brown, yellow, or green	Small to medium	Low to medium	6.0-7.5	4.0-4.8	Double (strong)	1.79-1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

[1]Small—up to 5 carats; medium—up to 50 carats; large—more than 50 carats.
[2]Low—up to $25 per carat; medium—up to $200 per carat; high—more than $200 per carat.

TABLE 4
SYNTHETIC GEMSTONE PRODUCTION METHODS

Gemstone	Production methods	Company	Date of first production
Ruby	Flux	Chatham	1950's
Do.	do.	Kashan	1960's
Do.	do.	Knischka	1980's
Do.	do.	J.O. Crystal (Ramaura)	1980's
Do.	Zone melt	Seiko	1980's
Do.	Melt pulling	Kyocera	1970's
Do.		(Inamori)	
Do.	Verneuil	Various producers	1900's
Star ruby	do.	Linde (Div. of Union Carbide)	1940's
Do.	Melt pulling	Kyocera	1980's
Do.	do.	Nakazumi	1980's
Sapphire	Flux	Chatham	1970's
Do.	Zone melt	Seiko	1980's
Do.	Melt pulling	Kyocera	1980's
Do.	Verneuil	Various producers	1900's
Star sapphire	Verneuil	Linde	1940's
Emerald	Flux	Chatham	1930's
Do.	do.	Gilson	1960's
Do.	do.	Kyocera	1970's
Do.	do.	Seiko	1980's
Do.	do.	Lennix	1980's
Do.	do.	Former U.S.S.R.	1980's
Do.	Hydrothermal	Lechleitner	1960's
Do.	do.	Regency	1980's
Do.	do.	Biron	1980's
Do.	do.	Former U.S.S.R.	1980's
Alexandrite	Flux	Creative crystals	1970's
Do.	Melt pulling	Kyocera	1980's
Do.	Zone melt	Seiko	1980's
Cubic zirconia	Skull melt	Various producers	1970's

TABLE 5
VALUE OF 1992 U.S. GEMSTONE PRODUCTION, BY GEM MATERIALS

Gem materials	Value
Agate	$548,000
Beryl	323,000
Coral (all types)	122,000
Garnet	108,000
Gem feldspar	1,042,000
Geode/nodules	260,000
Fire agate	45,000
Jasper	111,000
Obsidian	4,000
Opal	756,000
Peridot	1,306,000
Petrified wood	211,000
Quartz	638,000
Sapphire/ruby	895,000
Topaz	12,000
Tourmaline	82,000
Turquoise	1,994,000
Total	8,457,000

TABLE 6

PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Price range per carat[3] Jan. 1992-Jan. 1993	Average[4] July 1992
0.25	G	VS1	$1,400- $1,400	$1,400
.25	G	VS2	1,200 - 1,200	1,200
.25	G	SI1	970 - 970	970
.25	H	VS1	1,200 - 1,200	1,200
.25	H	VS2	1,100 - 1,100	1,100
.25	H	SI1	950 - 950	950
.50	G	VS1	2,700 - 2,900	2,900
.50	G	VS2	2,500 - 2,600	2,600
.50	G	SI1	2,300 - 2,300	2,300
.50	H	VS1	2,600 - 2,700	2,700
.50	H	VS2	2,400 - 2,500	2,500
.50	H	SI1	2,100 - 2,200	2,200
.75	G	VS1	3,500 - 3,500	3,500
.75	G	VS2	3,200 - 3,200	3,200
.75	G	SI1	2,800 - 2,800	2,800
.75	H	VS1	3,100 - 3,100	3,100
.75	H	VS2	2,800 - 2,800	2,800
.75	H	SI1	2,600 - 2,600	2,600
1.00	G	VS1	4,600 - 4,600	4,600
1.00	G	VS2	4,100 - 4,100	4,100
1.00	G	SI1	3,700 - 3,700	3,700
1.00	H	VS1	4,100 - 4,100	4,100
1.00	H	VS2	3,800 - 3,900	3,900
1.00	H	SI1	3,400 - 3,600	3,600

[1]Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; G-H-I—traces of color.
[2]Clarity: IF no blemishes; VVS1—very, very slightly included; VS—very slightly included; VS2—very slightly included, but not visible; SI1—slightly included.
[3]Jeweler's Circular-Keystone. V. 164, No. 3, Mar. 1993, p. 148.
[4]Jeweler's Circular-Keystone. V. 163, No. 9, Sept. 1992, p. 118.

TABLE 7

PRICES OF U.S. CUT COLORED GEMSTONES, BY SIZE[1]

Gemstone	Carat weight	Price range per carat in 1992[2]	Average price per carat[2] Jan. 1992	Average price per carat[2] Jan. 1993
Amethyst	1	$8 - $18	$13.00	$13.00
Aquamarine	1	75 - 250	175.00	82.50
Emerald	1	2,500- 3,500	2,750.00	2,750.00
Garnet, tsavorite	1	600 - 900	750.00	750.00
Ruby	1	3,000- 4,800	3,900.00	3,900.00
Sapphire	1	800- 2,000	1,400.00	1,400.00
Tanzanite	1	100 - 240	210.00	130.00
Topaz	1	5 - 12	9.00	7.00
Tourmaline, red	1	60 - 125	92.50	92.50

[1]Fine quality.
[2]Jewelers' Circular-Keystone. V. 164, No. 3, Mar. 1993, p. 148. These figures represent a sampling of net prices that wholesale colored stone dealers in various U.S. cities charged their cash customers during the month for fine-quality stones.

TABLE 8

U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY

Country	1991 Quantity (carats)	1991 Value[1] (millions)	1992 Quantity (carats)	1992 Value[1] (millions)
Exports and reexports:				
Belgium	r2,177,190	r$430.5	2,404,886	$368.6
Canada	r305,702	r32.1	413,285	30.7
France	8,746	23.7	7,455	25.2
Hong Kong	r291,537	r270.4	198,418	312.5
Israel	r364,495	r272.1	335,521	279.0
Japan	r125,260	r196.3	80,953	121.5
Singapore	r20,653	r27.5	24,213	30.9
Switzerland	r116,246	r149.7	52,447	146.4
Thailand	r39,748	r39.7	23,057	17.1
United Kingdom	r20,516	r38.5	16,156	51.7
Other	r240,323	r41.3	393,999	65.8
Total	r3,710,416	r1,521.6	3,950,390	1,449.5

rRevised.
[1]Customs value.
[2]Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census.

TABLE 9

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY

Kind, range, and country of origin	1991 Quantity (carat)	1991 Value[1] (millions)	1992 Quantity (carat)	1992 Value[1] (millions)
Rough or uncut, natural:[2]				
Belgium	455,621	$40.7	402,763	$81.9
Brazil	106,396	9.8	26,867	1.4
Israel	17,097	10.3	26,699	10.7
Netherlands	18,334	9.2	79,564	17.6
South Africa, Republic of	13,787	7.6	13,405	17.6
Switzerland	64,717	18.9	1,156	9.4
United Kingdom	625,965	249.5	685,544	189.1
Venezuela	20,580	0.3	318	0.1
Other	460,339	181.1	392,059	167.1
Total	1,782,836	527.4	1,628,375	495.0
Cut but unset, not more than 0.5 carat:				
Belgium	789,422	280.1	795,348	270.5
Brazil	41,626	17.6	15,414	6.6
Canada	4,419	1.2	6,558	2.1
Hong Kong	132,735	29.0	247,289	44.1
India	3,373,905	825.4	4,249,843	935.2
Israel	727,175	357.9	670,327	313.0
Netherlands	5,612	1.7	3,338	1.1
South Africa, Republic of	16,517	10.0	7,263	6.3
Switzerland	21,237	6.2	11,055	4.6
United Kingdom	1,424	0.7	4,779	1.4
Other	86,601	20.9	80,899	19.2
Total	5,200,673	1,550.7	6,092,113	1,604.2
Cut but unset, more than 0.5 carat:				
Belgium	592,530	793.9	589,036	776.2
Hong Kong	14,196	34.5	14,879	30.8
India	41,316	33.8	30,634	18.0
Israel	783,799	834.4	915,487	973.8
Netherlands	4,491	13.8	3,928	18.9
South Africa, Republic of	5,291	12.2	5,706	22.4
Switzerland	23,766	115.2	10,712	95.1
United Kingdom	9,018	34.8	20,061	35.1
Other	23,553	41.3	41,319	74.3
Total	1,497,960	1,913.9	1,631,762	2,044.5

[1]Customs value.
[2]Includes some natural advanced diamond.
[3]Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census.

TABLE 10

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY

Kind and country	1991 Quantity (carats)	1991 Value[1] (millions)	1992 Quantity (carats)	1992 Value[1] (millions)
Emerald:				
Belgium	10,782	$1.6	4,381	$0.7
Brazil	1,554,717	6.7	125,548	4.5
Colombia	212,818	51.5	403,988	92.4
France	7,456	3.0	3,753	4.1
Germany	19,828	2.2	149,870	4.3
Hong Kong	114,521	13.4	232,025	19.2
India	1,298,384	22.7	1,208,678	16.5
Israel	134,178	21.3	116,586	21.4
Japan	2,946	0.7	125	0.2
South Africa, Republic of	206	0.3	962	0.1
Switzerland	66,283	23.3	164,283	39.6
Taiwan	414	0.1	3,452	0.3
Thailand	483,037	12.6	299,313	6.6
United Kingdom	8,755	0.9	1,957	1.2
Other	24,980	5.1	240,985	2.5
Total[3]	3,939,305	165.5	2,955,906	213.5
Ruby:				
Belgium	8,127	1.3	9,065	1.1
Brazil	11,517	0.5	6,793	0.3
Colombia	145	([2])	70	([2])
France	4,686	0.9	790	0.6
Germany	15,438	1.6	17,677	1.1
Hong Kong	38,030	4.4	99,817	3.8
India	455,938	1.9	375,745	1.7
Israel	10,736	0.8	12,094	1.5
Japan	647	0.1	3	([2])
Switzerland	72,979	16.5	36,221	23.3
Thailand	[r]1,715,520	37.3	2,008,030	39.1
United Kingdom	12,089	3.2	2,401	3.3
Other	32,128	2.4	66,233	2.1
Total[3]	[r]2,377,980	70.9	2,634,939	77.8
Sapphire:				
Australia	3,963	0.3	4,682	0.1
Austria	603	([2])	65	([2])
Belgium	5,044	1.3	6,744	0.7
Brazil	7,932	0.4	23,326	0.2
Canada	8,109	0.4	187,196	0.5
Colombia	111	([2])	82	0.1
France	4,695	1.3	597	1.4
Germany	21,882	0.8	49,194	1.3
Hong Kong	141,486	6.2	113,670	3.8
India	59,588	0.6	71,670	0.5
Israel	10,723	0.8	28,987	1.2
Japan	6,536	0.5	2,159	0.1
Korea, Republic of	1,980	([2])	NA	NA
Singapore	833	0.4	101	([2])

See footnotes at end of table.

TABLE 10—Continued
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY

Kind and country	1991 Quantity (carats)	1991 Value[1] (millions)	1992 Quantity (carats)	1992 Value[1] (millions)
Sapphire—Continued:				
Sri Lanka[4]	54,023	$3.9	85,218	$3.5
Switzerland[4]	21,096	16.2	27,608	13.6
Thailand	3,122,987	46.1	3,991,362	45.5
United Kingdom	15,895	1.4	4,210	1.2
Other	14,062	0.9	13,989	1.4
Total[2]	3,501,548	81.5	4,610,860	75.1
Other:				
Rough, uncut:				
Australia		1.1		2.1
Brazil		35.2		30.2
Colombia		1.4		4.4
Hong Kong		2.0		1.0
Nigeria	NA	0.2	NA	0.2
Pakistan		0.7		0.3
South Africa, Republic of		0.6		0.3
Switzerland		1.0		0.7
United Kingdom		1.2		0.1
Zambia		0.8		1.0
Other		11.8		13.1
Total	NA	56.0	NA	53.5
Cut, set and unset:				
Australia		3.2		3.8
Brazil		9.3		9.0
Canada		0.2		0.4
China		0.8		0.9
Germany		15.2		15.7
Hong Kong	NA	[r]16.6		17.2
India		7.4		6.9
Japan		[r]9.4		9.3
Switzerland		1.1		0.8
Taiwan		2.8		3.1
Thailand		72.3		47.5
United Kingdom		2.1		0.7
Other		[r]14.6		16.0
Total[2]	NA	[r]155.0	NA	131.4

[r]Revised. NA Not available.
[1]Customs value.
[2]Data may not add to totals shown because of independent rounding.
[3]Less than 1/10 unit.
[4]Erroneously omitted in 1991.

Source: Bureau of the Census.

TABLE 11

VALUE OF U.S. IMPORTS OF SYNTHETIC AND IMITATION GEMSTONES, INCLUDING PEARLS, BY COUNTRY

(Million dollars[1])

Country	1991	1992
Synthetic, cut but unset:		
Australia	0.5	1.9
Austria	3.4	6.3
France	1.9	1.4
Germany	[r]8.8	10.3
Hong Kong	1.6	2.9
Japan	.7	1.2
Korea, Republic of	4.9	4.2
Switzerland	2.8	4.6
Taiwan	.5	0.9
Thailand	16.0	23.2
Other	[r]1.8	1.4
Total	[r]42.9	58.2
Imitation:		
Austria	[r]58.6	69.8
Czechoslovakia	[r]4.0	7.0
Germany	1.8	2.8
Japan	1.5	2.3
Other	3.0	2.7
Total	[r]69.0	84.6

[r]Revised.
[1]Customs value.
[2]Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census.

TABLE 12

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES

(Thousand carats and thousand dollars)

Stones	1991 Quantity	1991 Value[1]	1992 Quantity	1992 Value[1]
Diamonds:				
Rough or uncut	1,783	527,424	1,628	495,003
Cut but unset	6,699	3,464,599	7,724	3,648,626
Emeralds: Cut but unset	3,939	165,508	2,956	213,497
Coral and similar materials, unworked	[r]2,554	[r]6,741	2,787	6,115
Rubies and sapphires: Cut but unset	5,880	[r]152,484	7,246	152,886
Pearls:				
Natural	NA	[r]4,645	NA	3,896
Cultured	NA	[r]16,812	NA	18,313
Imitation	NA	[r]2,492	NA	3,710
Other precious and semiprecious stones:				
Rough, uncut	338,300	43,825	408,236	41,446
Cut, set and unset	NA	[r]133,530	NA	109,233
Other	429	[r]5,435	281	5,957
Synthetic:				
Cut but unset	[r]148,203	[r]42,901	217,059	58,189
Other	NA	[r]2,099	NA	1,636
Imitation gemstone	NA	[r]66,507	NA	80,927
Total[2]	XX	[r]4,635,002	XX	4,839,43

[r]Revised. NA Not available. XX Not applicable.
[1]Customs value.
Source: Bureau of the Census.

TABLE 13
DIAMOND: WORLD PRODUCTION, BY TYPE AND COUNTRY[1]

(Thousand carats)

Country	1988 Natural Gem[2]	1988 Natural Industrial	1988 Natural Total[3]	1988 Synthetic[4]	1989 Natural Gem[2]	1989 Natural Industrial	1989 Natural Total[3]	1989 Synthetic[4]	1990 Natural Gem[2]	1990 Natural Industrial	1990 Natural Total[3]	1990 Synthetic[4]
Angola[e]	950	50	1,000	—	1,165	80	[5]1,245	—	[r]1,060	[r]73	[r]1,133	—
Australia	17,413	17,413	34,826	—	17,540	17,540	35,080	—	17,331	17,331	34,662	—
Botswana	10,660	[r]4,570	15,229	—	[r]10,680	[r]4,570	15,252	—	[r]12,150	[r]5,200	17,352	—
Brazil	[r]350	180	[r]530	—	350	150	500	—	600	900	1,500	—
Central African Republic	284	59	343	—	334	81	415	—	303	78	381	—
China[e]	200	800	1,000	15,000	200	800	1,000	15,000	200	800	1,000	15,000
Côte d'Ivoire[6]	8	3	11	—	9	3	12	—	9	3	12	—
Czechoslovakia[e]	—	—	—	5,000	—	—	—	5,000	—	—	—	5,000
France[e]	—	—	—	4,000	—	—	—	4,000	—	—	—	4,000
Gabon[e]	400	100	500	—	400	100	500	—	400	100	500	—
Ghana[7]	55	[r]465	[r]520	—	[r]124	[r]370	[r]494	—	[r]163	[r]487	[r]650	—
Greece[e]	—	—	—	1,000	—	—	—	1,000	—	—	—	1,000
Guinea[7]	136	10	146	—	[r]137	10	[r]147	—	[r]119	[r]8	[r]127	—
Guyana	1	3	4	—	3	5	8	—	[r]5	[r]13	[r]18	—
India	11	3	14	—	3	12	15	—	3	[r, e]15	[r]18	—
Indonesia[e]	7	22	29	—	7	25	32	—	7	23	30	—
Ireland[e]	—	—	—	60,000	—	—	—	60,000	—	—	—	60,000
Japan[e]	—	—	—	25,000	—	—	—	25,000	—	—	—	25,000
Liberia	67	100	167	—	62	93	155	—	40	60	[e]100	—
Namibia	[r]925	[r]50	[r]975	—	910	[r]20	[r]927	—	[r]750	[r]15	[r]763	—
Romania[e]	—	—	—	5,000	—	—	—	4,500	—	—	—	4,500
Russia[e, 9]	—	—	—	—	—	—	—	—	—	—	—	—
Sierra Leone[6]	12	6	18	—	90	39	129	—	66	12	78	—
South Africa, Republic of:												
Finsch Mine	[r]1,320	[r]2,600	3,920	—	[r]1,600	[r]3,000	4,610	—	[r]1,480	[r]2,700	4,178	—
Premier Mine	[r]700	[r]1,540	2,239	—	[r]700	[r]1,520	2,215	—	[r]720	[r]1,600	2,328	—
Venetia Mine	—	—	—	—	—	—	—	—	20	40	62	—
Other De Beers' properties[10]	[r]1,400	[r]520	1,919	—	[r]1,350	[r]530	1,880	—	[r]1,200	[r]460	[r]1,652	—
Other	[r]380	[r]40	426	—	[r]350	[r]50	411	—	[r]380	[r]100	488	—
Total	3,800	4,700	8,504	[e]55,000	4,000	5,100	9,116	[e]60,000	[r]3,800	[r]4,900	8,708	[e]60,000
Swaziland	44	29	73	—	33	22	55	—	25	17	42	—
Sweden[e]	—	—	—	25,000	—	—	—	25,000	—	—	—	25,000
Tanzania	[r]105	[r]45	[r]150	—	[r]105	[r]45	[r, e]150	—	[r]60	[r]25	85	—
U.S.S.R.[e, 9, 11]	[r]11,000	[r]11,000	[r]22,000	41,500	[r]11,500	[r]11,500	[r]23,000	41,500	[r]12,000	[r]12,000	[r]24,000	41,000
United States	—	—	—	W	—	—	—	W	—	—	—	W
Venezuela	54	[r]75	[r]129	—	70	185	255	—	88	245	333	—
Yugoslavia[e, 12]	—	—	—	5,000	—	—	—	5,000	—	—	—	5,000
Zaire	2,724	15,439	18,163	—	2,663	15,092	17,755	—	2,914	16,513	19,427	—
Total	[r]49,206	[r]55,122	[r]104,331	241,500	[r]50,385	[r]55,842	[r]106,242	246,000	[r]52,093	[r]58,818	[r]110,919	245,500

See footnotes at end of table.

TABLE 13—Continued
DIAMOND: WORLD PRODUCTION, BY TYPE AND COUNTRY[1]

(Thousand carats)

Country	1991				1992[p]			
	Natural			Synthetic[4]	Natural			Synthetic[4]
	Gem[2]	Industrial	Total[3]		Gem[2]	Industrial	Total[3]	
Angola[e]	[r]899	[r]62	[r][4]961	—	935	65	1,000	—
Australia	17,978	17,978	35,956	—	21,000	21,000	42,000	—
Botswana	[r]11,550	[r]4,950	[r]16,506	—	10,000	5,000	15,000	—
Brazil	600	900	[e]1,500	—	600	900	1,500	—
Central African Republic	[r]296	[r]82	[r]379	—	296	82	378	—
China[e]	200	800	1,000	15,000	200	800	1,000	15,000
Côte d'Ivoire[6]	11	4	15	—	11	4	15	—
Czechoslovakia[e]	—	—	—	5,000	—	—	—	5,000
France[e]	—	—	—	[e]4,000	—	—	—	4,000
Gabon[e]	400	100	500	—	400	100	500	—
Ghana[7]	[r]175	[r]525	[e]700	—	175	525	700	—
Greece[e]	—	—	—	1,000	—	—	—	750
Guinea[e][7]	[r]91	6	[r]97	—	90	5	95	—
Guyana	[r]7	[r]38	[r][e]45	—	8	42	50	—
India	3	[r]15	[r]18	—	3	15	18	—
Indonesia[e]	8	24	32	—	6	21	27	—
Ireland[e]	—	—	—	60,000	—	—	—	60,000
Japan[e]	—	—	—	30,000	—	—	—	30,000
Liberia	40	60	[e]100	—	60	90	150	—
Namibia	1,170	[r]20	[r]1,187	—	1,500	50	[5]1,549	—
Romania[e]	—	—	—	4,500	—	—	—	4,000
Russia[8][9]	—	—	—	—	9,000	9,000	18,000	60,000
Sierra Leone[5]	[r]160	[r]83	243	—	165	85	250	—
South Africa, Republic of:								
Finsch Mine	[r]1,200	[r]2,280	[r]3,483	—	1,200	2,250	[5]3,446	—
Premier Mine	700	[r]1,550	[r]2,250	—	740	1,700	[5]2,444	—
Venetia Mine	100	200	303	—	660	1,200	[5]1,868	—
Other De Beers' properties[10]	[r]1,500	[r]400	[r]1,897	—	1,350	500	[5]1,849	—
Other	400	[r]100	[r]498	—	450	100	[5]549	—
Total	[r]3,900	[r]4,530	[r]8,431	[e]60,000	4,400	5,750	10,156	60,000

See footnotes at end of table.

TABLE 13—Continued

DIAMOND: WORLD PRODUCTION, BY TYPE AND COUNTRY[1]

(Thousand carats)

Country	1990				1991[e]			
	Natural			Synthetic[4]	Natural			Synthetic[4]
	Gem[2]	Industrial	Total[3]		Gem[2]	Industrial	Total[3]	
Swaziland	r34	r23	r57	—	36	24	60	—
Sweden[e]	—	—	—	25,000	—	—	—	25,000
Tanzania	r70	r30	r100	—	70	30	100	—
U.S.S.R.[e 9 10]	r10,000	r10,000	r20,000	60,000	—	—	—	—
United States	—	—	—	90,000	—	—	—	90,000
Venezuela	r102	r112	r214	—	108	115	223	—
Yugoslavia[e 12]	—	—	—	5,000	—	—	—	5,000
Zaire	3,000	r14,814	r17,814	—	3,000	12,000	15,000	—
Total	r50,694	r55,156	r105,855	359,500	52,063	55,703	107,771	358,750

[e]Estimated. [r]Revised. W Withheld to avoid disclosing company proprietary data.

[1]Table includes data available through May 25, 1993. Total natural diamond output (gem plus industrial) for each country actually is reported, except where indicated by a footnote to be estimated. In contrast, the detailed separate production data for gem diamond and industrial diamond are U.S. Bureau of Mines estimates except Brazil (1988-90), and Central African Republic (1988-90), for which source publications give details on grade as well as totals. The estimated distribution of total output between gem and industrial diamond is conjectural, and for most countries, is based on the best available data at time of publication.

[2]Includes near-gem and cheap-gem qualities.

[3]Natural gem and industrial data may not add to totals shown because of independant rounding.

[4]Includes all synthetic diamond production.

[5]Reported figure.

[6]Figures are estimates based on reported exports and do not include smuggled diamonds.

[7]Figures do not include smuggled artisanal production.

[8]Formerly part of the U.S.S.R.

[9]All production in the U.S.S.R. from 1988-91 came from Russia.

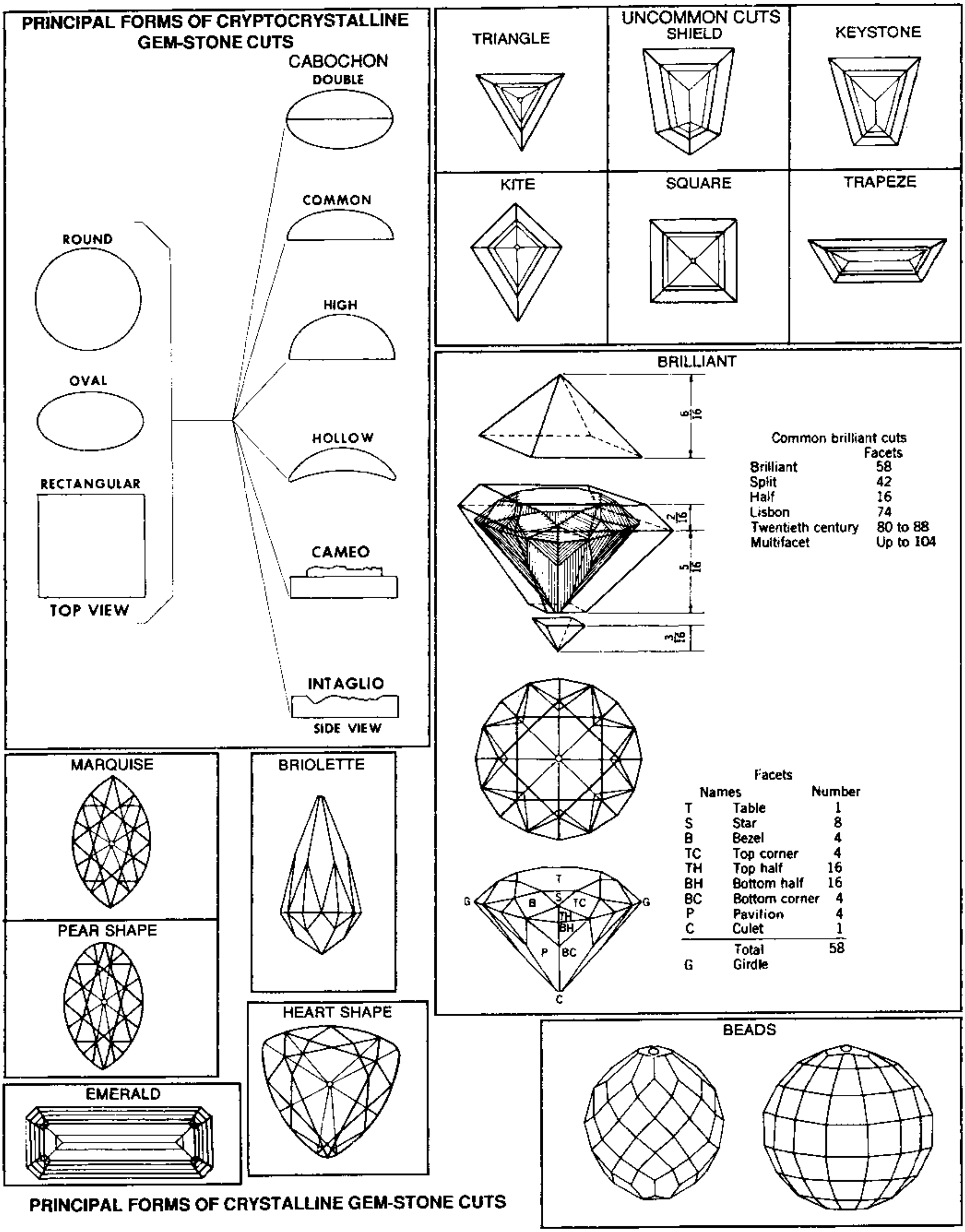
[10]Other De Beers' Group output from the Republic of South Africa includes Kimberley Pool, Koffiefontein Mine, and Namaqualand mines.

[11]Dissolved in Dec. 1991.

[12]Dissolved in Apr. 1992; however, information is inadequate to formulate reliable estimates of individual country production.

FIGURE 1

PRINCIPAL FORMS OF CRYPTOCRYSTALLINE AND CRYSTALLINE GEMSTONE CUTS



GEMSTONES

By Gordon T. Austin

Mr. Austin, a physical scientist with more than 30 years of industry and Government experience, has been the gemstones commodity specialist since 1986. Ms. Kelly Dorney of the Branch of Data Collection and Coordination prepared the domestic production survey data.

Webster's dictionary defines a gem "as any jewel, whether stone, pearl or the like, having value and beauty that are intrinsic and not derived from its setting; a precious or, sometimes, a semiprecious stone cut and polished for ornament. A stone of value because it is carved or engraved, as a cameo or intaglio." Additionally, the dictionary states that gemstone or gem material is a stone or material from which a gem may be cut. So a gem, gemstone, or gem material may be described as inorganic or organic minerals used for personal adornment, display, or to manufacture objects of art because they possess beauty, rarity, and durability.

In 1993, the value of natural gemstones from deposits in the United States was $57.7 million, a decrease of 13% compared with that of 1992. Production of gemstones included faceting rough, lapidary rough, carving material, specimen material, natural and cultured freshwater pearls, mother of pearl, shell, fossil ivory, amber, and coral.

Laboratory grown synthetic gemstones have essentially the same appearance and optical, physical, and chemical properties as the natural material that they represent. Synthetic gemstones produced in the United States include alexandrite, coral, diamond, emerald, garnet, lapis lazuli, quartz, ruby, sapphire, spinel, and turquoise. Laboratory grown simulants have an appearance similar to that of a natural gem material but have different optical, physical, and chemical properties. The gemstone simulants produced in the United States include coral, cubic zirconia, lapis lazuli, malachite, and turquoise. Additionally, certain colors of synthetic sapphire and spinel, used to represent other gemstones, would be classed as simulants. Colored and colorless varieties of cubic zirconia are the major simulants produced. In 1993, the reported value of production of U.S. synthetic and simulant materials was $17.9 million, about a 5% decrease from that of 1992.

Wholesale and retail stores, gem and mineral shops, gem and mineral dealers, cutting factories, and jewelry manufacturers were the major purchasers of domestic gem materials.

DOMESTIC DATA COVERAGE

The U.S. Bureau of Mines (USBM) estimates U.S. production from the "Natural and Synthetic Gem Material Survey," a voluntary survey of U.S. operations, and from USBM estimates of unreported production. Of the 387 operations surveyed, 84% responded, 84% of the natural gemstone producers and 95% of the synthetic and simulant producers.

The number of operations surveyed in 1993 was 3% less than the number surveyed in 1992. The response rate was about the same. The USBM estimated the production by nonresponding operations, by professional collectors, and by amateur or hobbyist collectors. The basis for these estimates was information from published data, conversations with gem and mineral dealers, analyses of gem and mineral shows and sales statistics, and from information informally supplied by collectors.

BACKGROUND

The history of production and preparation of gemstones begins with the wearing of items for personal adornment in prehistoric times; this preceded even the wearing of clothes. Amber was mined in the Baltic countries for use as a gem material before 25000 B.C. Later, the Phoenicians in their writings described their trade routes to the Baltic for amber and to areas in Asia and Africa for other gemstones. The voyages of Columbus brought increased interest in gemstone deposits, especially emerald, in South America. The discovery of diamond in Africa in 1859 focused major interest on Africa. More recently, the discovery of diamond in Western Australia in 1967 resulted in the development of the largest known diamond deposit in the world.

Commercial mining of gemstones is extensive in the United States but not as large-scale operations. More than 60 different gemstones have been produced commercially from small domestic sources. Often, production rests in the hands of hobbyists and members of mineralogical and lapidary clubs. The Crater of Diamonds State Park near Murfreesboro, AR, is open to the public on a fee-per-day basis, as are many gemstone deposits throughout the United States. Each year many gem-quality stones are found at these locations.

Definitions, Grades, and Specifications

The gemstones data include information on select rocks, certain varieties of mineral specimens, and some organic materials, such as pearl, amber, jet, and coral. Customarily, diamond, ruby, sapphire, and emerald are the major gems.

The most important qualities of gemstones are beauty, durability, uniqueness, and rarity. Beauty, indicated as splendor, purity, or attractiveness, is according to the taste of the beholder and includes such appearances as luster, transparency, brilliance, and color. Luster of a mineral or stone is independent of color and is the surface appearance in reflected light. Apart from materials that have a metallic luster, the chief contributors to luster are transparency and refractive index. In cut gems, the perfection of the polish enhances the luster. Visible imperfections impair the luster of transparent stones. Yet, defects, described as "jardens" or "inclusions," may enhance the beauty and value of natural rubies, emeralds, and other gemstones. Sometimes these inclusions may be used to identify the country and even the mine from which the stone came. Durability is the resistance of a stone to abrasion, pitting, chipping, or splitting. Resistance to abrasion is correlated with relative hardness, but intrinsic brittleness and toughness suggest resistance to wear in other aspects. Rarity is an essential qualification and is more important for some stones in determining their value than their physical characteristics.

Of the approximate 2,900 mineral species, only about 100 possess all the attributes required of a gem. Collectors of gems may not require that a gem be durable because the stone is for display and is not to be worn. Therefore, the number of species of gemstones may be greater than the 100 that meet all the requirements.

Silicates furnish the greatest number, including such minerals as beryl, topaz, tourmaline, and feldspar. Oxides such as corundum (ruby and sapphire) and quartz (amethyst, agate, etc.) comprise the second largest group. Sulfides, carbonates, and sulfates are of small importance; the phosphates yield primarily turquoise and variscite. An exception is pearl, essentially calcium carbonate, which ranks high as a gem. Diamond, the best known gem, is an isometric crystalline form of the element carbon.

Gemstones are classified the same as minerals; that is, into group, species, and variety. Group refers to two or more gem materials that are similar in crystal structure and physical properties but have different chemical properties. Each member of the group is a species. Varieties of species have similar crystal structure and chemical characteristics but differ in color. An example of this would be the hessonite variety of grossular species of the garnet group.

Products for Trade and Industry

Cutting of gems from gemstones is to obtain the most effective display of the material. No significant change is made in the fundamental properties, and the preparation is to enhance the desirable characteristics that are present initially. Gemstones are cut into gems in three main styles: faceted, cabochons, and baroque.

Facet cutting usually is on transparent gemstones to increase brilliancy and appearance. Often it is confined to the harder materials. Softer materials may be faceted, but extreme care must be exercised in cutting and polishing the stones and in their use in jewelry. Often the softer gems are only for display and not for making jewelry. The "round brilliant" cut, most commonly used in faceting, has 58 facets, 33 above the circle "girdle" and 25 below it, arranged in eightfold symmetry. The "round brilliant" and other common cuts are illustrated in figure 1. *(See figure 1.)*

Cabochons are cut in four operations: sawing, grinding, sanding, and polishing. Sawing, the first step in cutting, customarily is done with a diamond saw to obtain a slab or slice of the desired size and thickness from the rough gemstone. The cabochon outline is scribed onto a flat surface, using a template for making a standard size for jewelry mountings. Rough grinding of the stone may be by metal-bond diamond, electroplated diamond, silicon carbide, or aluminum oxide wheels or coated abrasive disks. In grinding, the hardness of the gemstone determines the grit and hardness of the abrasive used. Multiple grinding steps starting with 80- to 100-mesh (grit) through 600-mesh abrasives are used. The scratches left by grinding are removed by progressively finer grinding and sanding. Disk or belt sanders use abrasives bonded to cloth, waterproof reinforced paper abrasives, or cloth charged with abrasive pastes. The final polish is on hard felt, wood, or leather laps, with various polishing agents such as fine diamond compound, tin oxide, tripoli, chromium oxide, cerium oxide, alumina, or rouge.

Polished irregular shapes are baroque gems. An inexpensive method of polishing baroque gems is to tumble them in rubber-lined drums, using a grinding and polishing medium with or without water.

Industry Structure

The Central Sales Organization (CSO), the marketing arm of De Beers Centenary AG, highly controls the world market for rough diamonds. It is by far the most controlled of the world's commodity markets. The CSO markets about 80% of the world's gem and natural industrial diamond. The marketing through the CSO is by the Diamond Trading Co. Ltd. and Industrial Distributors Ltd. The CSO sells uncut gem diamonds for De Beers and most other major producers at sights (approved bidder viewings) in London, England, and Lucerne, Switzerland. There are 10 such sights each year.

Diamonds reach the CSO sights through three channels—De Beers owned and operated mines, contracts sales by mine owner and operators, and open-market competitive sales.

The distribution of rough diamonds in the Republic of South Africa is by the South Africa Diamond Board. A new agreement was reached between De Beers Consolidated Mines Ltd., its customers, and the Government of South Africa on the method of domestic rough diamond distribution. In the past, all categories of rough diamonds that could be processed economically in South Africa must first be offered to local manufacturers. Rough could be exported duty free only if it had first been offered to the local market, otherwise a 15% duty was charged. Now, all rough will be shipped to London and mixed with diamonds from the other producers. Rough for South African cutters is then drawn from the world rough supply.

The CSO has been extremely successful at maintaining the rough diamond market for more than 50 years. In modern times there has never been a decrease in CSO's price of rough diamonds. *(See tables 1 and 2.)* The compounded effect over 44 years of these increases is a price increase of about 1,800%. Thus, a piece of rough that sold for $100 in August 1949 would sell for about $1,830 in February 1993.

For more than 30 years, the major diamond cutting and polishing centers of the world were in Belgium and Israel, with a certain amount of the larger stones being cut in the United States. In the early 1980's, the development of a large cottage industry in India—today there are more than 500,000 cutters—made a major impact on world diamond trade. India consumes most of the world's small-gem, cheap-gem, and near-gem rough material in the manufacture of small stones, which resulted in annual cut-stone exports worth billions of dollars. These small stones averaged less than one-fifth of a carat (0.20 carat). The availability of small inexpensive stones resulted in substantial changes in the design of jewelry. The utilization of small cut diamond stones (usually 0.07 to 0.14 carats each, called melee) to create a pavé effect (set close together to conceal the metal base) is but one example.

Estimates are that Russia's diamond cutting industry employs about 16,000 workers. The eight Krystall factories at Moscow, Smolensk, Kiev, Barnaul, Vinnitsa, Yerevan, Kusa, and Gomel employ fewer than 8,000, with the Moscow plant having about 900 workers. The workers at the various factories may be paid by different methods.

The workers at the Moscow plant are paid by the piece according to its size and difficulty of the cut. At Kiev, those workers whose work is not subject to inspection receive a 50% higher salary. Some Krystall factories have an incentive program for workers producing stones of 0.3 carat and larger. The incentive is a bonus of 5% of the added value that is paid to each 20-worker team and is shared by the team.

The diamond cutting and polishing factory at Nur Adjen, Armenia, produced about $60 million of income per year. The factory works at full capacity even in the winter because of its priority for electricity and heat. The factory's 1,800 workers are not allowed to drink at lunch (unlike Russian and Ukrainian diamond factory workers), have high morale, and comparatively high salaries; these factors resulted in high-quality production.

Annual cut diamond production depends on the number of workers in the industry and their productivity. If it is assumed that the industry has a production rate of 20 carats of finished goods per month per worker and that polished yields are less than 40%, then the industry's consumption of rough and yield of finished goods can be estimated. It is estimated that during a year, the Russian diamond cutting industry processes about 3.8 million carats of rough that yields about 1.6 million carats of polished goods. The polished goods would be worth between $500 million and $550 million on the world market.

During 1991, Leo and Schachter & Co. opened the newest, largest, and most modern U.S. diamond polishing factory in New York. The factory is computerized to track every diamond from rough to finished stone. The computer predicts the cash return from each piece of rough based on estimates of the rough's color, clarity, yield, and make; estimates are reported to be within 2% of actuals. The factory employs 40 polishers.

Cutting and polishing of colored, synthetic, and simulant gemstones are centered in, listed according to importance, Thailand, India, Hong Kong, Republic of Korea, China, and Brazil, where cheap labor and favorable export laws ensure the lowest total costs for finished gems.

Geology-Resources

Gemstones form in a large variety of igneous, metamorphic, and sedimentary deposits, usually as a small fraction of the total deposit. The origins are as varied as the deposits. Gemstones form primarily by precipitation from watery solutions, by crystallization from molten rock, and by metamorphic processes. Approximately one-third of gemstones is silicate minerals, about one-fifth alumina-silicates, and almost one-seventh oxides. The remaining compositional groups include the sulfides, phosphates, borosilicates, carbonates, and, in the single case of diamond, an element. The composition of selected gem materials is one line item in table 3. *(See table 3.)*

There are no large resources of major gem materials defined in the United States. North Carolina has emerald, ruby, and sapphire deposits. Historically, sapphires have been mined in Montana, and commercial mining is underway again. Many other domestic deposits of gemstones are known and have been mined for many years. Still, there are no systematic evaluations of the magnitude of these deposits, and no statements can be made about their reserve or the size of the resource.

Occasional finds of diamond have been made, but no great diamond pipes or alluvial deposits similar to those of Africa have been reported. Diamond exploration is underway by several companies in the Colorado-Wyoming State line area, and in Michigan, Minnesota, Wisconsin, and Arkansas. Diamond-bearing kimberlites have been located and bulk samples have been processed for diamond recovery.

World resources of gemstones are nearly all unevaluated. However, world gem diamond reserves are estimated to be about 300 million carats, including near-gem and cheap-gem qualities. Nearly all the reserves are in, listed in order of size, Australia, Africa and Russia. The estimates for diamond reserves are of limited value because data needed for reliable estimates are not available from the producers. Reserve data on other gemstones are even less available than for diamond.

Technology

Synthetic Gems.—Synthetic gemstone producers use many different methods, but they can be grouped into one of three types of processes: melt growth, solution growth, or extremely high-temperature, high-pressure growth.

The year 1902 saw the first production of synthetic ruby using the Verneuil flame-fusion process. Later, sapphire, spinel, rutile, and strontium titanate were grown with this technique. In this process, a single crystal, called a boule, forms in the flame of a simple, downward-impinging oxygen-hydrogen blowtorch. Pure oxides of aluminum (in the cases of ruby, sapphire, and spinel) or titanium (rutile and strontium titanate) are poured into the top of a small furnace and melted. Other oxides are added as needed for process control and to obtain the specific color desired. The melted material solidifies as a boule on a rotating fire-clay peg as the peg is slowly withdrawn.

A boule has a very characteristic shape, with a rounded end, a long, cylindrical body, and a tapering end. It is usually about 13 to 25 millimeters in diameter, 50 to 100 millimeters long, and weighs 75 to 250 carats (a carat is 200 milligrams). Under controlled conditions, a boule about 5 millimeters in diameter and more than 890 millimeters long can be produced for the manufacturing of jewel bearings.

Another melt technique is the Bridgman-Stockbarge solidification method, named for an American, P.W. Bridgman, and a German, D.C. Stockbarge, who, aided by three Russians, J. Obreimov, G. Tammann, and L. Shubnikov, discovered and perfected the process between 1924 and 1936. Currently, the method is used primarily for growing nongem halide, sulfide, and various metallic oxide crystals, one of the metallic oxides being aluminum oxide or sapphire.

The Bridgman-Stockbarge process uses a specially shaped crucible, which is a cylindrical tube open at one end and capped at the other by a small, pointed cone. The crucible is filled with the powdered chemicals necessary to grow a specific crystal and is lowered slowly through a furnace. The small, pointed end of the cone cools first because it is the first part of the crucible that moves from the hottest part of the furnace into cooler regions and it is the first part to emerge from the furnace. As the crucible cools, the molten materials solidify, hopefully in a single crystal, in the point of the crucible. The crystal then acts as a seed around which the remainder of the molten material solidifies until the entire melt has frozen, filling the container with a single crystal.

This process is simple, and crystals of various sizes can be grown. The crystals are typically about 51 millimeters in diameter and 15 millimeters in length, but large ones exceeding 890 millimeters in diameter and weighing more than 1 metric ton have been grown. The crystals have the same shape as the crucible.

The Czochralshi pulled-growth method is used for ruby, sapphire, spinel, yttrium-aluminum-garnet (YAG), gadolinium-gallium-garnet (GGG), and alexandrite. Czochralshi developed his method about 1917 while working with crystals of metallic nutrients.

In the Czochralshi method, ingredient powders—nutrients—are melted in a platinum, iridium, graphite, or ceramic crucible. A seed crystal is attached to one end of a rotating rod, the rod is lowered into the crucible until the seed just touches the melt, and then the rod is slowly withdrawn. The crystal grows as the seed pulls materials from the melt, and the material cools and solidifies. Yet, because of surface tension of the melt, the growing crystal stays in contact with the molten material and continues to grow until the melt is depleted.

Typically, the seed is pulled from the melt at a rate of 1 to 100 millimeters per hour. Crystals grown using this method can be very large, more than 51 millimeters in diameter and 1 meter in length, and of very high purity. Each year this method grows millions of carats of crystals for use as gems, laser rods, windows for special scientific or technical applications, and for other industrial applications.

Certain gemstones pose unique problems when attempting to grow them. The problems arise because certain materials are either so reactive that they cannot be melted even in unreactive platinum and iridium crucibles or they melt at higher temperatures than the crucible materials can endure. Therefore, another melting system must be used, called the skull melting system. Cubic zirconia, because of its high melting point (2,700 ° C) must be grown using the skull melting method.

The "skull" is a hollow-walled copper cup. Water is circulated through the hollow walls to cool the inside wall of the skull. The cup is filled with powdered ingredients and heated by radio frequency induction until the powders melt. Because the water cools the walls of the skull, the powdered materials next to the walls do not melt, and the molten material is contained within a shell of unmelted material. Therefore, the reactive or high-temperature melt is contained within itself. When the heat source is removed and the system is allowed to cool, crystals form by nucleation and grow until the entire melt solidifies. Crystals grown using this system vary in size, depending on the number of nucleations. In growing cubic zirconia, a single skull yields about 1 kilogram of material per cycle.

Solution techniques for making synthetic gems include flux methods for emerald, ruby, sapphire, spinel, YAG, GGG, and alexandrite. The other solution method is the hydrothermal method, often used for growing beryl (emerald, aquamarine, and morganite) and quartz.

Quartz crystals are grown in a hydrothermal solution in large pressure vessels known as autoclaves. Careful control of temperature and pressure in the different areas of the autoclave result in the feed material, known as lascas, dissolving in the hotter portion. The material redeposits on seed crystals, located in the cooler portion, forming synthetic quartz crystals. The process usually takes 30 to 60 days for the crystals to reach the desired size. The process can produce rock crystal, amethyst, or citrine.

The same system is used to grow beryl crystals. Beryl seed crystals are suspended in the cooler upper portion of an autoclave. Nutrient materials dissolve in the hotter, lower portion of the autoclave and, because of the temperature and pressure gradients, migrate to the cooler seeds and are deposited.

Other techniques involve solid- or liquid-state reactions and phase transformations for jade and lapis lazuli; vapor phase deposition for ruby and sapphire; ceramics for turquoise, lapis lazuli, and coral; and others for opal, glass, and plastics.

The Verneuil, Czochralshi, and scull melting processes are the melt techniques most often used for gem materials. *(See table 4.)*

Enhancement of Gemstones.—Enhancement of gemstones through chemical and physical means has become much more commonplace in the past few years and includes a wider variety of materials. Irradiation by electromagnetic spectrum (X-rays, gamma rays, etc.) and by energetic particles (neutrons, electrons, alphas, etc.) is used to enhance or change the color of diamonds, topaz, tourmaline, quartz, beryl, sapphire, zircon, scapolite, and pearls. Nearly all blue topaz is irradiated, but this does not imply that these gem materials are irradiated regularly.[1]

Many gemstones can be enhanced by chemical treatment or impregnations. The treatments may alter the bulk of the gem material or only penetrate the surface. This includes bleaching, oiling, waxing, plastic impregnations, color impregnations, and dyeing. The treatments that alter only the surface of the material include surface coatings of various types, interference filters, foil backings, surface decoration, and inscribing. Chemical treatment is more widespread than just the common dyeing of quartz, treatment of turquoise, and oiling of emeralds. Chemical treatment and impregnations have been used to enhance amber, beryl, chalcedony, coral, diamonds, emerald, ivory, jade, lapis lazuli, opal, pearl, quartz, ruby, sapphire, tiger's eye, and turquoise.[2]

In recent years the bleaching and impregnating of jadeite jade have become much more common. Investigators at gem laboratories estimate that as much as 90% of the jadeite sold in Taiwan is bleached; this includes both high- and low-quality material. The treatment is a two-step process where the jadeite is first chemically bleached using hydrochloric acid, nitric acid, or sodium compounds. The bleaching can take several hours to several weeks. The jadeite is then impregnated with a polymer, wax, or resin.[3]

Since about 1987, fractures, cleavages, and other void-type imperfections that reach the surface in diamonds have been filled using a process developed by Mr. Zvi Yehuda, of Ramat Gan, Israel. This treatment can enhance that apparent clarity of treated faceted diamonds; examples are available that show SI stones enhanced to VS and I_1 improved to SI_2. Yehuda also had developed a similar treatment for emeralds.

The oldest and most common method of gemstone enhancement is heat treating. Heat treatment of gem materials was used in Greece and Rome well before the Christian Era. Heat treatment can cause color change, structural change, and improve clarity. In the past, heat treatment was common for quartz and gem corundum. Today, materials that are heat treated to enhance their appearance include amber, beryl, diamond, quartz, ruby, sapphire, topaz, tourmaline, zircon, and zoisite.[4]

An additional type of treatment for sapphire and ruby is diffusion treatment, a chemical-heat treatment. In this process a thin layer of color is diffused into the surface of the gem. The color may be diffused as little as 0.1 millimeter or as much as 0.4 millimeter into the gem. The treatment is a long process of heat treatment in a bath of chemicals containing the proper proportions of titanium and iron. The American Gem Trade Association (AGTA) adopted a policy for the disclosure of diffusion treated gems. The policy is "If the color of a gemstone is confined to an area near the surface so that the color of the stone would be visibly affected by recutting or repolishing then the following statement must also appear: Although the color induced in the diffusion treated gems is permanent, it remains confined to a shallow surface layer." Therefore, recutting or repolishing is not recommended.[5]

Exploration.—Gemstone exploration should be undertaken in much the same manner as any other mineral exploration program. Historically, this has not been the case, except for diamond exploration. Exploration for diamonds starts with an area analysis to determine favorable geologic settings. The analysis is followed by on-the-ground regional reconnaissance and mapping. Airborne geophysical surveys may be completed before or after the regional reconnaissance work. Followup geologic work on the ground is used to determine the presence of kimberlite or lamproite host rock. If a host rock is present, then drilling and sampling determine if diamonds are present and in what quantity and quality.

Historically, most gemstone deposits have been found by following float material to the source or by alluvial sample collected while searching for some other mineral, usually gold. One of the largest Maine tourmaline deposits was found when tourmaline crystal were found in the roots of an overturned tree. In the future, gemstone exploration will be conducted in a more businesslike and scientific manner. Successful exploration for gemstone deposits begins with the selection of target areas based on the presence of known favorable host rocks. Geologic studies and maps, topographic maps, and aerial photographs are used to identify favorable metamorphic, igneous, alluvial, or eolian geological formations.

The second step is field examination of the selected targets. This may include geologic mapping and limited sampling, but in many cases reconnaissance studies are sufficient. The next step, if warranted, is to sample the deposit in detail to measure the physical parameters of the deposit, specifically its grade and size.

The method of sampling used depends upon the type of deposit. Hard-rock deposits, igneous or metamorphic, are sampled differently than alluvial or eolian deposits.

Hard-rock deposits can be either diamond core drilled or trenched. Trenches should be oriented perpendicular to the strike of the formation and can be dug by hand, with a dozer, or with a backhoe.

Placer deposits can be sampled by drilling, trenching, or by excavating pits or shafts. The physical nature of the deposit; its thickness, hardness, and grain size; and whether it is above or below the water table influence the method of sampling chosen. For shallow deposits, hand augers or power augers can be used to drill sample holes. In deposits that are too hard to hand auger because of the presence of clay, iron oxide cement, or mild calcium carbonate cement, two-person motor-driven augers or vehicle-mounted augers (such as post hole diggers or telephone pole hole diggers) work well. However, augering does not always provide uncontaminated samples and is not effective below the water table.

Truck-mounted water-jet drills and rotary hammer drills are used to test thick deposits and deposits that are too hard to drill with other methods. A water-jet drill uses flush-jointed drill pipe with perforations near the bit to direct jets of water forward and downward from the bit. A hammer advances the drill bit and casing at the same time. Water from the jets flushes out the hole and returns cuttings to the surface in the annulus between the drill pipe and casing. Also, truck-mounted rotary drills equipped with double-pipe drill string and downhole hydraulic hammers can be used. Compressed air is forced down the inner pipe and returns samples to the surface in the annulus between the inner pipe and outer casing. Bits are selected depending on the type of material to be drilled.

Trenching can be carried out using either a dozer or a backhoe, depending on the size and depth of the deposit. In unconsolidated sediments it is difficult to maintain the stability of the walls of trenches, and samples can be contaminated by material sloughing from above. Bulk samples can be collected from 1-cubic-meter pits or shafts. However, again, wall stability can be a problem unless some form of shoring is used.

Mining.—Gemstone mining operations can range from the most primitive to the most sophisticated. In hard rock, at shallow depths, an operation by one, two, or three persons may be mined by prybar, pick, shovel, and buckets or baskets for carrying material; drilling and blasting may be employed. A larger operation includes drilling, blasting, and minimum timbering. Mechanized hauling and hoisting is done only at the larger mines.

Diamond mining in the kimberlite pipes of Africa and Russia and the lamproite pipes of Australia represent the ultimate in that huge quantities of ore must be mined to extract small quantities of diamond (as few as 20 to 30 carats per 100 tons of ore) produced at as low a cost as possible.

Placer mining for gemstones ranges from small-scale, simple procedures to huge, complicated operations. In some areas, digging is by hand, and sorting and recovery is by panning, screening, or sluicing. Diamond miners in the larger placer operations use bucket dredges and heavy-duty excavating equipment, as, for example, in Australia, Brazil, Namibia, the Republic of South Africa, and Russia.

Processing.—Most gemstone ores are broken or crushed where necessary and concentrated by various combinations of hand picking, washing, screening, or jigging. In large-scale operations, mineral beneficiation methods are mechanized and employ the latest technology in each step from primary crushing and screening to the final recovery processes. Diamond recovery, in particular, makes use of standard gravity methods, grease belts, electrostatic separation, skin-flotation, magnetic separation, separation by X-ray luminescence, and separation by optical sorting.

ANNUAL REVIEW

Production

In 1993, all 50 States produced at least $1,000 worth of gem materials. Ten States accounted for 93% of the total value of production of natural gemstones. The States, in order of declining value of production, were Tennessee, Maine, Arizona, Arkansas, Alabama, Kentucky, Oregon, Utah, California, and Nevada. These States accounted for about 93% of the total value of U.S. production of natural gemstones. Certain States were known best for the production of a single gem material (i.e., Tennessee for freshwater pearls and Arkansas for quartz). Other States produced a variety of gemstones. Tennessee, Arkansas, Alabama, and Kentucky, in declining order of value of production, were the major producers of freshwater mussel shell and pearl. Arizona produced the greatest variety. Production included agate, amethyst, antlerite, azurite, chrysocolla, fire agate, garnets, jade, malachite, obsidian, onyx, peridot, petrified wood, precious opal, shattuchite, smithsonite, and turquoise. California, Idaho, Montana, and North Carolina also produced a variety of gemstones. Historically, North Carolina is the only State to have produced all four of the major gems: diamond, emerald, ruby, and sapphire.

The reported value of synthetic and simulant gemstone production was $17.9 million in 1993, a decrease of 5% over that of 1992. Fourteen firms, four in California; four in Arizona; and one each in Massachusetts, Michigan, New Jersey, North Carolina, Ohio, and Washington, produced synthetic and simulant gem material. Production during 1993 included the manufacture of amethyst, azurite/malachite, cubic zirconia, emerald, lapis, ruby, sapphire, and turquoise. The materials were made by

10 plants operating in 8 States. The States, in descending order of value of production, were California, Massachusetts, New Jersey, Washington, Arizona, Michigan, New Mexico, and Ohio.

Arizona is known for its variety of gemstones that include agate, amethyst, antlerite, azurite, chrysocolla, fire agate, fluorite, garnet, jade, jasper, malachite, obsidian (Apache tears), onyx, peridot, petrified wood, precious opal, shattuchite, smithsonite, and turquoise. Yet, turquoise, peridot, petrified wood, and azurite-malachite accounted for more than 90% of the total value of gem material produced. Arizona was the largest domestic producer of azurite, fire agate, peridot, petrified wood, and turquoise. Also, it is estimated that Arizona was the world's largest producer of peridot, turquoise, and petrified wood and a significant producer of pyrope garnet. Many gem and mineral dealers believe that the value of mineral specimens produced from Arizona deposits is equal to, if not greater than, the value of gemstone produced. The USBM does not survey the production of mineral specimens, but its gemstones survey does capture data on that portion of the mineral specimens that are gemstones. The mineral specimen information collected is for gemstones that are used as specimen, because the value of the specimen is in the total value of production of the individual gemstone. This is particularly true for the production of Arizona's petrified wood. Additionally, four manufacturers of synthetic or simulant gem materials in Arizona produced about $0.3 million worth of material.

Arkansas continued to be the State with the greatest value of quartz production. At least four firms produced significant amounts of gem and specimen rock crystal from deposits in the areas around Hot Springs, Mt. Ida, and Jessieville. As stated earlier, the rivers, lakes, and reservoirs of Arkansas continued as the second largest source of U.S. freshwater mussel shell and pearl. Arkansas also produces several different mineral specimens other than rock crystals, but only the rock crystal specimen production is in the gemstone production numbers.

During 1993 at Crater of Diamonds State Park, Murfreesboro, AR, visitors reported finding 800 diamonds that totaled 144.44 carats. Crater of Diamonds State Park is the only location in the United States to have reported sustained production of diamonds for any appreciable length of time. Diamonds are found by visitors to the State park who pay a daily fee to hunt for diamonds using only handtools. It is possible that 1993 could be the last year that Arkansas has the only operating diamond mine. Mining tests were underway during late 1993 and early 1994 on two diamond properties in the Colorado-Wyoming Stateline Mining District. Since 1972, hobbyists have found from 300 to 1,500 diamonds per year at the Crater of Diamonds State Park. From 1906 to the present, it is estimated that production from the deposit is 100,000 to 150,000 carats; this amount of diamond production is insufficient to classify the United States as a diamond-producing country. Still, the potential to become a diamond producer may be there, and efforts were underway to evaluate this potential more fully.

Gemstone production from California includes a variety of materials almost a large as Arizona's. Tourmaline production from the State is significant, and California has the only producer of benitoite. Additionally, deposits in the State produce agate, alabaster, beryl, dumortierite, fire agate, garnet, gem feldspar, jade, jasper, kunzite, lepidolite, obsidian, quartz, rhodonite, topaz, and turquoise. Yet, even with this long list of gemstones, most people think of California in terms of its State gem benitoite, its high-quality tourmalines, and its fine orange spessartine garnets.

The State also has a freshwater culture pearl farm at Marysville, but it did not harvest shell or pearls during 1993. The farm uses animals imported from Tennessee and other southeastern States. Production includes pearls, shell, and finished nucleus for cultured pearl implants.

California also has four manufacturers of synthetic or simulant gemstones. The value of production from the State is the largest of any State for synthetics and simulants.

Colorado is not known as a gemstone-producing State, but it does hold some gemstone honors. It has the only commercially mined deposit of lapis lazuli in the United States and one of the few fee-for-dig topaz deposits currently operating. Additionally, the State was the first to produce turquoise commercially, and it still has commercial turquoise mines. It also produced the United States' finest gem-quality rhodochrosite and a quantity of high-quality rhodonite.

During 1993, two diamond deposits in the Colorado-Wyoming State Line diamond district were tested by bulk sampling. Reports in the International California Mining Journal, February 1994, issue indicated that the Kelsey Lake project of Colorado Diamond Corp., project manager for Redaurum Red Lake Mines Ltd., collected several bulk samples from the alluvial deposits associated with the Kelsey Lake kimberlites. A 6.2-carat, gem-quality diamond was recovered from one sample and a 1.1-carat stone from another. To date, sampling of the Kelsey Lake projects has yielded 268 stones larger than 2 millimeters, of which 60% was gem quality and 25% was more than 1 carat. Plans have been completed and activities are underway for a 100,000-ton test mining program. On May 31, 1994, the Denver Post reported the underground mining test by Royal Star Resources Ltd., a Canadian company, of the Sloan Ranch kimberlite deposit 40 kilometers northwest of the town of Fort Collins. Samples totaling 1,200 tons were processed and yielded more than 3,500 diamonds, the largest a 5.51-carat stone. Additional kimberlite will be mined and processed before a decision can be made about the economic feasibility of mining diamonds from the Sloan Ranch kimberlite.

Many locations in the State produce small quantities of aquamarine, the Colorado State gemstone. The best locations and the locations with the longest history of continued production (since about 1884) are Mount Antero and White Mountain in Chaffee County. Mount Antero, at 4,349 meters, may be the highest gemstone location in the United States. White Mountain, separated from Antero by a small saddle, is only slightly lower at 4,237 meters.

Star garnet, the Idaho State gemstone, and other gem-quality garnet lead the list of gemstones produced in the State. Idaho is one of two places that produce significant amounts of star garnet; India is the other. These almandite garnets are translucent, purplish-red stones that show four- or six-ray stars when cabochon cut or are transparent deep red stones that can be faceted. The primary sources of Idaho star garnet are the placer deposits on the East Fork of Emerald Creek and its tributary gulches in Benewah County. Additionally, the placers of Purdue Creek in Latah County yield star garnets. Currently, garnets that do not cut stars are mined commercially from areas in Clearwater County. These garnets range from purplish rose-red to a highly prized "special pink." Gem-quality garnets are found at several other locations in Idaho and are mined periodically by hobbyists or professional collectors for the gemstone market.

Opal is the second largest contributor to the total value of gemstone production in Idaho. The varieties produced include precious, yellow, blue, pink, and common. The Spencer opal mine is the largest producer. At the Spencer Mine, precious opal occurs as one or more thin layers within common opal that have partially filled gas cavities within a rhyolite-obsidian flow. About 10% of the material is thick enough to cut into solid gems; the remainder is suitable for making doublets and triplets. The Spencer Mine is also the source of the pink opal, which occurs as either pink common opal or pink-bodied precious opal.

Maine and tourmaline are almost synonymous in the gemstone industry. In 1822, Maine's Mount Mica was the site of the first gemstone production in the United States. In 1993, Plumbago Mining Corp. was actively mining the Mount Mica pegmatite for gem material and mineral specimens. Over the years, production from Mount Mica has included hundreds of kilograms of fine-quality gem and mineral specimen tourmaline. At least two deposits in the State produced significant quantities of tourmaline during the year.

Mount Mica is not the only large producer of high-quality tourmalines. Dunton Mine of Newry Hill is the most prolific gem tourmaline producer in Maine. Since its discovery in 1898, the mine has produced tons of gem- and specimen-grade tourmaline. Other mines and quarries in a three-county area produce gem- and mineral specimen-grade tourmalines. These include the Bennett, BB #7, Emmons, Harvard, Tomminen, Waisenen, Black Mountain and Red Hill Quarries, and Nevel Mine in Oxford County. It also includes the Mount Apatite Quarries in Androscoggin County and the Fisher and Porcupine Hill Quarries in Sagadahoc County.

Production from Maine deposits also includes fine-quality beryls—aquamarine, heliodor, and morganite. Pegmatites in Oxford, Androscoggin, and Sagadahoc Counties regularly produce fine-quality blue and blue-green aquamarine, rich yellow- and gold-colored heliodor, and rose- and peach-colored morganite.

A new discovery of amethyst in an old producing area resulted in the production of a significant amount of faceting- and specimen-grade amethyst in 1993.

Montana produces many different gemstones, some suited for faceting, while others are suited for the cutting of cabochons, carvings, or objects-of-art. Montana is noted for the production of sapphires, Montana moss agate, and Dryhead agates. Yet, deposits in the State also produced amethyst, amazonite, azurite, covellite, cuprite, garnet, onyx, opal, petrified wood, rhodochrosite, rhodonite, smokey quartz, sphalerite, and wonderstone (banded rhyolite) for use as gemstones.

Sapphires have been produced from Montana deposits since 1865. In recent years, Montana sapphire has gained in popularity, and because of the improved popularity, production has increased significantly. Currently, commercial sapphire production is from deposits on the Missouri River in Lewis and Clark County, the Rock Creek area in Granite County, and from the Yogo Gulch area in Judith Basin County. Additionally, there are fee-for-dig sapphire operations on the Missouri River, Dry Cottonwood Creek, and Rock Creek.

Nevada has been a major producer of turquoise since the 1930's, and until the early 1980's, the State was the largest turquoise producer in the United States. Estimates show that over the years, 75 to 100 different mines or prospects produced sizable quantities of turquoise. The value of production varied from a few thousand dollars at some properties to more than $1 million at others. Estimates of total production to date are between $40 to $50 million.

Precious opal production from deposits in the Virgin Valley area began in about 1906. The opal from Virgin Valley is comparable to any in the world for its vivid play of color and is unsurpassed in terms of the size of material available. The material varies in color from deep pure black to brown to yellowish-white to white to colorless. The play of color includes all the colors common to precious opal—red, blue, green, yellow, orange, and so on. The opal forms primarily as replacement of wood, or sometimes, the replacement of cones of conifer trees. A severe crazing problem restricts the use of the opal. Currently, two mines in Virgin Valley are open on a fee-to-dig basis during the summer months. The operators of these mines also mine the deposits for their inventories.

North Carolina is the only State in the United States where all four major gem materials, diamond, ruby, sapphire, and emerald, have been found. During 1988 was the last time all four major gemstones were found in the same year. The diamond was from a gold placer mine, the rubies and sapphires were from the Cowee Valley, and the emeralds were from near Hiddenite and Little Switzerland.

Production of ruby and sapphire from deposits along the Cowee Valley in

Macon County began in 1895 when the American Prospecting and Mining Co. systematically mined and washed the gravels of Cowee Creek. Today ruby, sapphire, and fee-for-dig operations are in the Cowee Valley. Many people pay to dig or purchase buckets of gravel to wash to recover gem corundum, garnets, and other gemstones. During 1993, deposits in North Carolina also produced gem-quality garnets, kyanite, emerald, and aquamarine.

Historically, Oregon has been known for the production of various picture and scenic jaspers, agates, thundereggs, petrified wood, and to a certain degree, gem labradorite. Oregon's State rock, the "thunderegg," may be the best known gem material from Oregon. Graveyard Point, Priday, and Polka Dot are names that are associated uniquely with beautiful Oregon agates. The same is true for the relationships between the names Biggs, Deschutes, and Sucker Creek and picture or scenic jasper. Yet, gem labradorite (sunstone) is currently the largest single contributor to the value of annual gemstone production in Oregon. At least seven firms or individuals currently are producing sunstone from three different geographic areas.

The other gemstone to contribute significantly to the value of production from Oregon is opal. During 1988, the first significant, commercial mining and marketing of very fine-quality opals from Opal Butte began. The varieties include hyalite, rainbow, contra luz, hydrophane, crystal, fire, blue, and dendritic. Exquisite stones as large as 315 carats have been cut from contra luz rough from this deposit and the fire opal is as fine as the best from Mexico.

Tennessee has the largest U.S. production of freshwater mussel shells and pearls of the 11 producing States. There has been an established U.S. freshwater mussel fishing industry since the mid-1850's. The mussels are from the family Unioidae, of which about 20 different species are harvested commercially. During 1993, the value of U.S. mussel shell exports was more than $32 million.

Historically, freshwater pearls from the United States were a byproduct of the shell industry. With the coming of the freshwater cultured pearl farms in Tennessee and the increasing popularity of freshwater pearl jewelry with the U.S. consumer, this has changed. Since the technology for culturing freshwater pearls was proven in the late 1970's, six freshwater pearl farms have been established. These farms are the beginning and heart of the U.S. pearl industry.

In Wisconsin and Michigan, 12 kimberlite pipes have been identified on exploration holdings, 7 have yielded microdiamonds, and 3 have not been tested. Ashton Mining of Canada, Inc. announced that its Great Lakes project found a small kimberlite body in the Crystal Falls area of Michigan. The company also reported the possibility of additional kimberlite bodies in the Upper Peninsula of Michigan.

Utah topaz is not well suited for use as a gem, but it does make a fine mineral specimen. Topaz crystals have been collected from certain rhyolite flows in the Thomas Mountains and the Wah Wah Mountains. The crystals from the Thomas Mountains are predominately small, 10 to 20 millimeters long and 4 to 6 millimeters across, and crystals from the Wah Wah Mountains are even smaller. Occasionally, large gem-quality crystals are found. The color of the topaz varies from colorless, to light yellow, sherry brown, rose, or light pink. The light yellow to sherry brown color fades to colorless if exposed to sunlight or heat and rose or light pink colored crystals are rare. Because of the size of the crystals and problem with color fading, the material yields only small to very small colorless stones.

Another Utah gemstone is variscite, first produced in about 1893 near Fairfield. The latest recorded commercial production was from near Lucin during the summer of 1992. Variscite forms as fracture fillings or as nodules. The nodules may be solid, almost geode in nature, or fractured solid nodules that have undergone alteration. The color of the variscite varies from a shade of light to dark yellow-green, but can be a dark, nearly jade green and so pale as to appear almost white. It also can have black and brown spiderwebbing.

Another material from Utah is snowflake obsidian. Snowflake obsidian (also known as flower obsidian) earns its name from the bluish-white or grayish-white patterns of cristobalite included into the normally black obsidian. During 1992, two different firms produced this material commercially.

The red beryl from the Wah Wah Mountains is the most remarkable and desirable of Utah's gemstones. Bixbite, the variety name for red beryl, is found in rhyolites at several locations in the Thomas and Wah Wah Ranges. The beryl varies in color from a pink to bright red, with the bright red being what could be called strong raspberry-red. The material from most of the locations is not as spectacular, either in crystal size or color, as the crystals from the Violet claims in the Wah Wah's.

The Violet claims in the Wah Wah's are the only known location for commercial production of red beryl. In recent years, the claims have furnished a small but steady supply of materials for both mineral specimens and a few fine-quality gems. The crystals average about 10 millimeters in length, and most are flawed. Because of the size of the crystals and flaws, finished stones only average about 0.40 carat with few more than 1 carat. The largest finished stone to date is about 10 carats. The material is expensive, but justifiably so, because of its beauty and rarity.

Certain other States produce a single gem material of note, they are: Alaska with its two jade mines; Florida's agatized coral; New York reported significant quartz production (herkimer diamonds) from the Herkimer-Middleville area and a small amount of almandite garnet production from the North Creek area; New Mexico reported production of agate, turquoise, copper minerals, and gem feldspar; both Alaska and Hawaii reported the production of gem-quality coral; Minnesota reported production of thomsonite and agate; Ohio reported production of flint; and South Dakota produced rose quartz.

The value of 1993 production by individual gemstone can be reported for those materials that have three or more producers and if one producer does not account for more than 75% of the total or if two do not account for 95% or more of the production. *(See table 5.)*

Consumption and Uses

Consumption of domestic gemstones was in the manufacture of jewelry; for exhibit in gem and mineral collections; for decorative purposes in statuettes, vases, and other art objects; and for certain industrial applications.

Frequently, tourmaline is used as a standard for calibrating piezoelectric manometers and testing devices. It is also a control substance in boron experiments because it is itself an inert boron-containing compound. Tourmaline is the standard used in tests to check possible effects of water-soluble boron in fertilizers.

Many scientific and industrial instruments use tourmaline. One such use is tourmaline tongs, a simple laboratory instrument that shows the polarization of light. Because tourmaline is both pyroeletric and piezoelectric, meaning it generates electricity when heated or compressed, it is a component of instruments for measuring high pressures and fluid compressibility. Thermal dosimeters, which were early instruments that measured the intensity of radium emanations, depended upon tourmaline's pyroelectric properties.

Once the mark of a top-rated watch or timepiece was that it was Swissmade and had 18 or 21 ruby or sapphire jewel bearings. Originally, these jewel bearings were made from natural ruby and sapphire. Later, the availability of inexpensive synthetic gemstones allowed the natural materials to be replaced in the manufacture of jewel bearings.

Why are ruby and sapphire used as bearings? Because ruby and sapphire, color variations of the mineral corundum, are second only to diamond in hardness; they have no cleavage (cleavage being the tendency for a crystallized mineral to break in certain definite directions, showing a minimum value of cohesion in the direction of easy fracture) and thus they are very durable; they have a very low coefficient of friction when highly polished; they are chemically inert; and they can be cut and polished without great difficulty.

Watches were not the only instruments in which sapphire and ruby bearings were used. Most precision gauges in aircraft and boats depend upon jewel bearings, as do many gauges, meters, and other instruments in manufacturing and chemical plants. The military is still highly dependent on jewel bearings for many of its high-tech weapons systems. Another use for one type of jewel bearing is as connectors for optical fibers.

In recent years, technological advances allowed the growth of large, high-quality synthetic ruby crystals, called laser ruby, for the manufacture of laser rods. Several other synthetic gemstones also are produced for lasers, including chromium-doped chrysoberyl (dope being an element added to the crystal growing nutrients to get a particular color), synthetic alexandrite, and varieties of doped YAG.

Lasers require high-purity, optically perfect crystals. The crystal must be large enough so that a laser rod can be cut from the raw crystal, and the mineral or material must have the correct physical properties to allow light amplification without the necessity of excessive energy. Synthetic ruby, sapphire, and YAG have these characteristics.

Over the years, both natural and synthetic corundum have been ground and graded as an abrasive. Corundum was the major compound used in the polishing of eyeglass lenses. Although industrial diamond has replaced much of the corundum used in the lens-polishing industry, some still use corundum for specialized lenses.

Other gem materials have enjoyed limited uses in nongem applications. The abrasive and ceramic industries use topaz as a raw material because of its hardness and chemical features. Once, lenses for eyeglasses were made from gem-quality beryl—if the morganite variety of beryl was used, one would truly be looking at the world through rose-colored glasses. Mortar and pestle sets, knife edges for balances, textile rollers, and spatulas are some nongem uses of agate.

Some industrial applications requiring clean homogeneous stones used low-quality gem diamond. The quantity of natural and synthetic industrial-grade diamonds used in the United States each year is 12 to 15 times greater than the amount of diamonds consumed by the jewelry industry.

The 1993 estimated value of U.S. apparent consumption of gems and gemstones was $4,266 million, up about 24% from that of 1992. In 1993, the value of U.S. estimated apparent consumption of diamonds increased about 29% to $3.6 billion. The 1993 estimated apparent consumption of colored stones, led by emerald, ruby, and sapphire, was valued at $517 million, an increase of 30%. The estimated apparent consumption of pearls—natural, cultured, and imitations—was $18 million, a 6% decrease. Estimated apparent consumption of synthetic and imitation gemstones decreased about 13% to $102.3 million.

Prices

Demand, beauty, durability, rarity, freedom from defects, and perfection of cutting decide the value of a gem. In establishing the price of gem diamond, the CSO's control over output and prices of diamond rough also is a major factor.

The average U.S. wholesale asking price of the top 25 grades (D through H color and IF through VS_2 clarity) of a 1-carat diamond fluctuated between $7,200 and $7,300, and was about $7,300 at yearend. The average value per carat of all grades, sizes, and types of gem-quality diamond imports was $444, essentially the same as that of 1992. The average yearend wholesale purchase price of a fine-quality 1-carat ruby, paid by retail jewelers on a per stone or memo basis, was $3,900, the same as that of 1992. The average value of ruby imports decreased 15% to $25.14 per carat.

The average yearend wholesale purchase price of a fine-quality 1-carat sapphire, paid by retail jewelers on a per stone or memo basis, was $1,400, the same as that of 1992. The average value of sapphire imports decreased 5% to $15.46 per carat.

The average yearend wholesale purchase price of a fine-quality 1-carat emerald, paid by retail jewelers on a per stone or memo basis, was $2,750, the same as for 1992. The average value of emerald imports decreased 38% to $44.83 per carat. *(See tables 6 and 7.)*

Foreign Trade

The value of all diamond exports plus reexports increased 10% to $1.50 billion. The quantity of cut diamonds exported and reexported decreased 10% to 911,419 carats, and the value of diamond exported and reexported increased 9% to $1.44 billion.

The value of other precious stones, cut but unset or rough other than diamonds, pearls, and synthetics, exported and reexported decreased from $241.2 million to $103.1 million. The value of synthetic gemstone exports plus reexports decreased from $21.2 million to $19.3 million.

The value of natural, cultured, and imitation pearls, not set or strung, exports and reexports of pearls increased from $6.7 million to more than $7.3 million.

The value of gems and gemstones imported increased 18% to a record high $5,850.9 million. The value of imported gem diamonds accounted for about 86% of the total.

The value of imported gem diamonds increased 23% to a record high $5,096.3 million. The imports of cut diamonds increased 26% in quantity and 23% in value to 9.7 million carats and $4,486.3 million, respectively.

The value of imports of other gem and gemstones, led by emerald, ruby, and sapphires, was $754.5 million. Emerald imports increased 14% to $244.4 million. The value of ruby imports increased 16% to $90.6 million, but was less than the record-high value for the past 10 years of $98.4 million in 1990. The value of sapphire imports was $79.3 milion, an increase of 6% compared to that of 1992.

The value of imported gem materials other than diamond, emerald, ruby, and sapphire increased 35% to $327.7 million. *(See tables 8, 9, 10, 11, and 12.)*

World Review

Diamond sales by De Beers Centenary AG was $4.4 billion in 1993, an increase of 28% compared with 1992 sales of $3.4 billion. Sales during the first half of 1993 were $2.5 billion, 42% more than the $1.8 billion for the first half of 1992. Sales during the second half of 1992 were only $1.8 billion, but still 12% more than the $1.6 billion sales for the second half of 1992. A De Beers official stated that there were sharp sales gains in the Indian-type cheaper rough, but larger rough, more than 3 carats, was sold sparingly. De Beers controls about 80% of the rough, uncut diamonds sold in the world. Sales of colored stones remained strong. In February, De Beers increased the price of rough diamonds by an average of 1.5%. Not all prices went up 1.5%—some were unchanged while others increased as much as 8%.

Natural diamond production occurs in Africa, Asia, Australia, and South America. The principal producing localities are as follows: in Africa—Angola, Botswana, Namibia, the Republic of South Africa, and Zaire; in Asia—Russia (northeastern Siberia and in the Yakutia); in Australia; and in South America—Venezuela and Brazil. *(See table 13.)*

Foreign countries in which major gemstone deposits (other than diamond) occur are Afghanistan (beryl, kunzite, ruby, tourmaline); Australia (beryl, opal, sapphire); Brazil (agate, amethyst, beryl, kunzite, ruby, sapphire, tourmaline, topaz); Burma (beryl, jade, ruby, sapphire, topaz); Colombia (beryl, sapphire); Kenya (beryl, garnet, sapphire); Madagascar (beryl, rose quartz, sapphire, tourmaline); Mexico (agate, opal, topaz); Sri Lanka (beryl, ruby, sapphire, topaz); Tanzania (tanzanite, garnet, ruby, sapphire, tourmaline); and Zambia (amethyst, beryl).

Angola.—Odebrecht, a Brazilian company, purchased modular diamond recovery plants from Van Eck & Lurie for use on its diamond projects in Angola. Odebrecht is undertaking projects in Quango Province for Endiama, the Angolan state mining corporation.

Australia.—Argyle's diamond production of 42 million carats was another record year for the mine. Since the start of mining in 1983, more than 304 million carats of diamonds has been recovered from the AK-1 pipe and alluvial operations. Argyle's annual pink diamond sale saw a single buyer, a Geneva-based jeweler, buy the entire 46-stone, 41.48-carat offering for $2.25 million.

The Philips Range Joint Venture, a venture between Triad Minerals NL and Black Hill Minerals Ltd., both Australian companies, and the Canadian firm Cliff Resources Corp., has completed a drilling project on the Aries kimberlite pipe and has started a 100,000-ton bulk sampling of the overburden. The venture has processed 1,700 tons of overburden through its 100-tons-per-hour plant and recovered 69 diamonds that weighed 26.7 carats with five stones greater than 1 carat.[6] Ashton Mining Ltd. continued to explore the Merlin and adjacent Excalibur prospects in the Northern Territory. A 70-ton sample from Merlin produced 20 commercial-size stones; 20% were gem quality, 20% were near-gem, and the largest stone was 2.44 carats. On the Excalibur, a 60-kilogram sample produced 7 macrodiamonds and 92 microdiamonds. Many drill holes on the prospect have intercepted kimberlite down to 111 meters.

Botswana.—The largest diamond ever found in Botswana, 446 carats, was recovered at the Jwaneng Mine. The stone is currently being evaluated and no value has been set.

Preliminary exploration work is underway on the Gemsbok project to evaluate five diamond prospecting licenses. The licenses cover about 4,800 square kilometers. The project is a 50-50 joint venture between Scintilore Explorations and Fancamp Resources.

The $3 million diamond cutting and polishing factory jointly owned by Lazare Kaplan Botswana, a subsidiary of the U.S. firm Lazare Kaplan International, and the Government of Botswana is the newest cutting factory in Botswana. The factory was subsidized to train local cutters under Botswana's financial assistance policy for foreign investors. The factory will purchase rough from De Beers' CSO.

Brazil.—Southwestern Gold Corp. and Hillsborough Resources have had encouraging results from their joint-venture exploration on the 592,000-hectare Canabrava project in Minas Gerais. Sampling discovered kimberlite indicator minerals and stream samples contained diamonds. Diamonds from the stream samples contained one pink diamond.[7]

The KWG Resources and Diamond Co. Ltda. Charneca diamond property joint venture in Minas Gerais began production with a 750-cubic-meter-per-day washing plan and plans to add a second 300-cubic-meter-per-day plant. KWG, the operating partner, reported the recovery of 31 gem-quality diamonds weighing 79 carats during the first 19-days of operation. The joint venture controls two additional concessions in Minas Gerais—the Santo Antonio and Grupiaria.[8]

Burma (Myanmar).—The Burmese 30th Annual Gems, Jade, and Pearl Emporium attracted 654 buyers from 16 countries and accounted for a near record $14.7 million. Jade sales were $11.5 million; pearls, $0.6 million; and gems, $1 million. The gem sales were mostly cut rubies and sapphires. Some rough was offered as well as cut peridot, spinel, green tourmaline, danburite, almandine garnet, aquamarine, diopside, enstatite, zircon, colorless topaz, and scapolite. For the first time heat-treated rubies were offered for sale. The heat-treated material was all from the new Monghsu Mine.[9]

Canada.—Broken Hill Proprietary Co., an Australian company, and its Canadian partner Dia Met Minerals, Ltd. announced the start of work on the first diamond mine in Canada with their presentation of their mining plan to environmental authorities. The mine and other facilities would cost about $375 million and would be in full operation by 1997.

During 1993, diamond exploration activities were too extensive to be summarized in this limited space. It is recommended that interested individuals obtain copies of "Diamond in Canada: An Over View of Current Developments" by R. Irvine and M. Boucher, Industrial Minerals Division, Mineral Metal Commodities Branch Mineral Policy Sector, Energy, Mines and Resources Canada, Ottawa, Ontario; or "Mineral Exploration in Canada: Recent Developments and the Diamond Story" by J. M. Duke and B. A. Kjarsgaard, Geological Survey of Canada, Ottawa, Ontario.

China.—The New China News Agency announced a De Beers Chinese joint venture that includes equipment and technology for exploration and processing of diamond ore, assistance in training personnel, and the opening of a diamond cutting factory. The new factory will be in Shanghai, one of two major cities targeted by De Beers' recently announced $1.2 million marketing campaign to increase China's consumption of cut diamonds.

Ghana.—The Government of Ghana has agreed to sell 80% of the Government-owned Ghana Consolidated Diamond Mines, Ltd., 40% each to De Beers and Lazare Kaplan International. A new company, Birim River Diamonds Ltd., will operate the diamond mines with De Beers as the managing partner. Plans are for production to be increased to 0.4 million carats per year in 3 years; eventually production will increase to 1 million carats per year.

Greece.—In February, a new synthetic ruby, grown by a flux process, was announced to the industry at the Athens Jewelry Fair by J. and A. Douras, its producers. The material is grown in a plant in Piraeus. The Douros method grows crystals that are 20 to 50 grams and smaller that are almost identical in appearance to Ramaura material. The refractive indices, density, absorption spectrum, fluorescence, and dichroism of the new synthetic are the same as for natural ruby.

India.—India processed about 65% of the carats of the world's rough diamonds, accounting for a 45% share of the world trade in finished goods. While most of the finished goods were less than 20 points in size, the industry is increasing the amount of larger goods cut. The 11 million carats of cut diamonds exported accounted for 17% of the value of total exports from India.

Mali.—Mink Minerals Resources Inc., a Canadian firm, agreed to acquire 65% of Syndicat Diamat—the Mali diamond exploration and development company owned by the Governments of Mali and France—by spending more than $6 million over 3 years and additional amounts over 3 additional years. The Syndicat Kenieba district concession has 21 identified kimberlite pipes, 8 of which contain diamonds. Sampling of paleo placer deposits within the concession yielded more than 70 gem-quality diamond, many larger than 1 carat.

Namibia.—Namibian Minerals Corp. (Namco), a firm just listed on the Vancouver Stock Exchange, is undertaking a program to evaluate and develop two Namibian marine concessions covering 920 square kilometers. Detailed geophysical surveys and sampling are planned with the start of mining scheduled for early 1995. The concessions are off the coast for the port of Luderirz and Hottentots Bay in water 200 meters or more in depth. According to Namco, the concessions may contain as many as 27 million carats, and projections of production are 150,000 to 250,000 carats per year.

Russia.—The Russian diamond mining industry, with about 95% of production coming from five mines in Sakha—Udachny, Aikhal, Mir, International, and Sytykanskaya—is undergoing much change. Construction is underway on the Jubilee Mine that will begin production in 1994. Two deep vertical shafts have been completed at the International Mine, and plans are underway to convert the Mir from an open pit to underground mine. Additionally, efforts are underway to bring the five kimberlite pipes north of Archangel into production.

Current diamond exploration includes Ashton Mining's work in the Karelia area, work near Krasnovishersk in the Perm district, Kondor and Imperial, Inc. are exploring known pipes in Archangel, Gorizont Co. is exploring additional areas in Archangel, and geologists have discovered diamonds in the Khanka depression close to the city of Lesozavadsk near the Sino-Russian border.

Mr. Thomas Chatham, president of U.S.-based Chatham Created Gems, Inc., announced the formation of Chatham-Siberian Gem Co., based in Moscow. The company will grow and market synthetic white, yellow, and blue diamonds. The diamonds will be made using the high-temperature, high-pressure process. The new company plans to begin marketing about 100 carats of finished goods per month at a price that is 10% of that of equivalent natural diamonds.

In Moscow, J.V. Intertrade, a joint venture between the Moscow Municipality, the Russian Committee for Precious Stones and Metals, and Kaszirer Diamond and Oltusky—both Belgian firms—opened a diamond cutting factory. The Municipality provided land and construction. The committee is expected to insure a supply of rough, and the Belgians invested $6 to $7 million in funds. Ruisdiamond, an Israeli-Russian joint venture, also opened a new cutting factory in Moscow. It will use laser technology on types of rough that are difficult to cut. The newest cutting factory in Yakutia is in the city of Namtsy: It is the sixth factory to open in Yakutia during 1993, and an additional seven cutting factories have been announced.

Mr. Valerie Rudakov, president of Almazy Rossi-Sakha, the firm responsible for mining, sorting, pricing, and selling Russia's rough diamonds, announced the opening of an internal Russian Diamond Selling Center. Operating much like the CSO, the Selling Center will allocate diamonds to Russian cutting factories as if they were CSO sightholders. Almazy Rossi-Sakha is a joint stock company in which 32% is controlled by the governments of Russia and Sakha each, 8% by the eight regions of Sakha, 5% by the Guarantee Fund, and 23% by employees. The company's goals are to supply adequate rough diamonds at "world prices" to Russian cutting factories and to ensure the continued well being and growth of the Russian cutting industry.

South Africa, Republic of.—Diamond Field Resources (DFR), a Canadian company, purchased the Loxton Dan and Frank Smith diamond mines in the Kimberley area. The company reports that the mines have reserves sufficient for an additional 20 years of operation even at the increased rate plan. DFR plans to increase production from the mines to 100,000 carats per year. DFR also has a marine diamond concession off the coast of Luderitz in Namibia.

Tanzania.—During 1993, the Government of Tanzania lifted the restrictions on diamond sales and exploration to foreign investors. Because of these changes Dual Resources and Pue Gold Resources, both Canadian firms, each purchased 20% of Tanzania Diamond Mines' (TDM) diamondiferous kimberite project, two contiguous diamond lining leases, and three exploration licenses. East Africa Diamond Exploration, a wholly owned subsidiary of TDM, will manage the joint-venture project.[10]

European Ventures acquired a 50% interest in Tan Range Exploration Corp.'s 60-square-kilometer diamond concession; both firms are Canadian. European agreed to spend $300,000 on exploration over the next 2 years, and issued Tan Range 100,000 shares of European's common stock.[11]

Uruguay.—It is estimated that annual exports of amethyst are about 80 tons valued at more than $500,000. The amethyst is for mineral specimens, decorator pieces, and as gemstones.

Zaire.—Sediza, De Beers' Zairian diamond purchasing company, purchased a +770-carat top-colored, gem-quality rough diamond. It is reported that the firm paid an artisanal miner $7 million for the stone and paid the Government of Zaire a 10% fee to export it. Because of its shape, the rough will be sawed or cleaved into two pieces for cutting.

Zimbabwe.—The River Ranch Mine, operated by Auridiam Zimbabwe Ltd., a joint venture between the Canadian firm Cornerstone Investments Ltd. and Auridiam Consolidated NL of Australia, is expanding production from its current 50,000 carats per year to 130,000 carats per year and plan to produce 330,000 carats per year by 1995. Gem-quality stones account for about 60% of the production, and many of the stones are larger than 8 carats. During 1993, the mine produced two large fine stones—one was 29.6 carats and the other was 17 carats. Recovered fragments totaling 356.2 carats from one broken stone and 33.4 carats from another single stone suggest the presence of very large stones.

The joint venture between Reunion Mining and Argosy Mining Corp. has confirmed the discovery of a second kimberlite pipe on its Hwange project in western Zimbabwe. The pipe is about 10 kilometers from an earlier discovered pipe. The joint venture announced that additional exploration permits have been added to the venture to increase the Hwange project area.

OUTLOOK

World demand for gem diamond can be expected to rise because of increasing effective personal incomes and the populations of the United States and other industrialized countries. Also, demand will increase because of highly effective promotional efforts. These promotions are changing social customs in many eastern countries, particularly the use of diamond engagement rings. The changes are resulting in significant growth in the diamond market. Demand for other precious gems will continue to grow as diamonds become more expensive and the popularity and acceptance of colored gemstones increase. Demand for synthetic and simulant gemstones for both personal and industrial consumption is expected to increase. The diversity of sizes, types, uses, and values of gems and gemstones precludes any meaningful forecasting of future demand.

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[1]Nassau, K. Gemstone Enhancement. Butterworth, 1984, pp. 46-60.

[2]Pages 61-78 of work cited in footnote 7.

[3]Bleached and Impregnated Jadeite, Jewelry News Asia, Issue 103, March 1993, pp. 118,120.

[4]Pages 25-44 of work cited in footnote 7.

[5]Rapaport Diamond Report. Colored Stones Section. V. 15, No 9. Mar. 6, 1992, p. 26.

[6]Industrial Minerals (London). No. 312, 1993, p. 13.

[7]Mining Journal (London). V. 321, No. 8247, 1993, p. 277.

[8]———. V. 321, No. 8243, 1993, p. 209.

[9]Gemological Institute of America. Gems & Gemology. V. 29, No. 1. 1993, p. 64.

[10]Mining Journal (London). V. 320, No. 8227, 1993, p. 404.

[11]———. V. 320, No. 8220, 1993, p. 276.

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TABLE 1

DE BEER'S CSO ROUGH DIAMOND PRICE INCREASES, BY PERCENTAGE

Sept. 1949	25.0	Nov. 1967	16.0	Aug. 1973	10.2	Sept. 1982	2.5
Mar. 1951	15.0	Sept. 1968	2.5	Dec. 1974	1.5	Apr. 1983	3.5
Sept. 1952	2.5	July 1969	4.0	Jan. 1976	3.0	Aug. 1986	7.5
Jan. 1954	2.0	Nov. 1971	5.0	Sept. 1976	5.8	Nov. 1986	7.0
Jan. 1957	5.7	Jan. 1972	5.4	Mar. 1977	15.0	Sept. 1987	10.0
May 1960	2.5	Sept. 1972	6.0	Dec. 1977	17.0	Apr. 1988	13.5
Mar. 1963	5.0	Feb. 1973	11.0	Aug. 1978	30.0	Mar. 1989	15.5
Feb. 1964	7.5	Mar. 1973	7.0	Sept. 1979	13.0	Mar. 1990	5.5
Aug. 1966	7.5	May 1973	10.0	Feb. 1980	12.0	Feb. 1993	1.5

TABLE 2

DE BEER'S CSO ROUGH DIAMOND SALES AND STOCKS

(Billions of dollars)

Year	Sales	Stocks
1984	1.61	1.95
1985	1.80	1.90
1986	2.56	1.85
1987	3.07	2.30
1988	4.17	2.00
1989	4.09	2.47
1990	4.17	2.68
1991	3.93	3.03
1992	3.42	3.36
1993	4.40	4.10

TABLE 3

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characters
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0-2.5	1.0-1.1	Single	1.54	Synthetic or pressed, plastics	Fossil resin, soft.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5-8.0	2.63-2.80	Double	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	do.	Small	Very high	7.5-8.0	2.63-2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald	do.	Green	Medium	do.	7.5	2.63-2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet, doublets	Emerald filter, dichroism refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5-8.0	2.63-2.80	do.	1.58	Genuine emerald	Flaws, brilliant, fluorescence in ultra-violent light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5-8.0	2.63-2.80	do.	1.58	Citrine, topaz, glass, doublets	
Goshenite	do.	do.	Any	Low	7.5-8.0	2.63-2.80	do.	1.58	Quartz, glass, white sapphire, white topaz	Refractive index.
Morganite	do.	Pink to rose	Any	Low	7.5-8.0	2.63-2.80	Low	1.58	Kunzite, tourmaline, pink sapphire	Refractive index.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green or brown	Any	Low	3.0	2.72	Double (strong)	1.49-1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	Any	Low	3.0	2.72	do.	1.6	do.	Banded, translucent.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day, red by artificial light	Russia (small), Sri Lanka (medium)	High	8.5	3.50-3.84	Double	1.75	Synthetic	Dichroism, inclusions in synthetic sapphire.
Catseye	do.	Greenish to brownish	Small to large	do.	8.5	3.50-3.84	do.	1.75	Synthetic, shell	Gravity and translucence.
Chrysolte	do.	Yellow, green, and/or brown	Medium	Medium	8.5	3.50-3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Coral	Calcium carbonate	Orange, red, white, black, or green	Branching, medium	Low	3.5-4.0	2.6-2.7	do.	1.49-1.66	False coral	Dull translucent.

See footnotes at end of table.

TABLE 3—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characters
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95-4.10	Double	1.78	Synthetics, including spinel	Inclusions, fluorescence.
Sapphire	do.	Blue	Medium	High	9.0	3.95-4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, white, orange, green, or violet	Medium to large	Medium	9.0	3.95-4.10	do.	1.78	Synthetics, glass and doublets	Inclusions, double refraction, refractive index.
Sapphire and ruby stars	do.	Red, pink, violet blue, or gray	do.	High to low	9.0	3.95-4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color on side view.
Sapphire or ruby synthetic	do.	Yellow, pink, or blue	Up to 20 carats	Low	9.0	3.95-4.10	do.	1.78	Synthetic spinel, glass	Curved strae, bubble inclusions.
Diamond	Carbon	White, blue-white, yellow, brown, green, pink, blue	Any	Very high	10.0	3.516-3.525	Single	2.42	Zircon, titania, cubic zirconia	High index, dispersion, single refraction, hardness, cut, luster.
Feldspar:										
Amazonite	Alkali aluminum-silicate	Green	Large	Low	6.0-6.5	2.56	—	1.52	Jade	Cleavage, sheen, vitreous to pearly opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play	do.	Low	6.0-6.5	2.56	—	1.56	do.	Cleavage, sheen, vitreous to pearly opaque, grid.
Moonstone	do.	White	do.	Low	6.0-6.5	2.77	—	1.52-1.54	Glass or white onyx	Blue sheen, opalescent.
Garnet	Complex silicate	Brown, black, yellow, green, ruby red, or orange	Small to medium	Low to high	6.5-7.5	3.15-4.30	Single strained	1.79-1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Jade:										
Jadeite	do.	Green, yellow, black, white, or mauve	Large	Low to very high	6.5-7.0	3.3-3.5	Crypto-crystal-line	1.65-1.68	Onyx, bowenite, vesu-vianite , grossularite	Luster, spectrum, translucent to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0-6.5	2.96-3.10	do.	1.61-1.63	do.	Do.
Opal	Hydrous silica	Colors flash in white, gray, black, red, or yellow	Large	Low to high	5.5-6.5	1.9-2.3	Isotropic	1.45	Glass, synthetics, triplets	Play of color.
Pearl	Calcium carbonate	White, pink, or black	Small	do.	2.5-4.0	2.6-2.85	—	—	Cultured and imitation	Luster, structure, X-ray.
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5-7.0	3.27-3.37	Double (strong)	1.65-1.69	Tourmaline chrysoberyl	Strong double refracation, low dichroism.

See footnotes at end of table.

TABLE 3—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characters
Quartz:										
Agate	Silica	Any color	Large	Low	7.0	2.58-2.64	—	—	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65-2.66	Double	1.55	do.	Refractive index, double refraction, transparent.
Cairngorm	do.	Smoky	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Citrine	do.	Yellow	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Crystal, rock	do.	Colorless	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Jasper	do.	Uniform or spotted red, yellow, or green	do.	Low	7.0	2.58-2.66	—	—	do.	Opaque, vitreous.
Onyx	do.	Many colors	do.	Low	7.0	2.58-2.64	—	—	do.	Uniformly banded.
Rose	do.	Pink, rose red	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Refractive index, double refration, translucent.
Spinel	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5-3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	Any	Up to 40 carats	Low	8.0	3.5-3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubles.
Spodumene:										
Kunzite	Lithium aluminum silicate	Pink to lilac	Medium	Medium	6.5-7.0	3.13-3.20	Double	1.66	Amethyst, morganite	Refractive index.
Hiddenite	do.	Yellow to green	do.	do.	6.5-7.0	3.13-3.20	do.	1.66	Synthetic spinel	Do.
Tanzanite	Complex silicate	Blue	Small	High	6.0-7.0	3.30	do.	1.69	Sapphire, synthetics.	Strong trichroism.
Topaz	do.	White, blue, green	Medium	Low to medium	8.0	3.4-3.6	do.	1.62	Beryl, quartz	Refractive index.
Tourmaline	do.	All, including mixed	do.	do.	7.0-7.5	2.98-3.20	do.	1.63	Peridot, beryl, corundum, glass	Double refraction, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green	Large	Low	6.0	2.60-2.83	do.	1.63	Glass, plastics	Difficult if matrix not present, matrix usually limonitic.
Zircon	Zirconium silicate	White, blue, or brown, yellow, or green	Small to medium	Low to medium	6.0-7.5	4.0-4.8	Double (strong)	1.79-1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

[1]Small—up to 5 carats; medium—up to 50 carats; large—more than 50 carats.
[2]Low—up to $25 per carat; medium—up to $200 per carat; high—more than $200 per carat.

TABLE 4
SYNTHETIC GEMSTONE PRODUCTION METHODS

Gemstone	Production methods	Company	Date of first production
Ruby	Flux	Chatham	1950's
Do.	do.	Kashan	1960's
Do.	do.	Knischka	1980's
Do.	do.	J.O. Crystal (Ramaura)	1980's
Do.	do.	Douras	1990's
Do.	Zone melt	Seiko	1980's
Do.	Melt pulling	Kyocera (Inamori)	1970's
Do.	Verneuil	Various producers	1900's
Star ruby	do.	Linde (Div. of Union Carbide)	1940's
Do.	Melt pulling	Kyocera	1980's
Do.	do.	Nakazumi	1980's
Sapphire	Flux	Chatham	1970's
Do.	Zone melt	Seiko	1980's
Do.	Melt pulling	Kyocera	1980's
Do.	Verneuil	Various producers	1900's
Star sapphire	do.	Linde	1940's
Emerald	Flux	Chatham	1930's
Do.	do.	Gilson	1960's
Do.	do.	Kyocera	1970's
Do.	do.	Seiko	1980's
Do.	do.	Lennix	1980's
Do.	do.	Russia	1980's
Do.	Hydrothermal	Lechleitner	1960's
Do.	do.	Regency	1980's
Do.	do.	Biron	1980's
Do.	do.	Russia	1980's
Alexandrite	Flux	Creative crystals	1970's
Do.	Melt pulling	Kyocera	1980's
Do.	Zone melt	Seiko	1980's
Cubic zirconia	Skull melt	Various producers	1970's

TABLE 5
VALUE OF U.S. GEMSTONE PRODUCTION, BY GEMSTONE

(Thousand dollars)

Gem materials	1992	1993
Agate	548	843
Beryl	323	470
Coral (all types)	122	166
Garnet	108	233
Gem feldspar	1,042	701
Geode/nodules	260	207
Fire agate	45	40
Jasper	111	531
Obsidian	4	10
Opal	756	639
Peridot	1,306	1,520
Petrified wood	211	234
Quartz	638	1,036
Sapphire/ruby	895	313
Topaz	12	8
Tourmaline	82	9,534
Turquoise	1,994	3,035
Total	8,457	19,520

TABLE 6

PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Price range per carat[3] Jan. 1993-Jan. 1994	Average[4] July 1993
0.25	G	VS1	$1,400-$1,400	$1,400
.25	G	VS2	1,200- 1,200	1,200
.25	G	SI1	970- 970	970
.25	H	VS1	1,200- 1,200	1,200
.25	H	VS2	1,100- 1,100	1,100
.25	H	SI1	950- 950	950
.50	G	VS1	2,900- 3,050	3,050
.50	G	VS2	2,600- 2,700	2,700
.50	G	SI1	2,300- 2,400	2,400
.50	H	VS1	2,700- 2,800	2,800
.50	H	VS2	2,500- 2,600	2,600
.50	H	SI1	2,200- 2,300	2,300
.75	G	VS1	3,500- 3,650	3,650
.75	G	VS2	3,200- 3,350	3,350
.75	G	SI1	2,800- 2,950	2,950
.75	H	VS1	3,100- 3,250	3,250
.75	H	VS2	2,800- 2,950	2,950
.75	H	SI1	2,600- 2,750	2,750
1.00	G	VS1	4,600- 4,800	4,750
1.00	G	VS2	4,100- 4,250	4,200
1.00	G	SI1	3,700- 3,850	3,800
1.00	H	VS1	4,100- 4,250	4,200
1.00	H	VS2	3,900- 4,050	4,000
1.00	H	SI1	3,600- 3,750	3,700

[1]Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; G-H-I—traces of color.
[2]Clarity: IF—no blemishes; VVS1—very, very slightly included; VS—very slightly included; VS2—very slightly included, but not visible; SI1—slightly included.
[3]Jeweler's Circular-Keystone. V. 165, No. 3, Mar. 1994, p. 146.
[4]Jeweler's Circular-Keystone. V. 164, No. 9, Sept. 1993, p. 114.

TABLE 7

PRICES OF U.S. CUT COLORED GEMSTONES, BY SIZE[1]

Gemstone	Carat weight	Price range per carat in 1993[2]	Average price per carat[2] Jan. 1993	Average price per carat[2] Jan. 1994
Amethyst	1	$8- $18	$13.00	$13.00
Aquamarine	1	75- 90	82.50	82.50
Emerald	1	2,000- 3,500	2,750.00	2,750.00
Garnet, tsavorite	1	600- 900	750.00	750.00
Ruby	1	3,000- 4,800	3,900.00	3,900.00
Sapphire	1	800- 2,000	1,400.00	1,400.00
Tanzanite	1	100- 185	130.00	150.00
Topaz	1	5- 9	7.00	7.00
Tourmaline, red	1	60- 125	92.50	92.50

[1]Fine quality.
[2]Jewelers' Circular-Keystone. V. 165, No. 3, Mar. 1994, p. 146. These figures represent a sampling of net prices that wholesale colored stone dealers in various U.S. cities charged their cash customers during the month for fine-quality stones.

TABLE 8
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY

Country or territory	1992 Quantity (carats)	1992 Value[1] (millions)	1993 Quantity (carats)	1993 Value[1] (millions)
Exports and reexports:				
Australia	552	$1.7	585	$1.3
Belgium	r792,646	r322.3	443,623	363.9
Canada	r412,161	30.7	242,593	33.6
Germany	11,878	10.1	3,408	3.3
Hong Kong	r157,109	r311.3	232,487	333.5
India	101,717	15.4	128,675	15.8
Israel	r245,690	r250.3	320,100	286.7
Japan	r75,992	r121.4	88,756	144.5
Mexico	3,016	1.7	7,638	1.6
Singapore	r19,114	r30.7	14,604	35.7
South Africa, Republic of	928	1.7	1,276	2.0
Switzerland	r44,211	r146.2	36,605	160.4
Thailand	r17,369	r16.5	58,490	24.4
United Kingdom	r12,292	r50.8	13,925	43.5
Other	r29,903	r50.6	37,682	48.9
Total	r1,924,578	r1,361.4	1,630,447	1,499.1

rRevised.
[1]Customs value.

Source: Bureau of the Census.

TABLE 9

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY

Kind, range, and country or territory of origin	1992 Quantity (carats)	1992 Value[1] (millions)	1993 Quantity (carats)	1993 Value[1] (millions)
Rough or uncut, natural:[2]				
Belgium	402,763	$81.9	143,860	$111.7
Brazil	26,867	1.4	55,214	4.7
Isreal	26,699	10.7	13,535	5.7
Netherlands	79,564	17.6	1,607	2.6
South Africa, Republic of	13,405	17.6	26,058	43.7
Switzerland	1,156	9.4	8,549	12.6
United Kingdom	685,544	189.1	1,127,237	229.3
Venezuela	318	.1	161	.1
Other	392,059	167.1	394,271	199.6
Total[3]	1,628,375	495.0	1,770,492	610.1
Cut but unset, not more than 0.5 carat:				
Belgium	795,348	270.5	951,502	315.7
Brazil	15,414	6.6	5,928	2.0
Canada	[r]6,552	2.1	5,709	1.5
Hong Kong	247,289	44.1	147,006	40.8
India	4,249,843	935.2	5,577,187	1,178.7
Israel	670,327	313.0	800,084	347.8
Netherlands	3,338	1.1	1,778	.4
South Africa, Republic of	7,263	6.3	5,658	5.4
Switzerland	11,055	4.6	8,357	2.8
United Kingdom	4,779	1.4	3,146	.6
Other	80,899	19.2	109,748	25.7
Total[3]	[r]6,092,107	1,604.2	7,616,103	1,921.4
Cut but unset, more than 0.5 carat:				
Belgium	589,036	776.2	676,500	912.2
Hong Kong	[r]14,886	30.8	33,037	44.6
India	30,634	18.0	100,209	63.4
Israel	915,487	973.8	1,161,760	1,255.7
Netherlands	3,928	18.9	2,177	6.8
South Africa, Republic of	5,706	22.4	11,788	34.4
Switzerland	10,712	95.1	11,678	114.1
United Kingdom	20,061	35.1	14,041	35.9
Other	41,319	74.3	75,940	97.7
Total[3]	[r]1,631,769	2,044.5	2,087,130	2,564.8

[r]Revised.
[1]Customs value.
[2]Includes some natural advanced diamond.
[3]Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census.

TABLE 10

U.S. IMPORTS FOR CONSUMPTION OF NATURAL GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY

Kind and country or territory	1992 Quantity (carats)	1992 Value[1] (millions)	1993 Quantity (carats)	1993 Value[1] (millions)
Emerald:				
Belgium	4,381	$0.7	8,122	$2.1
Brazil	125,548	4.5	1,100,146	4.0
Colombia	403,988	92.4	581,333	118.9
France	3,753	4.1	490	1.0
Germany	149,870	4.3	66,929	2.3
Hong Kong	232,025	19.2	271,592	21.5
India	1,208,678	16.5	2,090,983	26.8
Israel	116,586	21.4	447,491	27.9
Switzerland	164,283	39.6	105,266	24.1
Taiwan	3,452	.3	581	2.5
Thailand	299,313	6.6	706,280	6.8
Other	r244,029	r4.0	72,928	6.5
Total	2,955,906	213.5	5,452,141	244.4
Jade:				
Brazil		9.0		7.3
Germany		15.7		13.8
Hong Kong		12.7		15.4
India	NA	6.1	NA	7.0
Israel		5.4		6.0
Taiwan		2.8		3.1
Thailand		47.5		17.5
Other		10.3		10.6
Total	NA	109.2	NA	80.7
Ruby:				
Belgium	9,065	1.1	4,932	.7
Brazil	6,793	.3	7,219	.1
France	790	.6	629	.7
Germany	17,677	1.1	101,945	1.2
Hong Kong	r99,823	r3.9	218,116	6.2
India	375,745	1.7	1,012,472	2.8
Israel	12,094	1.5	14,938	1.8
Switzerland	36,221	23.3	19,664	15.7
Thailand	2,008,030	39.1	2,181,489	47.9
United Kingdom	2,401	3.3	3,784	2.5
Other	r66,306	r2.0	39,175	10.3
Total	r2,634,945	r77.9	3,604,363	90.6
Sapphire:				
Australia	4,682	.1	12,377	.1
Beglium	6,744	.7	18,710	.8
Brazil	23,326	.2	2,585	.1
Canada	187,196	.5	48,593	.8
Germany	49,194	1.3	122,609	1.0
Hong Kong	r113,716	r3.9	202,914	3.7
Israel	28,987	1.2	30,554	1.0
Sri Lanka	85,218	3.5	196,128	4.5
Switzerland	27,608	13.6	32,786	7.8
Thailand	3,991,362	45.5	4,255,519	54.1

See footnotes at end of table.

TABLE 10—Continued
U.S. IMPORTS FOR CONSUMPTION OF NATURAL GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY

Kind and country or territory	1992 Quantity (carats)	1992 Value[1] (millions)	1993 Quantity (carats)	1993 Value[1] (millions)
Sapphire—Continued:				
United Kingdom	4,210	$1.2	5,404	$0.8
Other	[r]88,663	[r]3.4	201,604	4.6
Total	[r]4,610,906	75.1	5,129,783	79.3
Other:				
Rough, uncut:				
Australia	NA	2.1	NA	2.6
Brazil	NA	30.2	NA	21.4
Colombia	NA	4.4	NA	6.1
Hong Kong	NA	1.0	NA	7.1
South Africa, Republic of	NA	.3	NA	2.4
Switzerland	NA	.7	NA	.3
Zambia	NA	1.0	NA	.8
Other	11,702,472	13.8	21,772,815	9.0
Total	41,130,452	53.5	56,187,445	49.7
Cut, set and unset:				
Australia		3.8		4.2
Brazil		9.0		7.2
China		.9		1.8
Germany		15.7		13.8
Hong Kong	NA	[r]17.3	NA	20.3
India		6.9		8.0
Japan		9.3		10.1
Switzerland		.8		1.2
Taiwan		3.1		3.5
Thailand		47.5		17.5
Other		17.1		16.6
Total	NA	131.5	NA	104.2

[r]Revised. NA Not available.
[1]Customs value.

Source: Bureau of the Census.

TABLE 11

VALUE OF U.S. IMPORTS OF SYNTHETIC AND IMITATION GEMSTONES, INCLUDING PEARLS, BY COUNTRY

(Million dollars[1])

Country or territory	1992	1993
Synthetic, cut but unset:		
Australia	1.9	3.4
Austria	6.3	3.7
Germany	r10.1	10.7
Hong Kong	2.9	2.0
Korea, Republic of	4.2	2.1
Switzerland	4.6	3.8
Thailand	23.2	12.5
Other	r4.8	5.9
Total	r58.0	44.1
Imitation:		
Austria	r69.9	45.9
Czechoslovakia	7.0	—
Germany	2.8	2.0
Japan	2.3	.7
Other	2.7	11.4
Total	r84.7	60.0

rRevised.
[1]Customs value.

Source: Bureau of the Census.

TABLE 12

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES

(Thousand carats and thousand dollars)

Stones	1992		1993	
	Quantity	Value[1]	Quantity	Value[1]
Diamonds:				
Rough or uncut	1,628	495,003	1,770	610,113
Cut but unset	7,724	r3,648,640	9,703	4,486,270
Emeralds: Cut but unset	2,956	213,497	5,452	244,356
Coral and similar materials, unworked	2,787	6,115	2,800	5,442
Jade: Cut and rough	NA	109,233	NA	80,679
Rubies and sapphires: Cut but unset	7,246	r153,059	8,734	169,934
Pearls:				
Natural	NA	3,896	NA	2,887
Cultured	NA	r18,195	NA	20,483
Imitation	NA	r3,698	NA	1,957
Other precious and semiprecious stones:				
Rough, uncut	408,236	41,446	558,900	38,378
Cut, set and unset	NA	r109,376	NA	80,825
Other	281	5,957	175	5,869
Synthetic:				
Cut but unset	r217,010	r57,950	163,423	44,107
Other	NA	r1,628	NA	1,523
Imitation gemstone	NA	r81,029	NA	58,071
Total	XX	r4,948,722	XX	5,850,894

rRevised. NA Not available. XX Not applicable.
[1]Customs value.

Source: Bureau of the Census.

TABLE 13

DIAMOND: WORLD PRODUCTION, BY TYPE AND COUNTRY[1]

(Thousand carats)

Country	1989				1990				1991			
	Natural			Synthetic[4]	Natural			Synthetic[4]	Natural			Synthetic[4]
	Gem[2]	Industrial	Total[3]		Gem[2]	Industrial	Total[3]		Gem[2]	Industrial	Total[3]	
Angola[5]	1,165	80	1,245	—	1,060	73	1,133	—	899	62	961	—
Australia	17,540	17,540	35,080	—	17,331	17,331	34,662	—	17,978	17,978	35,956	—
Belarus	—	—	—	—	—	—	—	—	—	—	—	—
Botswana	10,680	4,570	15,252	—	12,150	5,200	17,352	—	11,550	4,950	16,506	—
Brazil	350	150	500	—	600	900	1,500	—	600	900	[e]1,500	—
Central African Republic	334	81	415	—	303	78	381	—	296	82	379	—
China[e]	200	800	1,000	15,000	200	800	1,000	15,000	200	800	1,000	15,000
Côte d'Ivoire[e] [6]	9	3	[7]12	—	9	3	12	—	11	4	15	—
Czech Republic[8]	—	—	—	—	—	—	—	—	—	—	—	—
Czechoslovakia[e] [9]	—	—	—	[e]10,000	—	—	—	[e]10,000	—	—	—	[e]10,000
France[e]	—	—	—	4,000	—	—	—	[r]5,000	—	—	—	4,000
Gabon[e]	400	100	500	—	400	100	500	—	400	100	500	—
Ghana[10]	[r]395	[r]99	494	—	[r]520	[r]130	650	—	[r]560	[r]140	700	—
Greece[e]	—	—	—	1,000	—	—	—	1,000	—	—	—	1,000
Guinea[e] [6]	137	10	147	—	119	8	127	—	91	6	97	—
Guyana	3	5	8	—	5	13	18	—	6	16	[r]22	—
India	[e]12	[r]3	15	—	[e]15	[r]3	18	—	[e]15	[r]3	18	—
Indonesia[e]	7	25	32	—	7	23	30	—	8	24	32	—
Ireland[e]	—	—	—	60,000	—	—	—	60,000	—	—	—	60,000
Japan[e]	—	—	—	25,000	—	—	—	25,000	—	—	—	30,000
Liberia[e] [11]	[7]62	[7]93	[7]155	—	40	60	100	—	40	60	100	—
Namibia	910	20	927	—	750	15	763	—	1,170	20	1,187	—
Romania[e]	—	—	—	[r]5,000	—	—	—	[r]3,000	—	—	—	[r]3,000
Russia[e]	—	—	—	—	—	—	—	—	—	—	—	—
Serbia and Montenegro[12]	—	—	—	—	—	—	—	—	—	—	—	—
Sierra Leone[6]	90	39	129	—	66	12	78	—	160	83	243	—
Slovakia[8]	—	—	—	—	—	—	—	—	—	—	—	—
South Africa, Republic of:												
Finsch Mine	1,600	3,000	4,610	—	1,480	2,700	4,178	—	1,200	2,280	3,483	—
Premier Mine	700	1,520	2,215	—	720	1,600	2,328	—	700	1,550	2,250	—
Venetia Mine	—	—	—	—	20	40	62	—	100	200	303	—
Other De Beers' properties[13]	1,350	530	1,880	—	1,200	460	1,652	—	1,500	400	1,897	—
Other	350	50	411	—	380	100	488	—	400	100	498	—
Total	4,000	5,100	9,116	[e]60,000	[r]3,800	4,900	8,708	[e]60,000	3,900	4,530	8,431	[e]60,000
Swaziland	33	22	55	—	25	17	42	—	34	23	57	—
Sweden[e]	—	—	—	25,000	—	—	—	25,000	—	—	—	25,000
Tanzania	105	45	[e]150	—	60	25	85	—	70	30	100	—
U.S.S.R.[e] [14]	11,500	11,500	23,000	[r]120,000	12,000	12,000	24,000	[r]120,000	10,000	10,000	20,000	[r]120,000
Ukraine	—	—	—	—	—	—	—	—	—	—	—	—
United States	—	—	—	W	—	—	—	W	—	—	—	90,000
Venezuela	70	185	255	—	[r]85	[r]248	333	—	102	112	214	—
Yugoslavia[e] [15]	—	—	—	5,000	—	—	—	5,000	—	—	—	5,000
Zaire	[7]2,663	[7]15,092	17,755	—	[7]2,914	[7]16,513	19,427	—	3,000	14,814	17,814	—
Total	[r]50,665	[r]55,562	106,242	[r]325,000	[r]52,459	[r]58,452	110,919	[r]269,000	[r]51,090	[r]54,737	[r]105,832	[r]423,000

See footnotes at end of table.

TABLE 13—Continued

DIAMOND: WORLD PRODUCTION, BY TYPE AND COUNTRY[1]

(Thousand carats)

Country	1992				1993[e]			
	Natural			Synthetic[4]	Natural			Synthetic[4]
	Gem[2]	Industrial	Total[3]		Gem[2]	Industrial	Total[3]	
Angola[5]	[r]1,100	[r]80	[r]1,180	—	470	30	500	—
Australia	[r]17,750	[r]22,250	[r, e]40,000	—	19,000	23,200	42,200	—
Belarus	—	—	—	[e]30,000	—	—	—	30,000
Botswana	[r]11,160	[r]4,790	[r]15,946	—	12,000	5,000	17,000	—
Brazil[e]	[r]653	[r]665	[r]1,318	—	600	900	1,500	—
Central African Republic	[r]307	[r]107	[r]414	—	307	106	413	—
China[e]	200	800	1,000	15,000	230	850	1,080	15,500
Côte d'Ivoire[e, 6]	11	4	15	—	11	4	15	—
Czech Republic[8]	—	—	—	—	—	—	—	5,000
Czechoslovakia[e, 9]	—	—	—	[r]10,000	—	—	—	—
France[e]	—	—	—	[r]3,500	—	—	—	3,500
Gabon[e]	400	100	500	—	400	100	500	—
Ghana[10]	[r]570	[r]140	[r]710	—	600	150	750	—
Greece[e]	—	—	—	750	—	—	—	1,000
Guinea[6]	90	5	95	—	90	5	95	—
Guyana	[r]13	[r]32	[r, e]45	—	14	36	50	—
India	[r]15	[r]3	18	—	16	3	19	—
Indonesia[e]	6	21	27	—	7	20	27	—
Ireland[e]	—	—	—	60,000	—	—	—	66,000
Japan[e]	—	—	—	30,000	—	—	—	32,000
Liberia[e, 11]	[r, 7]62	[r, 7]93	[r, 7]155	—	60	90	150	—
Namibia	[r]1,500	50	[r]1,548	—	1,100	40	[7]1,139	—
Romania[e]	—	—	—	[r, 7]—	—	—	—	—
Russia[e]	9,000	9,000	18,000	80,000	8,000	8,000	16,000	80,000
Serbia and Montenegro[12]	—	—	—	5,000	—	—	—	5,000
Sierra Leone[6]	[r]200	[r]96	[r]296	—	90	68	[7]158	—
Slovakia[9]	—	—	—	—	—	—	—	5,000
South Africa, Republic of:								
Finsch Mine	1,200	2,250	3,446	—	700	1,300	[7]2,012	—
Premier Mine	740	1,700	2,444	—	500	1,100	[7]1,596	—
Venetia Mine	660	1,200	1,868	—	1,750	3,200	[7]4,969	—
Other De Beers' properties[13]	1,350	500	1,849	—	900	350	[7]1,249	—
Other	450	100	549	—	450	100	550	—
Total	[r]4,400	[r]5,750	[r]10,166	[e]60,000	4,300	6,050	10,324	75,000
Swaziland	36	24	[r]51	—	27	18	45	—
Sweden[e]	—	—	—	25,000	—	—	—	25,000
Tanzania	[r]48	[r]20	[r]68	—	48	20	68	—
U.S.S.R.[e, 14]	—	—	—	—	—	—	—	—
Ukraine	—	—	—	[e]10,000	—	—	—	10,000
United States	—	—	—	90,000	—	—	—	103,000
Venezuela	[r]302	[r]176	[r]478	—	335	200	535	—
Yugoslavia[e, 15]	—	—	—	—	—	—	—	—

See footnotes at end of table.

TABLE 13—Continued

DIAMOND: WORLD PRODUCTION, BY TYPE AND COUNTRY[1]

(Thousand carats)

Country	1992				1993[e]			
	Natural			Synthetic[4]	Natural			Synthetic[4]
	Gem[2]	Industrial	Total[3]		Gem[2]	Industrial	Total[3]	
Zaire	r 7 8,934	r 7 4,567	r 13,501	—	9,500	5,500	15,000	—
Total	r 56,757	r 48,773	r 105,521	r 419,250	57,205	50,390	107,620	456,000

e Estimated. r Revised. W Withheld to avoid disclosing company proprietary data.

[1]Table includes data available through June 8, 1994. Total natural diamond output (gem plus industrial) for each country actually is reported, except where indicated by a footnote to be estimated. In contrast, the detailed separate production data for gem diamond and industrial diamond are U.S. Bureau of Mines estimates except Brazil (1989-90), and the Central African Republic (1989-90), for which source publications give details on grade as well as totals. The estimated distribution of total output between gem and industrial diamond is conjectural, and for most countries, is based on the best available data at time of publication.

[2]Includes near-gem and cheap-gem qualities.

[3]Natural gem and industrial data may not add to totals shown because of independent rounding.

[4]Includes all synthetic diamond production.

[5]Figures do not include smuggled artisanal production.

[6]Figures are estimates based on reported exports and do not include smuggled diamonds.

[7]Reported figure.

[8]Formerly part of Czechoslovakia.

[9]Dissolved on Dec. 31, 1992.

[10]"Gem" vs. "Industrial" diamond breakdown has been revised to reflect the value of near-gem material, classified as industrial prior to 1991, but which was ultimately being sold for well above industrial prices.

[11]Data for 1989 do not include smuggled production. Data for 1990-92 are estimates of artisanal production, likely smuggled out of Liberia, but which are comparable to that hitherto reported to the Government.

[12]Formerly part of Yugoslavia.

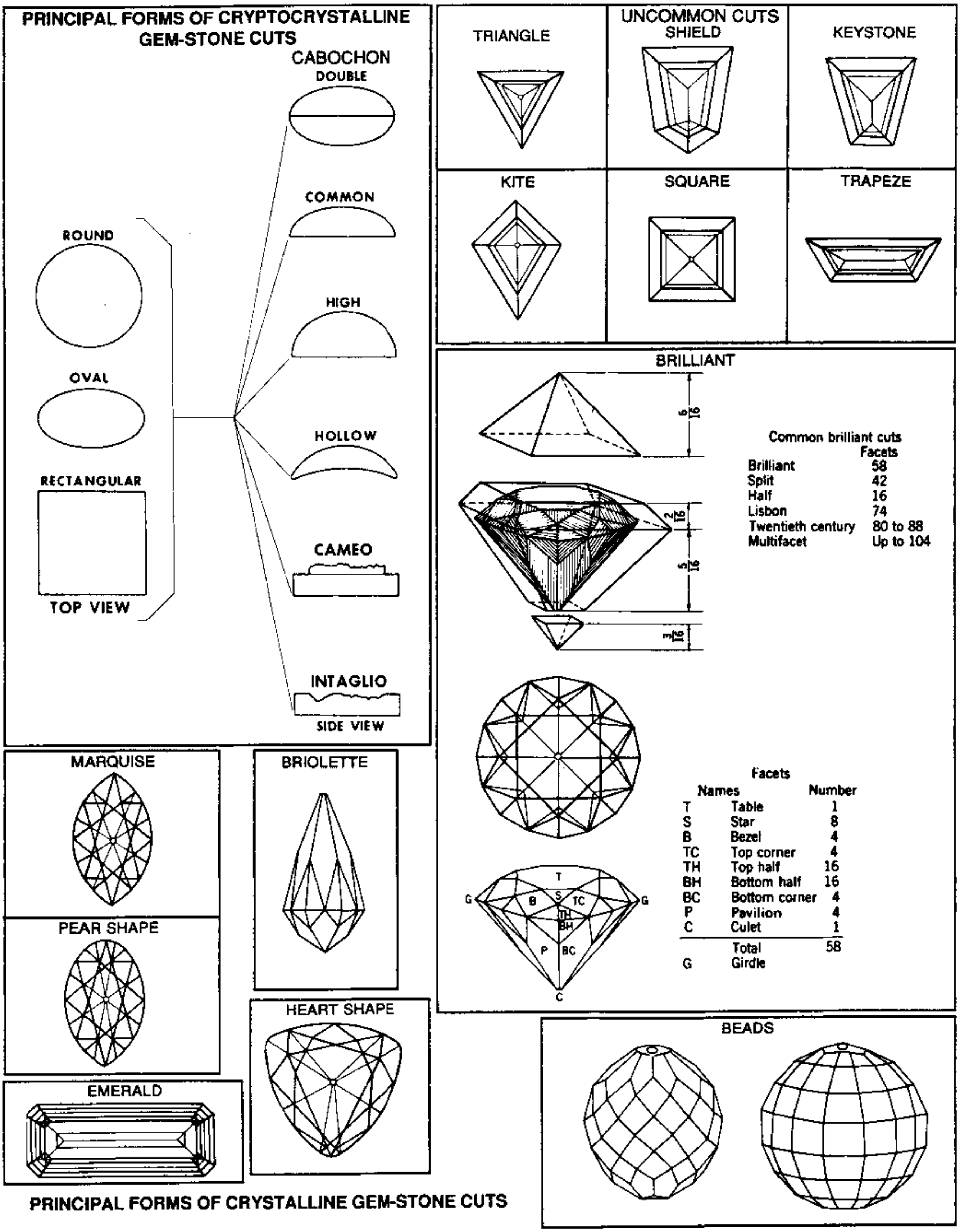
[13]Other De Beers' Group output from the Republic of South Africa includes Kimberley Mines, Koffiefontein Mine, and Namaqualand Mines.

[14]Dissolved in Dec. 1991.

[15]Dissolved in Apr. 1992.

FIGURE 1

PRINCIPAL FORMS OF CRYPTOCRYSTALLINE AND CRYSTALLINE GEM STONE CUTS



GEMSTONES

By Ronald F. Balazik

Webster's dictionary defines a gem as "any jewel, whether stone, pearl or the like, having value and beauty that are intrinsic and not derived from its setting; a precious or, sometimes, a semiprecious stone cut and polished for ornament. A semiprecious stone of value because it is carved or engraved, as a cameo or intaglio." Additionally, the dictionary states that gemstone is "any mineral or petrified material which can, when cut and polished, be used in jewelry." Therefore, a gem, gemstone, or gem material may be described as inorganic or organic minerals used for personal adornment, display, or to manufacture objects of art because they possess beauty, rarity, and durability. *(See table 1.)*

Production

Gemstones production in the United States during 1995 included cut, polished, engraved or carved material; specimen material; natural and cultured freshwater pearl; saltwater pearl; shell; amber; and coral. It is estimated that the value of domestic gemstone production from indigenous sources was at least $75 million in 1995. This estimate is based on a survey of more than 340 domestic gemstone operations conducted by the U.S. Geological Survey (USGS). The survey provides a foundation for projecting the scope and level of domestic gemstone operations. However, the survey is not necessarily representative of all gemstone activity in the United States, which includes thousands of professional and amateur collectors. Consequently, the USGS attempts to supplement its survey with estimates of domestic gemstones production from published data, contacts with gem dealers and collectors, and analyses of gem and mineral shows.

The USGS survey indicated that gem materials were produced in every State during 1995. Six States accounted for more than 90% of the total value of production reported by survey respondents. These States (in declining order of reported production value) were Tennessee, Alabama, Arkansas, Oregon, North Carolina, and Arizona. Certain States are known best for the production of a single gem material (e.g., Tennessee for freshwater pearls). Other States, however, produce a wide array of gemstones. For example, Arizona gemstone production includes agate, amethyst, antlerite, azurite, chrysocolla, fire agate, garnets, jade, malachite, obsidian, onyx, peridot, petrified wood, precious opal, shattuchite, smithsonite, and turquoise. California, Idaho, Montana, and North Carolina also produced a wide variety of gemstones.

New, potentially important gemstone mining operations were reported in 1995. For example, two new sapphire mining operations were initiated in Montana late in the year. Full-scale operations were expected to begin in 1996. Plans to open a commercial gem-quality diamond mine in Colorado also were reported during 1995.

It is estimated that U.S. synthetic gem production in 1995 was at least $25 million; simulant gemstone output reportedly was even greater. Some estimates of domestic synthetic/simulant production exceed $100 million. Laboratory grown synthetic gemstones have essentially the same appearance and optical, physical, and chemical properties as the natural material that they represent. Synthetic gemstones produced in the United States include alexandrite, coral, diamond, emerald, garnet, lapis lazuli, quartz, ruby, sapphire, spinel, and turquoise. Laboratory grown simulants have an appearance similar to that of a natural gem material but have different optical, physical, and chemical properties. The gemstone simulants produced in the United States include coral, cubic zirconia, lapis lazuli, malachite, and turquoise. Additionally, certain colors of synthetic sapphire and spinel, used to represent other gemstones, would be classed as simulants. Colored and colorless varieties of cubic zirconia are the major simulants produced.
(See table 2.)

Nine firms in five states reported the production of synthetic and simulant gem material in 1995. Reported production totalled $25 million. This output included the manufacture of alexandrite, azurite/malachite, cubic zirconia, emerald, lapis, ruby, sapphire, and turquoise. In descending order of production value, the States with reported output were California, New York, Michigan, Arizona, and New Jersey.

Consumption

Consumption of domestic gemstones was in the manufacture of jewelry; for exhibit in gem and mineral collections; for decorative purposes in statuettes, vases, and other art objects; and certain industrial applications. According to a survey conducted by a business association of domestic jewelry retailers, diamond remains the favorite gemstone jewelry among U.S. consumers. The survey also indicated that, in decreasing order of preference, diamonds were followed by emeralds, sapphires, and rubies as jewelry.

Prices

Values and prices of U.S. cut diamonds and U.S. cut gemstones are shown in tables 3, 4, and 5. Demand, beauty, durability, rarity, freedom from defects, and perfection of cutting generally govern the value of most gems. The Central Selling

Organization (CSO), controlled by De Beers Centenary AG, is a significant force affecting gem diamond prices worldwide.

Foreign Trade

The United States imported gemstones from more than 25 countries and exported/reexported gemstones to more than 75 countries during 1995. *(See tables 6 through 10.)*

The total value of all gemstones exported and reexported by the United States was about $2.53 billion; diamonds, including $2.01 billion for cut diamonds, accounted for 87% of the total. The value of U.S. exports plus reexports of natural rough colored gemstones was about $42.3 million, while the value of U.S. exports plus reexports of cut natural colored gemstones was about $207 million. Synthetic rough and cut gemstone exports plus reexports by the United States during the year were valued at $14.3 million and $14.5 million, respectively. Natural and cultured pearls exported and reexported by the United States were valued at $2.85 million and $5.33 million, respectively. Approximately $47.1 million of coral and shell was exported and reexported by the United States in 1995.

The United States remained the world's largest importer of colored gemstones in 1995. During the year, U.S. imports of gems and gemstones increased 3% to a record high of $6.66 billion. The value of imported gem diamonds accounted for about 89% of the total.

World Review

Foreign countries with major gemstone deposits other than diamond are Afghanistan (beryl, kunzite, ruby, and tourmaline); Australia (beryl, opal, and sapphire); Brazil (agate, amethyst, beryl, kunzite, ruby, sapphire, topaz, and tourmaline); Burma (beryl, jade, ruby, sapphire, and topaz); Colombia (beryl, and sapphire); Kenya (beryl, garnet, and sapphire); Madagascar (beryl, rose quartz, sapphire, and tourmaline); Mexico (agate, opal, and topaz); Sri Lanka (beryl, ruby, sapphire, and topaz); Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline); and Zambia (amethyst and beryl).

There are many natural diamond producers throughout the world. However, most production occurs in Africa (Angola, Botswana, Namibia, South Africa, and Zaire); Asia (northeastern Siberia and Yakutia in Russia); Australia; and South America (Venezuela and Brazil). *(See table 11.)*

De Beers Centenary AG, which controls most of the rough, uncut diamonds sold worldwide, reported record sales of $4.53 billion in 1995. This was an increase of 6.6% compared with 1994 sales. During 1995, diamond stocks held by De Beers ($4.67 billion) were greater than its annual sales for the second consecutive year; prior to 1994, stocks had never exceeded sales.

De Beers also encountered other significant issues in 1995. By yearend, for example, Australia's Argyle Diamond Mines Joint Venture was considering departure from the CSO. In addition, De Beers was seeking a trade agreement with Russia, which was selling diamonds independent of the CSO.

De Beers annual sales during the past five years were as follows: 1994, $4.25 billion; 1993, $4.40 billion; 1992, $3.42 billion; 1991, $3.93 billion; and 1990, $4.17 billion. During the same period De Beers' stocks of diamonds were: 1994, $4.38 billion; 1993, $4.10 billion; 1992, $3.36 billion; 1991, $3.03 billion; and 1990, $2.68 billion. (Estimated world retail sales of diamond jewelry rose 5% to more than $47 billion in 1995.)

Outlook

World demand for precious gems, particularly diamond, is expected to continue growing as personal disposable income rises in the United States and in other industrialized nations. Promotional efforts by producers and dealers also will further spur demand for gem diamond. Such efforts combined with rising incomes already are increasing retail diamond sales in Japan and other Asian countries. Demand for other precious gems will continue to rise as diamonds become more expensive and the popularity and acceptance of colored gemstones increase. Some in the industry anticipate further consolidation of jewelry retailing toward fewer companies and predict more niche marketing that targets specific demographic groups. Demand for synthetic and simulant gemstones for both personal and industrial consumption is expected to increase.

OTHER SOURCES OF INFORMATION

U.S. Geological Survey Publications

Gemstones, Mineral Commodity Summaries—1996.

Garnet, Mineral Industry Surveys, Annual Review—1995

Industrial Diamond, Mineral Industry Surveys, Annual Review—1995.

Other Sources

Annual Report—1995, De Beers Consolidated Mines Limited, Kimberley, South Africa.

Directory of Principal U.S. Gemstone Producers in 1995, Mineral Industry Surveys, U.S. Bureau of Mines, 1995.

An overview of Production of Specific U.S. Gemstones, Special Publication 14-95, U.S. Bureau of Mines, 1995.

TABLE 1
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0-2.5	1.0-1.1	Single	1.54	Synthetic or pressed, plastics	Fossil resin, soft.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5-8.0	2.63-2.80	Double	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	do.	Small	Very high	7.5-8.0	2.63-2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald	do.	Green	Medium	do.	7.5	2.63-2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5-8.0	2.63-2.80	do.	1.58	Genuine emerald	Flaws, brilliant, fluorescence in ultraviolent light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5-8.0	2.63-2.80	do.	1.58	Citrine, topaz, glass, doublets	
Goshenite	do.	do.	Any	Low	7.5-8.0	2.63-2.80	do.	1.58	Quartz, glass, white sapphire, white topaz.	Refractive index.
Morganite	do.	Pink to rose	Any	Low	7.5-8.0	2.63-2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	Any	Low	3.0	2.72	Double (strong)	1.49-1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	Any	Low	3.0	2.72	do.	1.6	do.	Banded, translucent.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day, red by artificial light	Former U.S.S.R. (small), Sri Lanka (medium)	High	8.5	3.50-3.84	Double	1.75	Synthetic	Dichroism, inclusions in synthetic sapphire
Cats-eye	do.	Greenish to brownish	Small to large	do.	8.5	3.50-3.84	do.	1.75	Synthetic, shell	Gravity and translucence.
Chrysolite	do.	Yellow, green, and/or brown	Medium	Medium	8.5	3.50-3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.

See footnotes at end of table.

TABLE 1--Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Coral	Calcium carbonate	Orange, red, white, black, or green	Branching, medium	Low	3.5-4.0	2.6-2.7	Double	1.49-1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95-4.10	do.	1.78	Synthetics, including spinel	Inclusions, fluorescence.
Sapphire	do.	Blue	Medium	High	9.0	3.95-4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, white, orange, green, or violet	Medium to large	Medium	9.0	3.95-4.10	do.	1.78	Synthetics, glass and doublets	Inclusions, double refraction, refractive index.
Sapphire and ruby stars	do.	Red, pink, violet blue, or gray	do.	High to Low	9.0	3.95-4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color on side view.
Sapphire or ruby synthetic	do.	Yellow, pink, or blue	Up to 20 carats	Low	9.0	3.95-4.10	do.	1.78	Synthetic spinel, glass	Curved strae, bubble inclusions.
Diamond	Carbon	White, blue-white, yellow, brown, green, pink, blue	Any	Very high	10.0	3.516-3.525	Single	2.42	Zircon, titania, cubic zirconia	High index, dispersion, single refraction, hardness, cut, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green	Large	Low	6.0-6.5	2.56	--	1.52	Jade	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play.	do.	Low	6.0-6.5	2.56	--	1.56	do.	Cleavage, sheen, vitreous to pearly, opaque, grid.
Moonstone	do.	White	do.	Low	6.0-6.5	2.77	--	1.52-1.54	Glass or white onyx.	Blue sheen, opalescent.
Garnet	Complex silicate	Brown, black, yellow, green, ruby red, or orange	Small to medium	Low to high	6.5-7.5	3.15-4.30	Single strained	1.79-1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Jade:										
Jadeite	do.	Green, yellow, black, white, or mauve	Large	Low to very high	6.5-7.0	3.3-3.5	Cryptocry stalline	1.65-1.68	Onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent, to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0-6.5	2.96-3.10	do.	1.61-1.63	do.	Do.

See footnotes at end of table.

TABLE 1--Continued

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Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Opal	Hydrous silica	Colors flash in white gray, black, red, or yellow	Large	Low to high	5.5-6.5	1.9-2.3	Isotropic	1.45	Glass, synthetics, triplets	Play of color.
Pearl	Calcium carbonate	White, pink, or black	Small	do.	2.5-4.0	2.6-2.85	--	--	Cultured and imitation	Luster, structure, X-ray.
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5-7.0	3.27-3.37	Double (strong)	1.65-1.69	Tourmaline chrysoberyl	Strong double refraction, low dichroism.
Quartz:										
Agate	Silica	Any color	Large	Low	7.0	2.58-2.64	--	--	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65-2.66	Double	1.55	do.	Refractive index, double refraction, transparent.
Cairngorm	do.	Smoky	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Citrine	do.	Yellow	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Crystal, rock	do.	Colorless	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Jasper	do.	Uniform or spotted red, yellow or green	do.	Low	7.0	2.58-2.66	--	--	do.	Opaque, vitreous.
Onyx	do.	Many colors	do.	Low	7.0	2.58-2.64	--	--	do.	Uniformly banded.
Rose	do.	Pink, rose red	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Refractive index, double refraction, translucent.
Spinel	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5-3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, Synthetic	do.	Any	Up to 40 carats	Low	8.0	3.5-3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Kunzite	Lithium aluminum silicate	Pink to lilac	Medium	Medium	6.5-7.0	3.13-3.20	Double	1.66	Amethyst, morganite	Refractive index.
Hiddenite	do.	Yellow to green	do.	do.	6.5-7.0	3.13-3.20	do.	1.66	Synthetic spinel	Do.
Tanzanite	Complex silicate	Blue	Small	High	6.0-7.0	3.30	Double	1.69	Sapphire, synthetics	Strong trichroism.
Topaz	do.	White, blue, green	Medium	Low to medium	8.0	3.4-3.6	do.	1.62	Beryl, quartz	Refractive index.
Tourmaline	do.	All, including mixed	do.	do.	7.0-7.5	2.98-3.20	do.	1.63	Peridot, beryl, corundum, glass	Double refraction, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green	Large	Low	6.0	2.60-2.83	do.	1.63	Glass, plastics	Difficult if matrix not present, matrix usually limonitic.
Zircon	Zirconium silicate	White, blue, or brown, yellow, or green	Small to medium	Low to medium	6.0-7.5	4.0-4.8	Double (strong)	1.79-1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

1/ Small-up to 5 carats; medium-up to 50 carats; large-more than 50 carats.

2/ Low-up to \$25 per carat; medium-up to \$200 per carat; high-more than \$200 per carat.

TABLE 2
SYNTHETIC GEMSTONE PRODUCTION METHODS

Gemstone	Production methods	Company	Date of first production
Ruby	Flux	Chatham	1950's
Do.	do.	Kashan	1960's
Do.	do.	J.O. Crystal (Ramaura)	1980's
Do.	do.	Douras	1990's
Do.	Zone melt	Seiko	1980's
Do.	Melt pulling	Kyocera (Inamori)	1970's
Do.	Verneuil	Various producers	1900's
Star ruby	do.	Linde (Div. of Union Carbide)	1940's
Do.	Melt pulling	Kyocera	1980's
Do.	do.	Nakazumi	1980's
Sapphire	Flux	Chatham	1970's
Do.	Zone melt	Seiko	1980's
Do.	Melt pulling	Kyocera	1980's
Do.	Verneuil	Various producers	1900's
Star sapphire	do.	Linde	1940's
Emerald	Flux	Chatham	1930's
Do.	do.	Gilson	1960's
Do.	do.	Kyocera	1970's
Do.	do.	Seiko	1980's
Do.	do.	Lennix	1980's
Do.	do.	Russia	1980's
Do.	Hydrothermal	Lechleitner	1960's
Do.	do.	Regency	1980's
Do.	do.	Biron	1980's
Do.	do.	Russia	1980's
Alexandrite	Flux	Creative crystals	1970's
Do.	Melt pulling	J.O. Crystal	1990's
Do.	do.	Kyocera	1980's
Do.	Zone melt	Seiko	1980's
Cubic zirconia	Skull melt	Various producers	1970's

TABLE 3
VALUE OF U.S. GEMSTONE
PRODUCTION, BY GEMSTONE 1/

(Thousand dollars)

Gem materials	1994	1995
Agate	234	907
Beryl	492	698
Coral (all types)	88	114
Diamonds	284	163
Garnet	780	4,180
Gem feldspar	2,620	3,150
Geode/nodules	127	206
Obsidian	40	64
Opal	1,120	475
Peridot	635	225
Petrified wood	208	150
Quartz	1,060	1,440
Sapphire/ruby	2,810	785
Shell	33,000	54,500
Topaz	13	9
Tourmaline	14	52
Turquoise	1,710	1,670
Other	5,310	5,580
Total	50,500 r/	74,400 2/

r/ Revised.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Estimated minimum production.

TABLE 4

PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY

Carat weight	Description, color 1/	Clarity 2/ (GIA terms)	Price range per carat 3/ Jan. 1995-Jan. 1996	Average 4/ July 1994
0.25	G	VS1	$1,400 - $1,400	$1,400
.25	G	VS2	1,300 - 1,300	1,300
.25	G	SI1	975 - 975	975
.25	G	VS1	1,300 - 1,300	1,200
.25	G	VS2	1,150 - 1,150	1,150
.25	G	SI1	950 - 950	950
.50	G	VS1	3,050 - 3,050	3,050
.50	G	VS2	2,700 - 2,700	2,700
.50	G	SI1	2,400 - 2,400	2,400
.50	G	VS1	2,800 - 2,800	2,800
.50	G	VS2	2,600 - 2,600	2,600
.50	G	SI1	2,300 - 2,300	2,300
.75	G	VS1	3,650 - 3,600	3,650
.75	G	VS2	3,350 - 3,350	3,350
.75	G	SI1	2,950 - 3,100	2,950
.75	G	VS1	3,250 - 3,400	3,250
.75	G	VS2	2,950 - 3,200	2,950
.75	G	SI1	2,750 - 2,900	2,750
1.00	G	VS1	4,800 - 4,900	4,800
1.00	G	VS2	4,250 - 4,600	4,250
1.00	G	SI1	3,850 - 4,200	3,850
1.00	G	VS1	4,250 - 4,500	4,250
1.00	G	VS2	4,050 - 4,400	4,050
1.00	G	SI1	3,750 - 4,000	3,750

1/ Gemological Institute of America (GIA) color grades: D- -colorless; E- -rare white; G - H - I - -traces of color.

2/ Clarity: IF--no blemishes; VVS1--very, very slightly included; VS1--very slightly included; VS2--very slightly included, but not visible; SI1--slightly included.

3/ Jeweler's Circular-Keystone. V. 167, No. 3, Mar. 1996, p. 142.

4/ Jeweler's Circular-Keystone. V. 166, No. 9, Sept. 1995, p. 232.

TABLE 5

PRICES OF U.S. CUT COLORED GEMSTONES, BY SIZE 1/

Gemstone	Carat weight	Price range per carat in 1995 2/	Average price per carat 2/ Jan. 1995	Jan. 1996
Amethyst	1	$8 - $18	$13.00	$13.00
Aquamarine	1	75 - 90	82.50	82.50
Emerald	1	1,750 - 3,200	2,475.00	2,475.00
Garnet, tsavorite	1	600 - 900	750.00	750.00
Ruby	1	2,450 - 3,900	3,175.00	3,175.00
Sapphire	1	800 - 1,800	1,300.00	1,300.00
Tanzanite	1	115 - 220	157.50	172.50
Topaz	1	3 - 5	4.00	4.00
Tourmaline, red	1	60 - 125	92.50	92.50

1/ Fine quality.

2/ Jewelers' Circular-Keystone. V. 167, No. 3, Mar. 1996, p. 142. These figures represent a sampling of net prices that wholesale colored stone dealers in various U.S. cities charged its cash customers during the month for fine-quality stones.

TABLE 6
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY 1/

Country	1994 Quantity (carats)	1994 Value 2/ (millions)	1995 Quantity (carats)	1995 Value 2/ (millions)
Belgium	462,000	$430	658,000	$475
Canada	263,000	46	123,000	44
France	11,100	27	23,900	31
Hong Kong	192,000	402	462,000	436
Israel	413,000	393	496,000	480
Japan	55,000	134	150,000	159
Singapore	14,000	36	26,500	57
Switzerland	36,200	190	54,100	183
Thailand	41,300	19	124,000	32
United Kingdom	23,300	66	10,900	64
Other	110,000	49	202,000	85
Total	1,620,000	1,790	2,330,000	2,040

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Customs value.

Source: Bureau of the Census, U.S. Department of Commerce.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY 1/

Kind, range, and country of origin	1994 Quantity (carats)	1994 Value 2/ (millions)	1995 Quantity (carats)	1995 Value 2/ (millions)
Rough or uncut, natural: 3/				
Belgium	301,000	$174	181,000	$119
Brazil	15,300	4	4,910	1
Israel	23,100	15	36,500	22
Netherlands	109	(4/)	--	--
South Africa	34,800	43	17,800	26
Switzerland	1,960	8	6,950	10
United Kingdom	482,000	225	969,000	155
Venezuela	556	(4/)	19,900	(4/)
Other	576,000	321	476,000	299
Total	1,440,000	790	1,710,000	631
Cut but unset, not more than 0.5 carat:				
Belgium	849,000	236	677,000	181
Brazil	27,000	4	6,450	1
Canada	10,000	2	3,990	1
Hong Kong	145,000	30	216,000	39
India	6,150,000	1,130	7,240,000	1,190
Israel	880,000	360	769,000	352
South Africa	3,680	3	8,580	4
Switzerland	5,260	2	8,600	1
United Kingdom	9,750	2	8,260	2
Other	83,300	21	112,000	23
Total	8,160,000	1,790	9,050,000	1,790
Cut but unset, over 0.5 carat:				
Belgium	769,000	1,030	873,000	1,110
Hong Kong	29,000	43	43,600	64
India	248,000	143	326,000	196
Israel	1,350,000	1,570	1,490,000	1,740
Netherlands	491	3	300	1
South Africa	19,700	54	15,100	37
Switzerland	16,900	153	19,600	196
United Kingdom	14,600	45	8,290	38
Other	78,300	121	105,000	143
Total	2,520,000	3,160	2,880,000	3,530

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Customs value.
3/ Includes some natural advanced diamond.
4/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY 1/

Kind and country	1994 Quantity (carats)	1994 Value 2/ (millions)	1995 Quantity (carats)	1995 Value 2/ (millions)
Emerald:				
Belgium	8,360	$2	27,000	$4
Brazil	1,140,000	7	2,620,000	6
Colombia	928,000	89	1,130,000	94
France	1,590	2	1,500	2
Germany	106,000	4	24,600	2
Hong Kong	295,000	13	315,000	17
India	2,310,000	33	2,570,000	47
Israel	107,000	25	116,000	27
Japan	1,940	1	1,300	(3/)
South Africa	249	(3/)	474	(3/)
Switzerland	33,200	28	50,900	26
Taiwan	545	(3/)	3,890	(3/)
Thailand	558,000	10	418,000	7
United Kingdom	4,300	4	2,630	1
Other	169,000	9	32,600	3
Total	5,670,000	227	7,320,000	236
Ruby:				
Belgium	26,900	2	14,600	1
Brazil	5,670	(3/)	233	(3/)
Colombia	7,390	(3/)	438	(3/)
France	393	1	482	2
Germany	90,900	3	129,000	1
Hong Kong	171,000	7	278,000	6
India	1,480,000	7	1,370,000	6
Israel	81,300	1	8,360	1
Japan	3,170	(3/)	1,050	(3/)
Switzerland	24,500	14	52,400	18
Thailand	2,950,000	56	2,270,000	41
United Kingdom	2,770	2	13,900	2
Other	25,900	4	39,400	5
Total	4,860,000	96	4,180,000	84
Sapphire:				
Australia	27,200	1	49,900	1
Austria	229	1	214	(3/)
Belgium	16,300	2	9,280	(3/)
Brazil	12,300	(3/)	7,570	(3/)
Canada	274,000	1	82,200	(3/)
Colombia	7,240	1	1,270	(3/)
France	739	(3/)	863	1
Germany	130,000	3	146,000	2
Hong Kong	172,000	5	505,000	4
India	244,000	2	329,000	1
Israel	34,500	1	17,500	2
Japan	1,950	(3/)	831	(3/)
Singapore	8,880	(3/)	1,250	(3/)
Sri Lanka (Ceylon)	341,000	8	328,000	9
Switzerland	17,000	12	17,700	13
Thailand	5,740,000	62	5,240,000	49
United Kingdom	7,130	2	7,750	2
Other	31,600	2	30,300	1
Total	7,060,000	101	6,780,000	84

See footnotes at end of table.

TABLE 8--Continued

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY 1/

Kind and country	1994 Quantity (carats)	1994 Value 2/ (millions)	1995 Quantity (carats)	1995 Value 2/ (millions)
Other:				
Rough, uncut:				
Australia		$3		$3
Brazil		27		32
Colombia		6		3
Hong Kong		1		1
Nigera	NA	(3/)	NA	(3/)
Pakistan		2		1
South Africa		1		(3/)
Switzerland		(3/)		(3/)
United Kingdom		(3/)		(3/)
Zambia		1		1
Other	30,500,000	13 r/	61,900,000	21
Total	97,400,000	54 r/	1,530,000,000	61
Cut, set and unset:				
Australia		4		6
Brazil		8		8
Canada		1		(3/)
China		4		5
Germany		15 r/		14
Hong Kong	NA	23 r/	NA	23
India		11 r/		13
Japan		10		11
Switzerland		2		1
Taiwan		3		2
Thailand		21 r/		19
United Kingdom		(3/)		1
Other	NA	18 r/	NA	22
Total	NA	122 r/	NA	125

r/ Revised. NA Not available.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Customs value.

3/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 9
VALUE OF U.S. IMPORTS OF SYNTHETIC AND IMITATION
GEMSTONES, INCLUDING PEARLS, BY COUNTRY

(Thousand dollars) 1/

Country	1994	1995
Synthetic, cut but unset:		
Australia	2,720	1,120
Austria	5,050	6,250
China	908	2,830
France	999	1,010
Germany	10,900	11,000
Hong Kong	1,890	1,390
Italy	688	1,120
Japan	1,080	512
Korea, Republic of	1,470	1,360
Sri Lanka (Ceylon)	725	510
Switzerland	3,530	4,430
Thailand	9,820	371
Other	1,130	1,780
Total	41,000	41,200
Imitation: 2/		
Austria	48,100	59,900
China	421	575
Czech Republic	9,830	12,800
Germany	2,160	1,640
Japan	552 r/	503
Taiwan	744	448
Other	1,020	1,240
Total	62,800 r/	77,100

r/ Revised.
1/ Customs value.
2/ Includes pearls.

Source: Bureau of the Census.

TABLE 10
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES 1/

(Thousand carats and thousand dollars)

	1994		1995	
Stones	Quantity	Value 2/	Quantity	Value 2/
Diamonds:				
Rough or uncut	1,440	790,000	1,710	631,000
Cut but unset	10,700	4,940,000	11,900	5,320,000
Emeralds: Cut but unset	5,670	227,000	7,320	236,000
Coral and similar materials, unworked	2,400	4,630	2,140	4,020
Rubies and sapphires: Cut but unset	11,900	197,000	11,000	168,000
Pearls:				
Natural	NA	2,360	NA	3,260
Cultured	NA	24,700	NA	30,400
Imitation	NA	1,870	NA	1,660
Other precious and semiprecious stones:				
Rough, uncut	971,000	44,100	1,420,000	48,600
Cut, set and unset	NA	94,600	NA	91,500
Other	157	5,000	108,000	8,800
Synthetic:				
Cut but unset	178,000	41,000	160,000	41,200
Other	NA	1,660	NA	1,830
Imitation gemstone 3/	NA	60,900	NA	75,400
Total	XX	6,440,000	XX	6,660,000

NA Not available. XX Not applicable.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Customs value.
3/ Does not include pearls.

Source: Bureau of the Census.

TABLE 11

NATURAL DIAMOND: WORLD PRODUCTION, BY TYPE AND COUNTRY 1/ 2/

(Thousand carats)

Country	1991			1992		
	Gem e/ 3/	Industrial e/	Total 4/	Gem e/ 3/	Industrial e/	Total 4/
Angola 5/	899	62	961	1,100	80	1,180
Australia	17,978	17,978	35,956	18,078	22,095	40,173
Botswana	11,550	4,950	16,500	11,160	4,790	15,950
Brazil	600	900	1,500 e/	653	665	1,318
Central African Republic	296	82	378	307	107	414
China	200	800	1,000 e/	200	800	1,000 e/
Gabon	400	100	500 e/	400	100	500 e/
Ghana	560	140	700 e/	570	140	710 e/
Namibia	1,170	20	1,190	1,520	30	1,550
Russia	XX	XX	XX	9,000	9,000	18,000
Sierra Leone 6/	160	83	243	180	116	296
South Africa	3,800	4,600	8,400 r/	4,600	5,600	10,200
U.S.S.R. 7/	10,000	10,000	20,000 e/	XX	XX	XX
Venezuela	102 8/	112 8/	214	302 8/	176 8/	478
Zaire	3,000	14,814	17,814	8,934	4,567	13,501
Other	275 r/	166 r/	441 r/	305 r/	218 r/	524 r/
Total	51,000	54,800	106,000	57,300	48,500	106,000

Country	1993			1994 e/		
	Gem e/ 3/	Industrial e/	Total 4/	Gem 3/	Industrial	Total
Angola 5/	130	15	145	270	30	300
Australia	18,844	23,032	41,876	19,485	23,815	43,300
Botswana	10,310	4,420	14,730	10,550 r/ 8/	5,000	15,550 r/ 8/
Brazil	600	900	1,500 e/	600	900	1,500
Central African Republic	370	125	495	400 r/	131 r/	531 r/
China	230	850	1,080 e/	230	850	1,080
Gabon	400	100	500 e/	400	100	500
Ghana	570	140	710 e/	580	145	725
Namibia	1,120	20	1,140	1,312 r/ 8/	-- r/	1,312 r/ 8/
Russia	8,000	8,000	16,000	8,500	8,500	17,000
Sierra Leone 6/	90	68	158	155	100	255
South Africa	4,600	5,700	10,300	4,340 r/	5,343 r/	9,683 r/
U.S.S.R. 7/	XX	XX	XX	XX	XX	XX
Venezuela	146 r/ 8/	155 8/	301	203 r/ 8/	214 r/ 8/	417 r/ 8/
Zaire	2,006	13,620	15,626	4,000	13,000	17,000
Other	296 r/	218 r/	513 r/	333 r/	221 r/	554 r/
Total	47,700	57,400 r/	105,000	51,400 r/	58,300 r/	110,000 r/

Country	1995 e/		
	Gem 3/	Industrial	Total
Angola 5/	450	50	500
Australia	18,312	22,381	40,693
Botswana	11,502	5,300	16,802 8/
Brazil	600	900	1,500
Central African Republic	400	130	530
China	230	900	1,130
Gabon	400	100	500
Ghana	580	145	725
Namibia	1,382 8/	--	1,382 8/
Russia	9,000	9,000	18,000
Sierra Leone 6/	113 8/	100	213 8/
South Africa	4,300	5,383	9,683 8/
U.S.S.R. 7/	XX	XX	XX
Venezuela	229 8/	64 8/	293 8/
Zaire	4,000	13,000	17,000
Other	363	246	609
Total	51,900	57,700	110,000

e/ Estimated. r/ Revised. XX Not applicable.

1/ Table includes data available through June 21, 1996.

2/ World totals are rounded to three significant digits; may not add to totals shown.

3/ Includes near-gem and cheap-gem qualities.

4/ Total natural diamond output (gem plus industrial) for each country actually is reported, except where indicated to be an estimate.

5/ Figures do not include smuggled artisanal production.

6/ Figures are estimates based on reported exports and do not include smuggled diamonds.

7/ Dissolved in Dec. 1991.

8/ Reported figure.

GEMSTONES

By Ronald F. Balazik

According to Webster's dictionary, a gem is "any jewel, whether stone, pearl or the like, having value and beauty that are intrinsic and not derived from its setting; a precious or, sometimes, a semiprecious stone cut and polished for ornament. A semiprecious stone of value because it is carved or engraved, as a cameo or intaglio." Additionally, the dictionary states that gemstone is "any mineral or petrified material which can, when cut and polished, be used in jewelry."

For this report, therefore, "gemstone" is defined as any organic or inorganic mineral used for personal adornment, display, or object of art because the mineral possesses beauty, rarity, and durability. Note that shell and cultured pearl are treated as gemstones in this report. Also, synthetic gems are covered in this report but are treated separately from natural gemstones. (*See tables 1 and 2.)*

Production

It is estimated that the value of natural gemstones produced in the United States from indigenous sources during 1996 was at least $44 million. *(See table 3.)* This output was significantly less than production in the preceding year because foreign markets for shell declined, particularly in Japan where the operations of cultured pearl producers who use shell material for pearl nuclei were adversely affected by massive pearl oyster deaths.

The estimate of 1996 gemstones production is based on a survey of more than 250 domestic gemstone operations conducted by the U.S. Geological Survey (USGS). The survey provides a foundation for projecting the scope and level of domestic gemstone production. However, the survey does not represent all gemstone activity in the United States, which includes thousands of professional and amateur collectors. Consequently, the USGS attempts to supplement its survey with estimates of domestic gemstones production from related published data, contacts with gem dealers and collectors, and analyses of gem and mineral shows.

Natural gem materials indigenous to the United States are collected, produced, or marketed in every State. However, six States accounted for more than 75% of the total value of production reported by survey respondents. These States (in declining order of reported production value) were Tennessee, Oregon, Kentucky, Arkansas, Arizona, and Alabama. Certain States are known best for the production of a single gem material (e.g., Tennessee for freshwater shell). Other States, however, have a wide array of gemstones. For example, Arizona gemstone deposits include agate, amethyst, azurite, chrysocolla, fire agate, garnets, jade, malachite, obsidian, onyx, petrified wood, precious opal, smithsonite, and turquoise. A great variety of gemstones also can be found in California, Idaho, Montana, and North Carolina.

Progress continued in 1996 toward opening the first commercial diamond mine in North America in almost a century. Colorado Diamond Co., a subsidiary of Redaurum Red Lakes Mines Ltd. (Toronto), announced a two-year trial mining program at its Kelsey Lake kimberlite prospect near Fort Collins, CO (U.S. Geological Survey 1997b). Open pit mining at Kelsey Lake commenced in 1995, and a diamond processing plant at the site began operating in May 1996. Production is expected to reach 100,000 to 150,000 carats at its peak.

Evaluation of a large lamproite intrusion located in Crater of Diamonds State Park near Murfreesboro, AR, also continued in 1996 (U.S. Geological Survey, 1997a). The intrusion has long been known to contain diamonds that range greatly in size and quantity. During 1996, the U.S. National Park Service permitted Arkansas to proceed with bulk sampling and testing operations.

In addition to natural gemstones, laboratory-grown synthetic gems and gem simulants are produced in the United States and elsewhere. Synthetic gemstones essentially have the same appearance and the same optical, physical, and chemical properties as the natural materials that they represent. Simulants have an appearance similar to that of a natural gem material but have different optical, physical, and chemical properties. Synthetic gemstones produced in the United States include alexandrite, emerald, ruby, sapphire, turquoise, and zirconia. Simulants produced in the United States include coral, cubic zirconia, lapis lazuli, malachite, and turquoise. Additionally, certain colors of synthetic sapphire and spinel, used to represent other gemstones, are classed as simulants. Colored and colorless varieties of cubic zirconia are the major simulants produced.

Synthetic gem production in the United States reached $24 million in 1996; simulant gemstone output was even greater (estimated to exceed $100 million). Five firms in four states, representing virtually all of the U.S. synthetic gem industry, reported production to the USGS in 1996. In descending order of production value, the States with reported output were California, New York, Michigan, and Arizona.

Consumption

The U.S. market in 1996 for natural, unset colored gemstones (excluding pearl and coral) was estimated to be more than $370 million. The domestic market for unset gem diamonds in 1996 was estimated to be more than $4.3 billion, the largest in the world.

Gemstones are used in the United States and elsewhere for jewelry, collections/exhibits, decorative art objects, and certain industrial applications. According to a poll conducted in 1996 by a U.S. jewelry retailers association, 61% of domestic consumers who were surveyed preferred diamond as their favorite gemstone; others preferred emeralds (10%), sapphires (9%), and rubies (7%) (International Colored Gemstone Association, 1996).

Prices

Gemstone prices are governed by many factors, including beauty, clarity, defects, demand, and rarity. Values and prices of gemstones produced and/or sold in the United States are shown in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported and exported or reexported are shown in tables 6 through 10.

The Central Selling Organization (CSO), controlled by De Beers Centenary AG (Switzerland), is a significant force affecting gem diamond prices worldwide. The average price of all rough uncut diamonds sold worldwide was estimated to be about $70 per carat in 1996; by country, the average value reported per carat ranged from $9 for Australian production to $315 for Namibian output (Financial Times, 1997).

Foreign Trade

By several standards, the United States is the world leader in gemstone trade. In 1996, U.S. gemstone imports came from 106 countries and domestic exports/reexports of gemstones went to 56 countries. *(See tables 6 through 10.)*

The United States remained the world's largest importer of colored gemstones in 1996; imports of natural colored gemstones, excluding coral and pearl, reached $572 million. During the year, U.S. imports of all gemstones, including synthetics and simulants, increased 8% to a record high of $7.24 billion. Gem diamonds accounted for about 90% of the total.

Domestic exports and reexports of all gemstones in 1996 totaled about $2.7 billion; diamonds, including $2.2 billion for cut diamonds, accounted for 81% of the total. The value of U.S. exports plus reexports of natural, rough, colored gemstones was about $29.1 million, while the value of U.S. exports plus reexports of natural, cut, colored gemstones was about $175 million. Synthetic gemstone exports and reexports during the year were valued at $12.4 million and $17.1 million, respectively. Exports and reexports of pearl were valued at $1.9 million and $6.6 million, respectively. Approximately $38.6 million of coral and shell was exported and reexported by the United States in 1996.

World Review

In 1996, world diamond production reached 117 million carats with an estimated value of approximately $7 billion. *(See table 11.)* Although there are many diamond mines throughout the world, much production is concentrated in a few regions. Most world diamond production occurs in Africa (Angola, Botswana, Namibia, South Africa, and Zaire); Asia (northeastern Siberia and Yakutia in Russia); Australia; and South America (Brazil and Venezuela).

In addition to the new U.S. diamond mine, noted on page 1, substantial progress was made in 1996 on plans for Canada's first gem-quality diamond mine (Wilkinson, 1997). Final approvals for construction of the mine, located in the Northwest Territories, were granted during the year by the Canadian government. The mine is expected to employ 800 workers and generate approximately $350 million annually over a 25-year lifespan. Production is scheduled to begin in 1998.

De Beers Centenary AG, through its CSO, controlled most of the rough, uncut diamonds sales worldwide during 1996. De Beers reported record sales of $4.83 billion during the year. The record was 7% greater than De Beers rough diamond sales in 1995. Moreover, the sales in 1996, unlike the preceding 2 years, surpassed the value of diamond stocks ($4.7 billion) held by De Beers (Cockle, 1997b). Nevertheless, world diamond retail sales decreased slightly to $52 billion, partly due to a weaker Japanese market (Cockle, 1997a).

De Beers also encountered significant events in the world diamond market during 1996. For example, Australia's Argyle Diamond Mines Joint Venture (which accounts for more than one-third of global diamond output) withdrew from the CSO to sell its production independently. In addition, Russia's marketing accord with the CSO was not renewed when agreement on the terms of a new contract could not be reached; negotiations between the two parties were continuing at yearend.

It is estimated that annual world production of cut natural gemstones other than diamond and pearl exceeded $2 billion in the mid-1990's. Foreign countries with major gemstone deposits other than diamond are Afghanistan (beryl, ruby, and tourmaline); Australia (beryl, opal, and sapphire); Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline); Burma (beryl, jade, ruby, sapphire, and topaz); Colombia (beryl, emerald, and sapphire); Kenya (beryl, garnet, and sapphire); Madagascar (beryl, rose quartz, sapphire, and tourmaline); Mexico (agate, opal, and topaz); Sri Lanka (beryl, ruby, sapphire, and topaz); Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline); and Zambia (amethyst and beryl). The world's largest blue sapphire (90,000 carats) reportedly was discovered in Madagascar during 1996 (Unpub. data accessed June 18, 1997, on the World Wide Web at URL http://www.gemstone.org/source.html).

Outlook

Trends toward the growth of personal disposable income, particularly in industrialized and developing nations, will continue to be the principal influence on world demand for precious gems. In addition, the independence displayed by major diamond producers in 1996 vis-a-vis the De Beers CSO may prove to be an important new trend in world diamond markets; however, its significance cannot be assessed at present.

Asian nations such as Japan and others with growing personal wealth are expected to be the most rapidly expanding markets for precious gems, particularly diamond. One indicator of this trend is that China will open its first diamond exchange and recently liberalized its investment policy for foreign jewelry manufacturers to allow more sales within the country (Henricus, 1997; Schlussel, 1997).

Demand for colored gemstones will continue to rise as diamonds become more expensive and promotional efforts by retailers promote the popularity of alternatives. The retail jewelry trade will further consolidate toward fewer companies while more dealers focus on niche markets and target specific demographic groups. Greater demand for synthetic and simulant gemstones also is anticipated.

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[1]Prior to January 1996, published by the U.S. Bureau of Mines.

TABLE 1
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0-2.5	1.0-1.1	Single	1.54	Synthetic or pressed plastics	Fossil resin, soft.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	do.	Medium to high	7.5-8.0	2.63-2.80	Double	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	do.	Small	Very high	7.5-8.0	2.63-2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald	do.	Green	Medium	do.	7.5	2.63-2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5-8.0	2.63-2.80	do.	1.58	Genuine emerald	Flaws, brilliant, fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5-8.0	2.63-2.80	do.	1.58	Citrine, topaz, glass, doublets	
Goshenite	do.	do.	do.	Low	7.5-8.0	2.63-2.80	do.	1.58	Quartz, glass, white sapphire, white topaz.	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5-8.0	2.63-2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49-1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.6	do.	Banded, translucent.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day, red by artificial light	Former U.S.S.R. (small), Sri Lanka (medium)	High	8.5	3.50-3.84	Double	1.75	Synthetic	Dichroism, inclusions in synthetic sapphire.
Cats-eye	do.	Greenish to brownish	Small to large	do.	8.5	3.50-3.84	do.	1.75	Synthetic, shell	Gravity and translucence.
Chrysolite	do.	Yellow, green, and/or brown	Medium	Medium	8.5	3.50-3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Coral	Calcium carbonate	Orange, red, white, black, or green	Branching, medium	Low	3.5-4.0	2.6-2.7	do.	1.49-1.66	False coral	Dull translucent.

See footnotes at end of table.

TABLE 1--Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95-4.10	Double	1.78	Synthetics, including spinel	Inclusions, fluorescence.
Sapphire	do.	Blue	Medium	High	9.0	3.95-4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, white, orange, green, or violet	Medium to large	Medium	9.0	3.95-4.10	do.	1.78	Synthetics, glass and doublets	Inclusions, double refraction, refractive index.
Sapphire and ruby stars	do.	Red, pink, violet, blue, or gray	do.	High to low	9.0	3.95-4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.
Sapphire or ruby synthetic	do.	Yellow, pink, or blue	Up to 20 carats	Low	9.0	3.95-4.10	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Diamond	Carbon	White, blue-white, yellow, brown, green, pink, blue	Any	Very high	10.0	3.516-3.525	Single	2.42	Zircon, titania, cubic zirconia	High index, dispersion, single refraction hardness, cut, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green	Large	Low	6.0-6.5	2.56	--	1.52	Jade	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play	do.	do.	6.0-6.5	2.56	--	1.56	do.	Do.
Moonstone	do.	White	do.	do.	6.0-6.5	2.77	--	1.52-1.54	Glass or white onyx	Blue sheen, opalescent.
Garnet	Complex silicate	Brown, black, yellow, green, ruby red, or orange	Small to medium	Low to high	6.5-7.5	3.15-4.30	Single strained	1.79-1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Jade:										
Jadeite	do.	Green, yellow, black, white, or mauve	Large	Low to very high	6.5-7.0	3.3-3.5	Cryptocry-stalline	1.65-1.68	Onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent, to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0-6.5	2.96-3.10	do.	1.61-1.63	do.	Do.
Opal	Hydrous silica	Colors flash in white gray, black, red, or yellow	Large	Low to high	5.5-6.5	1.9-2.3	Isotropic	1.45	Glass, synthetics, triplets	Play of color.
Pearl	Calcium carbonate	White, pink, or black	Small	do.	2.5-4.0	2.6-2.85	--	--	Cultured and imitation	Luster, structure, X-ray.
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5-7.0	3.27-3.37	Double (strong)	1.65-1.69	Tourmaline chrysoberyl	Strong double refraction, low dichroism.

See footnotes at end of table.

TABLE 1--Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Quartz:										
Agate	Silica	Any color	Large	Low	7.0	2.58-2.64	--	--	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65-2.66	Double	1.55	do.	Refractive index, double refraction, transparent.
Cairngorm	do.	Smoky	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Citrine	do.	Yellow	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Do.
Crystal, rock	do.	Colorless	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Do.
Jasper	do.	Uniform or spotted red, yellow, or green	do.	do.	7.0	2.58-2.66	--	--	do.	Opaque, vitreous.
Onyx	do.	Many colors	do.	do.	7.0	2.58-2.64	--	--	do.	Uniformly banded.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Refractive index, double refraction, translucent.
Spinel	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5-3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5-3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5-7.0	3.13-3.20	do.	1.66	Synthetic spinel	Refractive index.
Kunzite	do.	Pink to lilac	do.	do.	6.5-7.0	3.13-3.20	do.	1.66	Amethyst, morganite	Do.
Tanzanite	Complex silicate	Blue	Small	High	6.0-7.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism.
Topaz	do.	White, blue, green	Medium	Low to medium	8.0	3.4-3.6	do.	1.62	Beryl, quartz	Refractive index.
Tourmaline	do.	All, including mixed	do.	do.	7.0-7.5	2.98-3.20	do.	1.63	Peridot, beryl, corundum, glass	Double refraction, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green	Large	Low	6.0	2.60-2.83	do.	1.63	Glass, plastics	Difficult if matrix not present, matrix usually limonitic.
Zircon	Zirconium silicate	White, blue, or brown, yellow, or green	Small to medium	Low to medium	6.0-7.5	4.0-4.8	Double (strong)	1.79-1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

1/ Small-up to 5 carats; medium-up to 50 carats; large-more than 50 carats.
2/ Low-up to $25 per carat; medium-up to $200 per carat; high-more than $200 per carat.

TABLE 2
SYNTHETIC GEMSTONE PRODUCTION METHODS

Gemstone	Production methods	Company/producer	Date of first production
Alexandrite	Flux	Creative crystals	1970's
Do.	Melt pulling	J.O. Crystal	1990's
Do.	do.	Kyocera	1980's
Do.	Zone melt	Seiko	1980's
Cubic zirconia	Skull melt	Various producers	1970's
Emerald	Flux	Chatham	1930's
Do.	do.	Gilson	1960's
Do.	do.	Kyocera	1970's
Do.	do.	Seiko	1980's
Do.	do.	Lennix	1980's
Do.	do.	Russia	1980's
Do.	Hydrothermal	Lechleitner	1960's
Do.	do.	Regency	1980's
Do.	do.	Biron	1980's
Do.	do.	Russia	1980's
Ruby	Flux	Chatham	1950's
Do.	do.	Kashan	1960's
Do.	do.	J.O. Crystal (Ramaura)	1980's
Do.	do.	Douras	1990's
Do.	Zone melt	Seiko	1980's
Do.	Melt pulling	Kyocera (Inamori)	1970's
Do.	Verneuil	Various producers	1900's
Sapphire	Flux	Chatham	1970's
Do.	Zone melt	Seiko	1980's
Do.	Melt pulling	Kyocera	1980's
Do.	Verneuil	Various producers	1900's
Star ruby	do.	Linde (Div. of Union Carbide)	1940's
Do.	Melt pulling	Kyocera	1980's
Do.	do.	Nakazumi	1980's
Star sapphire	Verneuil	Linde	1940's

TABLE 3
VALUE OF U.S. GEMSTONE PRODUCTION, BY GEMSTONE 1/

(Thousand dollars)

Gem materials	1995	1996
Agate	907	1,110
Beryl	698	960
Coral (all types)	114	152
Diamonds	163	685
Garnet	54 r/	40
Gem feldspar	3,150	4,980
Geode/nodules	206	169
Obsidian	64	64 e/
Opal	475	363
Peridot	225	--
Petrified wood	150	54 e/
Quartz	1,440	1,880
Sapphire/ruby	4,910 r/	2,030
Shell	29,000 r/	22,800
Topaz	9	14
Tourmaline	52	25
Turquoise	1,670	1,410
Other	5,410 r/	6,900
Total	48,700 r/	43,600

e/ Estimated. r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.

TABLE 4
PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY 1/

Carat weight	Description, color 2/	Clarity 3/ (GIA terms)	Representative prices January 1996 4/	August 1996 5/	December 1996 6/
0.25	G	VS1	$1,400	$1,400	$1,500
.25	G	VS2	1,300	1,280	1,380
.25	G	SI1	975	1,030	1,130
.25	H	VS1	1,300	1,300	1,400
.25	H	VS2	1,150	1,150	1,250
.25	H	SI1	950	950	1,050
.50	G	VS1	3,050	3,200	3,300
.50	G	VS2	2,700	2,800	2,900
.50	G	SI1	2,400	2,300	2,500
.50	H	VS1	2,800	2,800	2,900
.50	H	VS2	2,600	2,500	2,600
.50	H	SI1	2,300	2,200	2,400
.75	G	VS1	3,600	3,600	3,800
.75	G	VS2	3,350	3,400	3,600
.75	G	SI1	3,100	3,100	3,300
.75	H	VS1	3,400	3,450	3,650
.75	H	VS2	3,200	3,250	3,450
.75	H	SI1	2,900	2,900	3,100
1.00	G	VS1	4,900	5,200	5,400
1.00	G	VS2	4,600	4,900	5,200
1.00	G	SI1	4,200	4,400	4,700
1.00	H	VS1	4,500	4,800	5,000
1.00	H	VS2	4,400	4,700	4,900
1.00	H	SI1	4,000	4,200	4,500

1/ Data are rounded to three significant digits.
2/ Gemological Institute of America (GIA) color grades: D--colorless; E--rare white; G - H - I --traces of color.
3/ Clarity: IF--no blemishes; VVS1--very, very slightly included; VS1--very slightly included; VS2--very slightly included, but not visible; SI1--slightly included.
4/ Jewelers' Circular-Keystone. V. 167, No. 3, Mar. 1996, p. 142.
5/ Jewelers' Circular-Keystone. V. 167, No. 9, Sept. 1996, p. 222.
6/ Jewelers' Circular-Keystone. V. 168, No. 1, Jan. 1997, p. 290.

TABLE 5
PRICES OF U.S. CUT COLORED GEMSTONES, BY SIZE 1/

Gemstone	Carat weight	Price range per carat January 1996 2/	December 1996 2/
Amethyst	1	$8 -$18	$7 - $16
Aquamarine	1	75-90	75 - 190
Emerald	1	1,750 - 3,200	1,575 - 2,900
Garnet, tsavorite	1	600 - 900	600 - 900
Rhodolite	1	20 - 30	20 - 30
Ruby	1	2,450 - 3,900	2,450 - 3,900
Sapphire	1	800 - 1,800	800 - 1,800
Tanzanite	1	125 - 220	125 - 220

1/ Fine quality.
2/ Jewelers' Circular-Keystone. V. 167, No. 3, Jan. 1996, p. 142; and V. 168, No. 1, Jan. 1997, p. 290. These figures represent a sampling of net prices that wholesale colored stone dealers in various U.S. cities charged its cash customers during the month for fine-quality stones.

TABLE 6
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY 1/

Country	1995 Quantity (carats)	1995 Value 2/ (millions)	1996 Quantity (carats)	1996 Value 2/ (millions)
Belgium	658,000	$475	576,000	$547
Canada	123,000	44	135,000	50
France	23,900	31	24,000	43
Hong Kong	462,000	436	324,000	400
India	146,000	21	137,000	21
Israel	496,000	480	546,000	558
Japan	150,000	159	106,000	139
Russia	9,930	23	569	4
Singapore	26,500	57	18,100	55
Switzerland	54,100	183	50,500	234
Thailand	124,000	32	95,000	42
United Arab Emirates	10,500	5	6,320	7
United Kingdom	10,900	64	31,900	94
Other	35,800 r/	35 r/	40,900	32
Total	2,330,000	2,040	2,090,000	2,230

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Customs value.

Source: Bureau of the Census.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY 1/

Kind, range, and country of origin	1995 Quantity (carat)	1995 Value 2/ (millions)	1996 Quantity (carat)	1996 Value 2/ (millions)
Rough or uncut, natural: 3/				
Australia	34,200	(4/)	74,600	$1
Belgium	181,000	$119	277,000	149
Brazil	4,910	1	38,500	5
Ghana	162,000	119	157,000	105
India	61,900	1	11,100	(4/)
Russia	34,900	33	34	(4/)
Israel	36,500	22	33,600	34
South Africa	17,800	26	21,900	33
Switzerland	6,950	10	20,900	44
United Kingdom	969,000	155	658,000	200
Venezuela	19,900	(4/)	11,300	2
Zaire	82,600	82	92,000	84
Other	100,000 r/	65 r/	51,500	75
Total	1,710,000	631	1,450,000	731
Cut but unset, not more than 0.5 carat:				
Belgium	677,000	181	841,000	232
Brazil	6,450	1	9,490	3
Canada	3,990	1	18,000	4
Hong Kong	216,000	39	358,000	68
India	7,240,000	1,190	7,140,000	1,250
Israel	769,000	352	890,000	387
Netherlands	--	--	1,000	(4/)
South Africa	8,580	4	5,350	7
Switzerland	8,600	1	7,420	2
Thailand	65,000	10	54,600	8
United Kingdom	8,260	2	1,450	1
Other	47,300 r/	13 r/	62,600	23
Total	9,050,000	1,790	9,390,000	1,980
Cut but unset, over 0.5 carat:				
Belgium	873,000	1,110	833,000	1,190
Hong Kong	43,600	64	48,300	60
India	326,000	196	259,000	151
Israel	1,490,000	1,740	1,580,000	2,020
Netherlands	300	1	199	1
Russia	40,500	63	39,400	53

See footnotes at end of table.

TABLE 7--Continued
U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY 1/

Kind, range, and country of origin	1995 Quantity (carat)	1995 Value 2/ (millions)	1996 Quantity (carat)	1996 Value 2/ (millions)
Cut but unset, over 0.5 carat--Continued:				
South Africa	15,100	37	15,800	52
Switzerland	19,600	196	16,100	163
United Kingdom	8,290	38	6,820	53
Other	64,800 r/	80 r/	69,400	111
Total	2,880,000	3,530	2,870,000	3,850

r/ Revised.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Customs value.

3/ Includes some natural advanced diamond.

4/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY 1/

Kind and country	1995 Quantity (carats)	1995 Value 2/ (millions)	1996 Quantity (carats)	1996 Value 2/ (millions)
Emerald:				
Belgium	27,000	$4	13,900	$2
Brazil	2,620,000	6	4,340,000	7
Canada	9,940	1	15,600	1
China	1,610	1	1,550	(3/)
Colombia	1,130,000	94	968,000	74
France	1,500	2	3,340	2
Germany	24,600	2	13,900	2
Hong Kong	315,000	17	304,000	17
India	2,570,000	47	3,280,000	39
Italy	10,300	(3/)	7,540	(3/)
Israel	116,000	27	401,000	26
Japan	1,300	(3/)	3,020	1
South Africa	474	(3/)	1,370	(3/)
Switzerland	50,900	26	89,800	18
Taiwan	3,890	(3/)	207	(3/)
Thailand	418,000	7	358,000	8
United Kingdom	2,630	1	2,330	3
Other	10,800 r/	2 r/	138,000	3
Total	7,320,000	236	9,930,000	203
Ruby:				
Belgium	14,600	1	11,000	1
Brazil	233	(3/)	11,300	(3/)
Canada	11,700	(3/)	9,540	(3/)
China	2,270	(3/)	9,020	(3/)
Colombia	438	(3/)	423	(3/)
France	482	2	1,260	1
Germany	129,000	1	31,000	1
Hong Kong	278,000	6	377,000	7
India	1,370,000	6	2,340,000	6
Israel	8,360	1	25,400	1
Italy	10,200	1	83	(3/)
Japan	1,050	(3/)	2,240	(3/)
Switzerland	52,400	18	14,900	17
Thailand	2,270,000	41	3,010,000	44
United Kingdom	13,900	2	3,370	4
Other	15,100 r/	3 r/	57,100	3
Total	4,180,000	84	5,910,000	86
Sapphire:				
Australia	49,900	1	9,190	(3/)
Austria	214	(3/)	56	(3/)
Belgium	9,280	(3/)	25,900	1
Brazil	7,570	(3/)	8,190	(3/)

See footnotes at end of table.

TABLE 8--Continued

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY 1/

Kind and country	1995 Quantity (carats)	1995 Value 2/ (millions)	1996 Quantity (carats)	1996 Value 2/ (millions)
Sapphire--Continued:				
Canada	82,200	(3/)	4,840	(3/)
China	1,670	(3/)	506,000	1
Colombia	1,270	(3/)	395	(3/)
France	863	1	738	1
Germany	146,000	2	64,500	2
Hong Kong	505,000	4	298,000	6
India	329,000	1	682,000	2
Israel	17,500	2	67,800	3
Italy	4,400	(3/)	10,500	(3/)
Japan	831	(3/)	1,640	(3/)
Korea, Republic of	--	--	1,110	(3/)
Singapore	1,250	(3/)	84	1
Sri Lanka (ceylon)	328,000	9	864,000	10
Switzerland	17,700	13	23,100	10
Tanzania	4,060	(3/)	3,010	(3/)
Thailand	5,240,000	49	5,920,000	55
United Kingdom	7,750	2	8,030	3
Other	20,100 r/	1 r/	26,600	2
Total	6,780,000	84	8,530,000	95
Other:				
Rough, uncut:				
Australia	NA	$3	NA	$4
Brazil	NA	32	NA	21
Colombia	NA	3	NA	1
Fiji	NA	(3/)	NA	1
Hong Kong	NA	1	NA	1
India	NA	1	NA	1
Kenya	NA	1	NA	2
Nigeria	NA	(3/)	NA	(3/)
Pakistan	NA	1	NA	(3/)
Philippines	NA	1	NA	1
Russia	NA	9	NA	(3/)
South Africa	NA	(3/)	NA	(3/)
Switzerland	NA	(3/)	NA	(3/)
Tanzania	NA	1	NA	1
Thailand	NA	1	NA	1
United Kingdom	NA	(3/)	NA	1
Zambia	NA	1	NA	2
Other	NA	6 r/	NA	12
Total	NA	61	NA	50
Cut, set and unset:				
Australia	NA	6	NA	5
Brazil	NA	8	NA	8
Canada	NA	(3/)	NA	(3/)
China	NA	5	NA	5
French Polynesia	NA	7	NA	4
Germany	NA	14	NA	11
Hong Kong	NA	23	NA	24
India	NA	13	NA	18
Israel	NA	5	NA	5
Japan	NA	11	NA	20
Kenya	NA	1	NA	1
Sri Lanka (ceylon)	NA	3	NA	3
Switzerland	NA	1	NA	2
Taiwan	NA	2	NA	2
Tanzania	NA	2	NA	2
Thailand	NA	19	NA	25
United Kingdom	NA	1	NA	1
Other	NA	2 r/	NA	4
Total	NA	125	NA	138

r/ Revised. NA Not available.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Customs value.

3/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 9
VALUE OF U.S. IMPORTS OF SYNTHETIC AND IMITATION
GEMSTONES, BY COUNTRY 1/

(Thousand dollars) 2/

Country	1995	1996
Synthetic, cut but unset:		
Australia	1,120	768
Austria	6,250	5,320
China	2,830	4,880
France	1,010	1,090
Germany	11,000	12,100
Hong Kong	1,390	2,060
India	938	1,000
Italy	1,120	318
Japan	512	93
Korea, Republic of	1,360	1,440
Sri Lanka (Ceylon)	510	649
Switzerland	4,430	3,780
Thailand	7,910 r/	6,410
Other	840 r/	855
Total	41,200	40,700
Imitation: 3/		
Austria	59,900	46,200
China	575	414
Czech Republic	12,800	17,300
Germany	1,640	2,360
Japan	503	788
Taiwan	448	214
Other	1,240	1,270
Total	77,100	68,500

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Customs value.
3/ Includes pearls.

Source: Bureau of the Census.

TABLE 10
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES 1/

(Thousand carats and thousand dollars)

	1995		1996	
Stones	Quantity	Value 2/	Quantity	Value 2/
Diamonds:				
Rough or uncut	1,710	631,000	1,450	731,000
Cut but unset	11,900	5,320,000	12,300	5,830,000
Emeralds: Cut but unset	7,320	236,000	9,930	203,000
Coral and similar materials, unworked	NA	4,020	NA	6,340
Rubies and sapphires: Cut but unset	11,000	168,000	14,400	181,000
Pearls:				
Natural	NA	3,260	NA	1,100
Cultured	NA	30,400	NA	31,800
Imitation	NA	1,660	NA	1,740
Other precious and semiprecious stones:				
Rough, uncut	1,420,000	48,600	1,610,000	37,400
Cut, set and unset	NA	91,500	NA	105,000
Other	NA	8,800	NA	6,320
Synthetic:				
Cut but unset	160,000	41,200	174,000	40,700
Other	NA	1,830	NA	3,800
Imitation gemstone 3/	NA	75,400	NA	66,800
Total	XX	6,660,000	XX	7,240,000

NA Not available. XX Not applicable.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Customs value.
3/ Does not include pearls.

Source: Bureau of the Census.

TABLE 11
NATURAL DIAMOND: ESTIMATED WORLD PRODUCTION, BY TYPE AND COUNTRY 1/ 2/

(Thousand carats)

Country	1992	1993	1994	1995	1996
Gemstones: 3/					
Angola 4/	1,100	130	270	2,700 r/	3,600
Australia	18,100	18,800	19,500	18,300	18,897 5/
Botswana	11,200	10,300	10,550 5/	11,500	11,000
Brazil	653	1,000 r/	300 r/	700 r/	700
Central African Republic	307 5/	370	400	400	350
China	200	230	230	230	230
Gabon	400	400	400	400	400
Ghana	104 r/ 5/	106 r/ 5/	118 r/	126 r/	125
Nambia	1,520	1,120	1,312 5/	1,382 5/	1,300
Russia	9,000	8,000	8,500	9,000	9,250
Sierra Leone	180	90	155	113 5/	162
South Africa	4,600	4,600	5,050 r/	5,070 r/	5,360
Venezuela	302	145 r/ 5/	203	229 5/	230
Zaire	8,930	2,010	4,000	4,000	3,000
Other	305	277 r/	463 r/	608 r/	813
Total	56,800 r/	47,600 r/	51,400	54,800 r/	55,400
Industrial:					
Angola 4/	80	15	30	300 r/	400
Australia	22,100	23,000	23,800	22,400	23,096 5/
Botswana	4,790	4,420	5,000	5,300	5,000
Brazil	665	600 r/	600 r/	600 r/	600
Central African Republic	107 5/	125	131	130	120
China	800	850	850	900	900
Gabon	100	100	100	100	100
Ghana	590 r/ 5/	484 r/ 5/	473 r/ 5/	505 r/	505
Nambia	30	20	--	--	--
Russia	9,000	8,000	8,500	9,000	9,250
Sierra Leone	116	68	100	101 r/	108
South Africa	5,600	5,700	5,800 r/	5,880 r/	6,000
Venezuela	176	155 5/	214 5/	64 5/	60
Zaire	4,570	13,600	13,000	13,000	15,000
Other	218	210 r/	277 r/	344 r/	464
Total	48,900 r/	57,400	58,900 r/	58,600 r/	61,600
Grand total	106,000	105,000	110,000	113,000 r/	117,000

r/ Revised.
1/ World totals and estimated data are rounded to three significant digits; may not add to totals shown.
2/ Table includes data available through May 28, 1997.
3/ Includes near-gem and cheap-gem qualities.
4/ Figures do not include smuggled artisanal production.
5/ Reported figure.

GEMSTONES

By Ronald F. Balazik

Gemstones have been used as symbols of beauty, wealth, and status for more than 10,000 years (Schumann, 1998). Despite its long history, however, "gemstone" has no single, precise definition that is generally accepted. According to Webster's New International Dictionary (2^{nd} edition), a gemstone is "any jewel, whether stone, pearl or the like, having value and beauty that are intrinsic and not derived from its setting; a precious or, sometimes, a semiprecious stone cut and polished for ornament. A semiprecious stone of value because it is carved or engraved, as a cameo or intaglio." Additionally, the dictionary states that a gemstone is "any mineral or petrified material which can, when cut and polished, be used in jewelry."

Natural gemstones are minerals; each type has its own chemical composition and physical attributes. For this report, therefore, "gemstone" means any mineral, organic or inorganic, used for personal adornment, display, or object of art because it possesses beauty, rarity, and durability. Note that shell and cultured pearl are treated as gemstones in this report. In addition, synthetic gems and gemstone simulants are included in this report but are treated separately from natural gemstones. *(See tables 1 and 2.)*

Production

The gemstone industry in the United States consists of several distinct sectors: (1) individuals and organizations that mine gemstones or harvest shell and natural/cultured pearls, (2) companies that manufacture synthetic gemstones, and (3) individuals or firms that process/cut natural and synthetic gemstones. The domestic gemstone industry is focused on the production of colored gemstones and the cutting of large diamonds. Employment in the industry is estimated to range between 1,000 and 1,500 persons (U.S. International Trade Commission, 1997).

Most natural gemstone producers in the United States are small businesses that are widely dispersed and operate independently. It is estimated that the small producers have an average of fewer than three employees, including many who only work part time. The number of gemstone mines operating from year to year fluctuates because the inherent uncertainty associated with the finding and marketing gem-quality minerals makes it difficult to obtain financing for developing and sustaining economically viable deposits (U.S. International Trade Commission, 1997).

The total value of natural gemstones produced in the United States during 1997 was estimated to be at least $25 million. *(See table 3.)* This production value was less than that of the preceding year primarily because foreign markets for U.S. shell material decreased, particularly in Japan where the operations of cultured pearl producers that use the shell for pearl nuclei were adversely affected by declining markets in Southeast Asia, competition from China, and high mortality rates among pearl oysters (Jewelers' Circular Keystone, 1997b). In addition, gemstone output in 1997 declined, in part, because a few of the larger producers halted mine operations and relied on materials stockpiled in previous years.

The estimate of 1997 U.S. gemstone production is based on a survey of approximately 200 domestic gemstone operations conducted by the U.S. Geological Survey (USGS). The survey provides a foundation for projecting the scope and level of domestic gemstone production. The survey, however, does not represent all gemstone activity in the United States, which includes thousands of professional and amateur collectors. Consequently, the USGS supplements its survey with estimates of domestic gemstones production from related published data, contacts with gem dealers and collectors, and analyses of gem and mineral shows.

Natural gem materials indigenous to the United States are collected, produced, and/or marketed in every State. In 1997, five States accounted for more than 70% of the total value of production reported by survey respondents. These States were (in declining order of reported production value) Tennessee, Kentucky, Arizona, California, and Montana. Certain States are best known for the production of a single gem material (for example, Kentucky and Tennessee for freshwater shell). Other States, however, have a wide array of gemstones. For example, Arizona gemstone deposits include agate, amethyst, azurite, chrysocolla, fire agate, garnet, jade, malachite, obsidian, onyx, petrified wood, precious opal, smithsonite, and turquoise. A great variety of gemstones also are found in California, Idaho, Montana, and North Carolina.

Estimated diamond production in the United States reached at least $1 million during 1997. Late in the year, Redaurum Limited (Toronto) announced that it planned to sell its Kelsey Lake diamond mine near Fort Collins, CO (H. Coopersmith, Colorado Diamond Company, oral commun., 1998). The mine, which opened in 1995, is North America's first commercial diamond mine in almost a century. The only other significant diamond-bearing area known in the United States is in Crater of Diamonds State Park near Murfreesboro, AR. Testing and evaluation of diamond-bearing rock in the Park was completed in 1997. A final report on the tests and evaluations was presented to the Arkansas Department of Parks and Tourism in late 1997 (U.S. Geological Survey, 1998).

In addition to natural gemstones, synthetic gems and gemstone simulants are produced in the United States. Synthetic gemstones essentially have the same appearance and the same optical, physical, and chemical properties as the natural materials that they represent. Simulants have an appearance similar to that of a natural gem material but have different optical, physical, and chemical properties. Synthetic gemstones produced in the United States include alexandrite, emerald, ruby, sapphire, turquoise, and zirconia. The major simulants produced in the United States are colored and colorless varieties of cubic zirconia. Coral, lapis lazuli, malachite, and turquoise are also produced. In addition, certain colors of synthetic sapphire and spinel, used to represent other gemstones, are classed as simulants.

In 1997, synthetic gem production in the United States reached $22 million; simulant gemstone output was even greater—estimated to exceed $100 million. Five firms in four states, representing the U.S. synthetic gem industry, reported production to the USGS in 1997. In descending order of production value, the States with reported output were New York, California, Michigan, and Arizona.

In late 1997, a company in North Carolina announced plans to market the first commercial supplies of moissanite, a gem-like silicon carbide made by the firm. The company will sell the moissanite as a diamond simulant (Jewelers' Circular Keystone, 1997a).

Consumption

Although the United States accounts for less than 1% of total global gem production, it is the world's leading gemstone market. On the basis of such indicators as trade data and income growth rates, it was estimated that U.S. gemstone markets, bolstered by a strong and growing national economy, accounted for at least one-third of world gem demand in 1997.[1] Domestic markets for natural, unset colored gemstones (excluding diamond but including shell, pearl, and coral) totaled approximately $650 million during the year. The domestic market for unset gem diamonds in 1997 was estimated to exceed $5 billion, the largest in the world.

Moreover, U.S. diamond jewelry sales in 1997 increased 8% to $19.3 billion; this was the sixth consecutive year that sales increased (Jewelers' Circular Keystone, 1998b).

Gemstones are used in the United States and elsewhere for jewelry, collections and exhibits, decorative art objects, and certain industrial applications. According to a poll conducted by a U.S. jewelry retailers association, 61% of domestic consumers who were surveyed preferred diamond as their favorite gemstone; others chose emeralds (10%), sapphires (9%), and rubies (7%) (International Colored Gemstone Association, 1996).

Prices

Gemstone prices are governed by many factors and qualitative characteristics, including beauty, clarity, defects, demand, and rarity. Colored gemstone prices are generally influenced by market supply/demand considerations, and diamond prices are supported by producer controls on the quantity and quality of supply. Values and prices of gemstones produced and/or sold in the United States are shown in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported and exported/reexported are shown in tables 6 through 10.

De Beers Consolidated Mines Limited in South Africa is a significant force affecting gem diamond price worldwide because it mines about one-half the diamonds produced each year worldwide and controls about three-fourths of global raw diamond supply through its Central Selling Organization (CSO) which has marketing agreements with other producers (Shor, 1997). The average price of all rough, uncut diamonds sold throughout the world was estimated to be about $70 per carat in 1997; by country, the average value reported per carat ranged from about $10 for Australian production to more than $300 for Namibian output (Financial Times, 1997).

Foreign Trade

As measured by several standards, such as imports, the United States is the world leader in gemstone trade. In 1997, U.S. gemstone exports/reexports were shipped to 86 countries, and imports of gemstones were received from 114 countries. *(See tables 6 through 10.)* Total U.S. gemstone trade with all countries in 1997 exceeded $11 billion; diamonds accounted for 89% of the trade.

The American Diamond Industry Association reported that U.S. trade in loose, polished diamonds reached unprecedented levels in 1997; records were set for imports and exports, as well as for quantity and value (Sheung, 1998). The records were attributed to the growing U.S. economy and a strong consumer demand for diamond jewelry.

The value of U.S. gemstone exports and reexports in 1997 totaled $2.8 billion; diamonds, including $2.3 billion for cut diamonds, accounted for 84% of the total. Domestic exports and reexports of natural, rough, colored gemstones were valued at $192 million, and the value of U.S. exports and reexports of natural, cut but unset, colored gemstones was $187 million. Synthetic gemstone exports and reexports during the year were valued at $10.6 million and $17.9 million, respectively. Exports and reexports of natural and cultured pearl were valued at $3.8 million and $7.4 million, respectively. Approximately $15 million of coral and shell was exported/reexported by the United States in 1997.

The United States remained the world's largest importer of gemstones in 1997; imports of natural, unset, colored gemstones, including coral and pearl, reached $671 million. During the year, U.S. imports of all gemstones, including synthetics and simulants, increased by 16%, to a record high of $8.38 billion. Diamonds accounted for 91% of the imports.

Also during 1997, the Office of the United States Trade Representative, assisted by the USGS, entered negotiations with 17 Asian and Pacific Rim governments to reduce barriers in gemstone trade. The negotiations, still underway at yearend, focused on tariffs and other barriers to international trade.

World Review

Global gemstone markets primarily are concerned with two distinctly different commodities: (1) diamonds, and (2) colored gemstones; that is, gems other than diamonds. Most diamond supplies are controlled by a few major mining companies; prices

[1]The domestic market rose by an average of 14% annually during 1995-1997.

are supported by managing the quantity and quality of the gems relative to demand, a function performed by the CSO. Unlike diamonds, colored gemstones are primarily produced at relatively small, low-cost operations with few dominant producers; prices are influenced more by supply availability and consumer demand.

World diamond output in 1997 totaled 110 million carats with an estimated value of approximately $7 billion. *(See table 11.)* Most production was concentrated in a few regions— Africa (Angola, Botswana, Namibia, South Africa, and Zaire); Asia (northeastern Siberia and Yakutia in Russia); Australia; and South America (Brazil and Venezuela).

Sales of rough diamond by the CSO in 1997 reached $4.6 billion, 4% less than the record sales of 1996 (Mining Journal, 1998). The sales loss reflected reduced demand in Asian markets following the decline of several national economies in the region. Nevertheless, strong market demand in the United States helped compensate for the Asian decline and make the 1997 sales level the second highest on record. It is estimated that U.S. demand for rough diamond alone has been equivalent to about 15% of the De Beers sales in recent years.

During 1997, De Beers took several actions to maintain its influence on global diamond supplies and respond to declining markets in Asia: (1) the company signed a new contractual agreement that returned Russia to the CSO after more than a 2-year absence (Teslenko, 1997); (2) the CSO began to reduce its supply of diamonds available in world markets to stabilize and support prices (Jewelers' Circular Keystone, 1998a); (3) De Beers prepared to increase output from its mines and compete more vigorously against producers outside the CSO (Jewelers' Circular Keystone, 1997c; Shor, 1997); and (4) the company continued planning for new markets, particularly in China, the Middle East, and South America (Diamond Registry Bulletin, 1998).

Construction of Canada's first commercial diamond mine was almost completed by year-end 1997; production was scheduled to begin in 1998. When fully operational, the mine (in Canada's Northwest Territories) will produce 4.5 million carats per year, or about 5% of world output valued from $350 million to $490 million, (Hart, 1998; Reuters, 1998). Planning also was underway in 1997 for another significant diamond mine in the Northwest Territories that could be operational within a few years.

It is estimated that annual world production of cut natural gemstones other than diamond and pearl exceeds $2 billion per year. Most colored gemstone mining consists of small, low-cost, and widely-dispersed operations in remote regions of developing nations. Pearls are cultured throughout the South Pacific and in other seas near the equator. The largest producers are Australia, China, and Japan.

Foreign countries with major gemstone deposits other than diamond are Afghanistan (beryl, ruby, and tourmaline); Australia (beryl, opal, and sapphire); Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline); Burma (beryl, jade, ruby, sapphire, and topaz); Colombia (beryl, emerald, and sapphire); Kenya (beryl, garnet, and sapphire); Madagascar (beryl, rose quartz, sapphire, and tourmaline); Mexico (agate, opal, and topaz); Sri Lanka (beryl, ruby, sapphire, and topaz); Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline); and Zambia (amethyst and beryl).

Like the diamond industry, colored gemstone producers and markets were adversely affected by the economic crisis in Asia during 1997. Mining and sales reportedly were disrupted in many Asian countries. Prices of high-quality colored gemstones, however, did not decline dramatically (Cavey, 1998).

The application of thermal, chemical, and physical treatments to enhance the color and other attributes of natural gemstones received considerable attention in various gem industry publications during 1997. Many business associations and professionals in the industry have proposed or adopted treatment guidelines. Standards for disclosure of treatment practices to consumers also have been an important issue in the industry. The Federal Trade Commission has addressed aspects of the issue in its Guides for the Jewelry Industry (Gemological Institute of America, 1994).

Outlook

All gemstone market forecasts, particularly long-range projections, must focus on the reality that gemstones are essentially luxury merchandise; consequently, consumer demand, and ultimately supply, is determined by personal discretionary income levels and consumer preferences among nonessential goods in the marketplace.[2] Fortunately for producers of precious gems, long-term economic forecasts anticipate continued growth of discretionary income in the industrialized countries and expect even higher growth rates of personal wealth in certain developing nations as well. In the next decade, for example, China and several Middle Eastern countries where personal wealth is growing, may emerge as major new markets for precious gems, particularly diamonds (Diamond Registry Bulletin, 1998).

If the CSO continues its 1997 restraints on diamond supplies to stabilize prices and restore market confidence, its rough diamond sales will fall significantly. Some market analysts predict that CSO rough diamond sales in 1998 will be the lowest in since 1992 (Jewelers' Circular Keystone, 1998c).

Diamond mining in Canada may prove to be part of a significant trend in world diamond markets. New Canadian mines are expected to produce as much as one-seventh of world diamond output early in the next century (Hart, 1998). Nevertheless, only a limited share of the new production is expected to be marketed through the CSO (Hart, 1998; Reuters, 1998). Thus, Canada with other important independent producers, such as Argyle Diamond Mines (Australia) which withdrew from the CSO in 1996, may bring a greater measure of competition to global diamond markets. Presumably, more competition would bring lower prices for buyers; however, the actual outcome and its significance are uncertain at present.

Demand for colored gemstones will continue to rise as diamonds become more expensive and retailers promote the popularity of alternatives. The retail jewelry trade will further consolidate toward fewer companies and more dealers will focus on niche markets and target specific demographic groups. Greater demand for synthetic and simulant gemstones also is anticipated.

[2]Related economic factors include consumer confidence and interest rates.

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TABLE 1
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0-2.5	1.0-1.1	Single	1.54	Synthetic or pressed plastics	Fossil resin, soft.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	Small to medium	High	6.0-6.5	3.64-3.68	Double	1.76-1.80	Sapphire, tanzanite, blue diamond, blue tourmaline	Strong blue in ultraviolet light.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5-8.0	2.63-2.80	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	do.	Small	Very high	7.5-8.0	2.63-2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald	do.	Green	Medium	do.	7.5	2.63-2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5-8.0	2.63-2.80	do.	1.58	Genuine emerald	Flaws, brilliant, fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5-8.0	2.63-2.80	do.	1.58	Citrine, topaz, glass, doublets	
Goshenite	do.	do.	do.	Low	7.5-8.0	2.63-2.80	do.	1.58	Quartz, glass, white sapphire, white topaz.	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5-8.0	2.63-2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49-1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.6	do.	Banded, translucent.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day, red by artificial light	Former U.S.S.R. (small), Sri Lanka (medium)	High	8.5	3.50-3.84	Double	1.75	Synthetic	Dichroism, inclusions in synthetic sapphire.
Cats-eye	do.	Greenish to brownish	Small to large	do.	8.5	3.50-3.84	do.	1.75	Synthetic, shell	Gravity and translucence.
Chrysolite	do.	Yellow, green, and/or brown	Medium	Medium	8.5	3.50-3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Coral	Calcium carbonate	Orange, red, white, black, or green	Branching, medium	Low	3.5-4.0	2.6-2.7	do.	1.49-1.66	False coral	Dull translucent.

See footnotes at end of table.

TABLE 1--Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95-4.10	Double	1.78	Synthetics, including spinel	Inclusions, fluorescence.
Sapphire	do.	Blue	Medium	High	9.0	3.95-4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, white, orange, green, or violet	Medium to large	Medium	9.0	3.95-4.10	do.	1.78	Synthetics, glass and doublets	Inclusions, double refraction, refractive index.
Sapphire and ruby stars	do.	Red, pink, violet, blue, or gray	do.	High to low	9.0	3.95-4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.
Sapphire or ruby synthetic	do.	Yellow, pink, or blue	Up to 20 carats	Low	9.0	3.95-4.10	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Diamond	Carbon	White, blue-white, yellow, brown, green, pink, blue	Any	Very high	10.0	3.516-3.525	Single	2.42	Zircon, titania, cubic zirconia	High index, dispersion, single refraction hardness, cut, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green	Large	Low	6.0-6.5	2.56	--	1.52	Jade	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play	do.	do.	6.0-6.5	2.56	--	1.56	do.	Do.
Moonstone	do.	White	do.	do.	6.0-6.5	2.77	--	1.52-1.54	Glass or white onyx	Blue sheen, opalescent.
Garnet	Complex silicate	Brown, black, yellow, green, ruby red, or orange	Small to medium	Low to high	6.5-7.5	3.15-4.30	Single strained	1.79-1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Jade:										
Jadeite	do.	Green, yellow, black, white, or mauve	Large	Low to very high	6.5-7.0	3.3-3.5	Cryptocry-stalline	1.65-1.68	Onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent, to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0-6.5	2.96-3.10	do.	1.61-1.63	do.	Do.
Opal	Hydrous silica	Colors flash in white gray, black, red, or yellow	Large	Low to high	5.5-6.5	1.9-2.3	Isotropic	1.45	Glass, synthetics, triplets	Play of color.
Pearl	Calcium carbonate	White, pink, or black	Small	do.	2.5-4.0	2.6-2.85	--	--	Cultured and imitation	Luster, structure, X-ray.
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5-7.0	3.27-3.37	Double (strong)	1.65-1.69	Tourmaline chrysoberyl	Strong double refraction, low dichroism.

See footnotes at end of table.

TABLE 1--Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Quartz:										
Agate	Silica	Any color	Large	Low	7.0	2.58-2.64	--	--	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65-2.66	Double	1.55	do.	Refractive index, double refraction, transparent.
Cairngorm	do.	Smoky	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Citrine	do.	Yellow	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Do.
Crystal, rock	do.	Colorless	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Do.
Jasper	do.	Uniform or spotted red, yellow, or green	do.	do.	7.0	2.58-2.66	--	--	do.	Opaque, vitreous.
Onyx	do.	Many colors	do.	do.	7.0	2.58-2.64	--	--	do.	Uniformly banded.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Refractive index, double refraction, translucent.
Spinel	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5-3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5-3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5-7.0	3.13-3.20	do.	1.66	Synthetic spinel	Refractive index.
Kunzite	do.	Pink to lilac	do.	do.	6.5-7.0	3.13-3.20	do.	1.66	Amethyst, morganite	Do.
Tanzanite	Complex silicate	Blue	Small	High	6.0-7.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism.
Topaz	do.	White, blue, green	Medium	Low to medium	8.0	3.4-3.6	do.	1.62	Beryl, quartz	Refractive index.
Tourmaline	do.	All, including mixed	do.	do.	7.0-7.5	2.98-3.20	do.	1.63	Peridot, beryl, corundum, glass	Double refraction, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green	Large	Low	6.0	2.60-2.83	do.	1.63	Glass, plastics	Difficult if matrix not present, matrix usually limonitic.
Zircon	Zirconium silicate	White, blue, or brown, yellow, or green	Small to medium	Low to medium	6.0-7.5	4.0-4.8	Double (strong)	1.79-1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

1/ Small-up to 5 carats; medium-up to 50 carats; large-more than 50 carats.

2/ Low-up to $25 per carat; medium-up to $200 per carat; high-more than $200 per carat.

TABLE 2
SYNTHETIC GEMSTONE PRODUCTION METHODS

Gemstone	Production methods	Company/producer	Date of first production
Alexandrite	Flux	Creative crystals	1970's
Do.	Melt pulling	J.O. Crystal	1990's
Do.	do.	Kyocera	1980's
Do.	Zone melt	Seiko	1980's
Cubic zirconia	Skull melt	Various producers	1970's
Emerald	Flux	Chatham	1930's
Do.	do.	Gilson	1960's
Do.	do.	Kyocera	1970's
Do.	do.	Seiko	1980's
Do.	do.	Lennix	1980's
Do.	do.	Russia	1980's
Do.	Hydrothermal	Lechleitner	1960's
Do.	do.	Regency	1980's
Do.	do.	Biron	1980's
Do.	do.	Russia	1980's
Ruby	Flux	Chatham	1950's
Do.	do.	Kashan	1960's
Do.	do.	J.O. Crystal (Ramaura)	1980's
Do.	do.	Douras	1990's
Do.	Zone melt	Seiko	1980's
Do.	Melt pulling	Kyocera (Inamori)	1970's
Do.	Verneuil	Various producers	1900's
Sapphire	Flux	Chatham	1970's
Do.	Zone melt	Seiko	1980's
Do.	Melt pulling	Kyocera	1980's
Do.	Verneuil	Various producers	1900's
Star ruby	do.	Linde (Div. of Union Carbide)	1940's
Do.	Melt pulling	Kyocera	1980's
Do.	do.	Nakazumi	1980's
Star sapphire	Verneuil	Linde	1940's

TABLE 3
VALUE OF U.S. GEMSTONE PRODUCTION, BY GEMSTONE 1/

(Thousand dollars)

Gem materials	1996	1997
Agate	1,110	218
Beryl	960	901
Coral (all types)	152	65
Diamonds	685	W
Garnet	40	35
Gem feldspar	4,980	579
Geode/nodules	169	100
Obsidian	64 e/	(2/)
Opal	363	341
Petrified wood	54 e/	2 e/
Quartz	1,880	1,130
Sapphire/ruby	1,680 r/	964
Shell	22,800	11,700
Topaz	14	8
Tourmaline	25	16
Turquoise	1,410	976
Other	6,900	7,990
Total	43,300 r/	25,000

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Less than 1/2 unit.

TABLE 4
PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY 1/

			Representative prices		
Carat weight	Description, color 2/	Clarity (GIA terms) 3/	January 1997 4/	June 1997 5/	December 1997 6/
0.25	G	VS1	$1,500	$1,500	$1,500
.25	G	VS2	1,380	1,380	1,380
.25	G	SI1	1,130	1,130	1,130
.25	H	VS1	1,400	1,400	1,400
.25	H	VS2	1,250	1,250	1,250
.25	H	SI1	1,050	1,050	1,050
.50	G	VS1	3,300	3,300	3,300
.50	G	VS2	2,900	2,900	2,900
.50	G	SI1	2,500	2,500	2,500
.50	H	VS1	2,900	2,900	2,900
.50	H	VS2	2,600	2,600	2,600
.50	H	SI1	2,400	2,400	2,400
.75	G	VS1	3,800	3,800	3,800
.75	G	VS2	3,600	3,600	3,600
.75	G	SI1	3,300	3,300	3,300
.75	H	VS1	3,650	3,650	3,650
.75	H	VS2	3,450	3,450	3,450
.75	H	SI1	3,100	3,100	3,100
1.00	G	VS1	5,400	5,400	5,500
1.00	G	VS2	5,200	5,200	5,200
1.00	G	SI1	4,700	4,700	4,700
1.00	H	VS1	5,000	5,000	5,100
1.00	H	VS2	4,900	4,900	4,900
1.00	H	SI1	4,500	4,500	4,500

1/ Data are rounded to three significant digits.
2/ Gemological Institute of America (GIA) color grades: D--colorless; E--rare white; G - H - I --traces of color.
3/ Clarity: IF--no blemishes; VVS1--very, very slightly included; VS1--very slightly included; VS2--very slightly included, but not visible; SI1--slightly included.
4/ Jewelers' Circular-Keystone. v. 168, no. 2, Feb. 1997, p. 316.
5/ Jewelers' Circular-Keystone. v. 168, no. 7, July 1997, p. 210.
6/ Jewelers' Circular-Keystone. v. 169, no. 1, Jan. 1998, p. 314.

TABLE 5
PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES 1/

	Price range per carat	
Gemstone	January 1997 2/	December 1997 2/
Amethyst	$7 - $16	$7 - $16
Aquamarine	75 - 190	75 - 190
Emerald	1,580 - 2,900	800 - 2,000
Garnet, tsavorite	600 - 900	600 - 900
Rhodolite	20 - 30	20 - 30
Ruby	2,450 - 3,900	1,800 - 2,900
Sapphire	800 - 1,800	800 - 1,800
Tanzanite	120 - 210	120 - 190

1/ Fine quality.
2/ Jewelers' Circular-Keystone. v. 168, no. 2, Feb. 1997, p. 316; and v. 169, no. 1, Jan. 1998, p. 314. These figures represent a sampling of net prices that wholesale colored stone dealers in various U.S. cities charged their cash customers during the month for fine-quality stones.

TABLE 6
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY 1/

	1996		1997	
Country	Quantity (carats)	Value 2/ (millions)	Quantity (carats)	Value 2/ (millions)
Belgium	576,000	$547	843,000	$614
Canada	135,000	50	151,000	61
France	24,000	43	26,200	31
Hong Kong	324,000	400	578,000	401
India	137,000	21	189,000	24
Israel	546,000	558	776,000	734
Japan	106,000	139	79,500	70
Russia	569	4	577	(3/)
Singapore	18,100	55	18,000	44
Switzerland	50,500	234	62,300	185
Thailand	95,000	42	101,000	24
United Arab Emirates	6,320	7	59,700	13
United Kingdom	31,900	94	27,200	87
Other	40,900	32	41,500	33
Total	2,090,000	2,230	2,950,000	2,320

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Customs value.
3/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY 1/

Kind, range, and country of origin	1996 Quantity (carat)	1996 Value 2/ (millions)	1997 Quantity (carat)	1997 Value 2/ (millions)
Rough or uncut, natural: 3/				
Australia	74,600	$1	1,320	(4/)
Belgium	277,000	149	585,000	$110
Brazil	38,500	5	26,000	11
Congo (Brazzaville)	13,100	18	11,600	13
Congo (Kinshasa) 5/	92,000	84	87,100	88
Ghana	157,000	105	195,000	97
Guinea	1,220	2	8,170	10
India	11,100	(4/)	110,000	4
Israel	33,600	34	60,500	47
Russia	34	(4/)	29,800	1
Sierra Leone	15,000	19	13,900	16
South Africa	21,900	33	120,000	40
Switzerland	20,900	44	7,360	12
United Kingdom	658,000	200	652,000	186
Venezuela	11,300	2	13,300	3
Other	22,200 r/	36 r/	17,300	9
Total	1,450,000	731	1,940,000	646
Cut but unset, not more than 0.5 carat:				
Belgium	841,000	232	779,000	213
Brazil	9,490	3	2,960	2
Canada	18,000	4	5,050	1
Germany	6,240	1	5,370	4
Hong Kong	358,000	68	419,000	77
India	7,140,000	1,250	7,790,000	1,320
Israel	890,000	387	1,010,000	568
Japan	7,980	2	7,000	4
South Africa	5,350	7	4,480	4
Switzerland	7,420	2	23,600	6
Thailand	54,600	8	57,100	11
United Kingdom	1,450	1	1,200	1
Other	49,400 r/	20 r/	51,100	12
Total	9,390,000	1,980	10,200,000	2,230
Cut but unset, over 0.5 carat:				
Belgium	833,000	1,190	989,000	1,470
Botswana	14,300	8	15,200	9
Canada	4,220	6	2,660	7
France	2,680	10	1,760	8
Hong Kong	48,300	60	62,900	83
India	259,000	151	375,000	260
Israel	1,580,000	2,020	1,690,000	2,390
Japan	1,270	2	5,800	17
Russia	39,400	53	44,100	41
Singapore	1,660	9	575	4
South Africa	15,800	52	25,200	106
Switzerland	16,100	163	30,400	235
Thailand	15,200	29	11,000	11
United Kingdom	6,820	53	12,300	32
Other	30,200 r/	47 r/	22,300	37
Total	2,870,000	3,850	3,280,000	4,720

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Customs value.
3/ Includes some natural advanced diamond.
4/ Less than 1/2 unit.
5/ Formerly Zaire.

Source: Bureau of the Census.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY 1/

Kind and country	1996 Quantity (carats)	1996 Value 2/ (millions)	1997 Quantity (carats)	1997 Value 2/ (millions)
Emerald:				
Belgium	13,900	$2	10,500	$3
Brazil	4,340,000	7	493,000	6
Canada	15,600	1	1,950	(3/)
China	1,550	(3/)	32	(3/)
Colombia	968,000	74	1,430,000	80
France	3,340	2	4,380	1
Germany	13,900	2	30,500	3
Hong Kong	304,000	17	356,000	18
India	3,280,000	39	2,830,000	45
Israel	401,000	26	162,000	23
Japan	3,020	1	4,590	(3/)
South Africa	1,370	(3/)	17,700	(3/)
Switzerland	89,800	18	71,300	25
Taiwan	207	(3/)	247	(3/)
Thailand	358,000	8	448,000	7
United Kingdom	2,330	3	3,600	2
Other	145,000 r/	4 r/	96,900	3
Total	9,930,000	203	5,960,000	217
Ruby:				
Belgium	11,000	1	2,100	1
Brazil	11,300	(3/)	5,550	(3/)
Burma	189	1	29,700	3
Canada	9,540	(3/)	1,010	(3/)
China	9,020	(3/)	14,200	(3/)
Colombia	423	(3/)	613	(3/)
France	1,260	1	366	(3/)
Germany	31,000	1	71,000	2
Hong Kong	377,000	7	404,000	11
India	2,340,000	6	1,480,000	8
Israel	25,400	1	218,000	1
Japan	2,240	(3/)	1,140	(3/)
Switzerland	14,900	17	69,400	30
Thailand	3,010,000	44	2,830,000	48
United Kingdom	3,370	4	5,780	4
Other	57,000 r/	2 r/	233,000	2
Total	5,910,000	86	5,360,000	111
Sapphire:				
Australia	9,190	(3/)	103,000	2
Belgium	25,900	1	3,480	(3/)
Brazil	8,190	(3/)	5,470	(3/)
Burma	539	1	331	1
Canada	4,840	(3/)	1,680	(3/)
China	506,000	1	64,100	(3/)
Colombia	395	(3/)	3,690	(3/)
France	738	1	337	(3/)
Germany	64,500	2	101,000	2
Hong Kong	298,000	6	246,000	7
India	682,000	2	354,000	3
Israel	67,800	3	99,600	2
Japan	1,640	(3/)	6,220	(3/)
Singapore	84	1	36	(3/)
Sri Lanka (ceylon)	864,000	10	616,000	12
Switzerland	23,100	10	349,000	20
Tanzania	3,010	(3/)	- -	- -
Thailand	5,920,000	55	4,450,000	64
United Kingdom	8,030	3	8,990	6

See footnotes at end of table.

TABLE 8--Continued

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY 1/

Kind and country	1996 Quantity (carats)	1996 Value 2/ (millions)	1997 Quantity (carats)	1997 Value 2/ (millions)
Sapphire: (continued)				
Other	37,700 r/	$1 r/	243,000	$3
Total	8,530,000	95	6,660,000	124
Other:				
Rough, uncut:				
Australia	NA	4	NA	3
Brazil	NA	21	NA	23
China	NA	1	NA	8
Colombia	NA	1	NA	1
Fiji	NA	1	NA	1
Hong Kong	NA	1	NA	1
India	NA	1	NA	1
Kenya	NA	2	NA	1
Nigeria	NA	(3/)	NA	(3/)
Pakistan	NA	(3/)	NA	1
Philippines	NA	1	NA	1
Russia	NA	(3/)	NA	(3/)
South Africa	NA	(3/)	NA	1
Switzerland	NA	(3/)	NA	1
Taiwan	NA	4	NA	12
Tanzania	NA	1	NA	2
Thailand	NA	1	NA	1
United Kingdom	NA	1	NA	1
Zambia	NA	2	NA	3
Other	NA	7 r/	NA	8
Total	NA	50	NA	70
Cut, set and unset:				
Australia	NA	5	NA	8
Brazil	NA	8	NA	10
Canada	NA	(3/)	NA	(3/)
China	NA	5	NA	7
French Polynesia	NA	4	NA	5
Germany	NA	11	NA	9
Hong Kong	NA	24	NA	31
India	NA	18	NA	26
Israel	NA	5	NA	5
Japan	NA	20	NA	10
Kenya	NA	1	NA	2
Sri Lanka (ceylon)	NA	3	NA	3
Switzerland	NA	2	NA	2
Taiwan	NA	2	NA	2
Tanzania	NA	2	NA	3
Thailand	NA	25	NA	28
United Kingdom	NA	1	NA	2
Other	NA	4	NA	4
Total	NA	138	NA	155

r/ Revised. NA Not available.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Customs value.

3/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 9
VALUE OF U.S. IMPORTS OF SYNTHETIC AND IMITATION
GEMSTONES, BY COUNTRY 1/

(Thousand dollars) 2/

Country	1996	1997
Synthetic, cut but unset:		
Australia	768	386
Austria	5,320	6,250
Brazil	116	176
China	4,880	10,100
France	1,090	1,120
Germany	12,100	11,500
Hong Kong	2,060	2,010
India	1,000	1,130
Italy	318	123
Japan	93	138
Korea, Republic of	1,440	1,710
Spain	83	123
Sri Lanka (ceylon)	649	674
Switzerland	3,780	4,930
Taiwan	376	519
Thailand	6,410	6,100
Other	280 r/	475
Total	40,700	47,400
Imitation: 3/		
Austria	46,200	40,000
China	414	609
Czech Republic	17,300	10,500
Germany	2,360	2,430
Japan	788	1,190
Spain	175	317
Taiwan	214	304
Other	1,090 r/	1,240
Total	68,500	56,600

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Customs value.
3/ Includes pearls.

Source: Bureau of the Census.

TABLE 10
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES 1/

(Thousand carats and thousand dollars)

Stones	1996 Quantity	1996 Value 2/	1997 Quantity	1997 Value 2/
Diamonds:				
Rough or uncut	1,450	731,000	1,940	646,000
Cut but unset	12,300	5,830,000	13,400	6,950,000
Emeralds, cut but unset	9,930	203,000	5,960	217,000
Coral and similar materials, unworked	NA	6,340	NA	6,080
Rubies and sapphires, cut but unset	14,400	181,000	12,000	235,000
Pearls:				
Natural	NA	1,100	NA	785
Cultured	NA	31,800	NA	34,000
Imitation	NA	1,740	NA	2,210
Other precious and semiprecious stones:				
Rough, uncut	1,610,000	37,400	1,180,000	57,900
Cut, set and unset	NA	105,000	NA	120,000
Other	NA	6,320	NA	5,640
Synthetic:				
Cut but unset	174,000	40,700	230,000	47,400
Other	NA	3,800	NA	6,040
Imitation gemstone 3/	NA	66,800	NA	54,400
Total	XX	7,240,000	XX	8,380,000

NA Not available. XX Not applicable.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Customs value.
3/ Does not include pearls.

TABLE 11

NATURAL DIAMOND: ESTIMATED WORLD PRODUCTION, BY TYPE AND COUNTRY 1/ 2/

(Thousand carats)

Country	1993	1994	1995	1996	1997
Gemstones: 3/					
Angola	130	270	2,600 r/	2,250 r/	1,110
Australia	18,800	19,500	18,300	18,897 4/	18,100
Botswana	10,300	10,550 4/	11,500	12,700 r/	13,000
Brazil	1,000	300	676 r/ 4/	200 r/	300
Central African Republic	370 4/	401 r/	400	350	400
China	230	230	230	230	230
Congo (Kinshasa) 5/	2,010	4,000	4,000	3,600 r/	2,500
Ghana	106 4/	118 4/	126	142 r/	140
Guinea	134	306	274	165	160
Liberia	60	40	60	60	60
Namibia	1,120	1,312 4/	1,382 4/	1,420 r/	1,500
Russia	8,000	8,500	9,000	9,250	9,550
Sierra Leone	90	155	113	162 4/	110
South Africa	4,600	5,050	5,070	4,280 r/	4,380
Venezuela	267 r/	380 r/	125 r/	105 r/	100
Zimbabwe	26	104	114	300 r/	350
Other	101 r/	180 r/	183 r/	231 r/	235
Total	47,400 r/	51,400	54,200 r/	54,400 r/	52,200
Industrial:					
Angola	15	30	300	250 r/	124
Australia	23,000	23,800	22,400	23,096 4/	22,100
Botswana	4,420	5,000	5,300	5,000	5,000
Brazil	600	600	600	600	600
Central African Republic	125	131	130	120	100
China	850	850	900	900	900
Congo (Kinshasa) 5/	13,600	13,000	13,000	17,000 r/	12,500
Ghana	484 4/	473 4/	505	573 r/	560
Guinea	33	75	91	40	40
Liberia	90	60	90	90	90
Russia	8,000	8,500	9,000	9,250	9,550
Sierra Leone	68	100	101	108	90
South Africa	5,700	5,800	5,880	5,670 r/	5,790
Venezuela	144 r/	203 r/	66 r/	55 r/	50
Zimbabwe	18	69	90	137 r/	100
Other	117 r/	96 r/	127 r/	149 r/	151
Total	57,300 r/	58,800 r/	58,600	63,000 r/	57,700
Grand total	105,000	110,000	113,000	117,000	110,000

r/ Revised.

1/ World totals and estimated data are rounded to three significant digits; may not add to totals shown.

2/ Table includes data available through May 27, 1998.

3/ Includes near-gem and cheap-gem qualities.

4/ Reported figure.

5/ Formerly Zaire.

GEMSTONES

By Ronald F. Balazik

Domestic survey data and tables were prepared by Christine K. Pisut, statistical assistant, and the world production table was prepared by Glenn J. Wallace, international data coordinator.

Gemstones have been used as symbols of beauty, wealth, and status since prehistoric times (Schumann, 1998). Amber, for example, has been mined for use as a gem since before 25,000 B.C. The oldest names for gems can be traced back to ancient China, Greece, and Rome.

Regardless of their long history, however, gems and gemstones have no single, precise definition that is generally accepted. According to Webster's New International Dictionary (1961, p. 1,042), a gem is "Any jewel, whether stone, pearl or the like, having value and beauty that are intrinsic and not derived from its setting; a precious or, sometimes, a semiprecious stone cut and polished for ornament. A semiprecious stone of value because it is carved or engraved, as a cameo or intaglio." Additionally, the dictionary states that a gemstone is "Any mineral or petrified material which can, when cut and polished, be used in jewelry" (Webster's New International Dictionary, 1961, p. 1,043).

For this report, the terms "gem" and "gemstone" mean any mineral or organic material (e.g., pearl and petrified wood) used for personal adornment, display, or object of art because it possesses beauty, rarity, and durability. Of the 2,700 mineral species, only about 100 possess all these attributes. Silicates compose the largest group of gemstones; oxides and quartz compose the second largest (table 1). A further refinement of "gemstone" is "colored gemstone," which in this report designates all nondiamond gems, including amber, coral, and shell. In addition, synthetic gems, cultured pearl, and gem simulants are discussed below but are treated separately from natural gemstones (table 2).

Production

Commercial mining of gemstones has never been extensive in the United States. More than 60 different gemstones have been produced commercially from domestic mines, but most of the deposits have been relatively small compared with many other mining operations. In many instances, moreover, contemporary gemstone mining in the country is conducted by hobbyists, collectors, and gem clubs rather than business organizations.

The commercial gemstone industry in the United States consists of several distinct sectors: (1) individuals and companies that mine gemstones or harvest shell and pearl, (2) firms that manufacture synthetic gemstones, and (3) individuals and companies that cut natural and synthetic gemstones. The domestic gemstone industry is focused on the production of colored gemstones and the cutting of large diamonds. Industry employment is estimated to range from 1,000 to 1,500 workers (U.S. International Trade Commission, 1997, p. 1).

Most natural gemstone producers in the United States are small businesses that are widely dispersed and operate independently. The small producers probably have an average of less than three employees, including those who only work part time. The number of gemstone mines operating from year to year fluctuates because the inherent uncertainty associated with the discovery and marketing of gem-quality minerals makes it difficult to obtain financing for developing and sustaining economically viable deposits (U.S. International Trade Commission, 1997, p. 23).

The total value of natural gemstones produced in the United States during 1998 was estimated to be at least $14.3 million (table 3). This production value was significantly less than that of the preceding year primarily because foreign markets for U.S. shell material decreased, particularly in Japan where the operations of cultured pearl producers that use the shell for pearl nuclei were adversely affected by declining markets in Southeast Asia, high mortality of pearl oysters, and competition from China (Jewelers' Circular Keystone, 1998c; Jewellery News Asia, 1998b). Unless new markets are acquired, shell production in the United States may not recover for many years; China, however, has the potential to become a larger U.S. market and, thereby, could help to offset the losses in Japan (Jewelers' Circular Keystone, 1998b).

The estimate of 1998 U.S. gemstone production was based on a survey of more than 200 domestic gemstone producers conducted by the U.S. Geological Survey (USGS). The survey provided a foundation for projecting the scope and level of domestic gemstone production during the year. The survey, however, did not represent all gemstone activity in the United States, including thousands of professional and amateur collectors. Consequently, the USGS supplemented its survey with estimates of domestic gemstone production from related published data, contacts with gem dealers and collectors, and information garnered at gem and mineral shows.

Natural gem materials indigenous to the United States are collected, produced, and/or marketed in every State. Only four States, however, accounted for more than two-thirds of the total value of production in 1998, as reported by survey respondents. These States were (in descending order of reported production value) Tennessee, Arizona, California, and Oregon. Certain States are best known for the production of a single gem material; for example, Kentucky and Tennessee (for freshwater shell). Other States, however, have a wide array of gemstones. For example, Arizona gemstone deposits include agate, amethyst, azurite, chrysocolla, fire agate, garnet, jade, malachite, obsidian, onyx, peridot, petrified wood, opal, smithsonite, and turquoise. A great variety of gemstones also are found in California, Idaho, Montana, and North Carolina. High-quality emeralds reportedly were discovered in North Carolina during 1998 (Jewelers' Circular Keystone, 1999a).

Following considerable attention in recent years, new U.S. diamond production declined and was virtually nonexistent in 1998. During the year, Colorado's Kelsey Lake diamond mine, which became North America's first commercial diamond producer in almost a century when it opened in 1995, ceased production and was offered for sale (Shor, 1998; Maria Musso, Redaurum Limited, oral commun., 1999). Nevertheless, further exploration for diamond continued in the Kelsey Lake area and in other parts of Colorado during 1998. The only other significant diamond-bearing area known in the United States is in Crater of Diamonds Park near Murfreesboro, AR, where a dig-for-fee operation for tourists is maintained by the State. An Arkansas law prohibiting commercial diamond mining in the park was debated in the State legislature during 1998 and was enacted early in 1999 (Diamond Registry Bulletin, 1999b).

In addition to natural gemstones, synthetic gems and gemstone simulants are produced in the United States. Synthetic gemstones have the same optical, physical, and chemical properties as the natural materials that they appear to be. Simulants have an appearance similar to that of a natural gem material but have different optical, physical, and chemical properties. Synthetic gemstones produced in the United States include alexandrite, emerald, ruby, sapphire, turquoise, and zirconia. The major simulants produced in the United States are colored and colorless varieties of cubic zirconia. Simulants of coral, lapis lazuli, malachite, and turquoise also are manufactured. In addition, certain colors of synthetic sapphire and spinel, used to represent other gemstones, are classified as simulants.

Synthetic gem production in the United States exceeded $24 million during 1998; simulant gemstone output was even greater—estimated to be well over $100 million. Six firms in five States, representing virtually all the U.S. synthetic gem industry, reported production to the USGS in 1998. In descending order of production value, the States with reported synthetic output were New York, California, North Carolina, Arizona, and Michigan. Some of the producers are attempting to produce synthetic gem-quality diamond (Tom Chatham, Chatham Created Gems, oral commun., 1998).

During 1998, a North Carolina firm began marketing moissanite, a gem-quality silicon carbide that it produces (C3 Inc., 1998). According to published reports, the moissanite is an excellent diamond simulant, but has been marketed for its other gem qualities as well.

Consumption

Although the United States accounts for less than 1% of total global gem production, it is the world's leading gemstone market. On the basis of indicators, such as trade data and income growth rates, U.S. gemstone markets—bolstered by strong demand among consumers with increasing personal wealth and growing discretionary income—apparently accounted for at least 35% of world gem demand in 1998. The U.S. market for unset gem diamonds during the year was estimated to have exceeded $8 billion, the largest in the world. Domestic markets for natural, unset nondiamond gemstones totaled more than $650 million.

In addition to jewelry, gemstones are used for collections, exhibits, and decorative art objects. According to a poll conducted by a U.S. jewelry retailers association in the mid-1990's, about two-thirds of domestic consumers who were surveyed preferred diamond as their favorite gemstone; most others chose, in descending order, emeralds, sapphires, and rubies (ICA Gazette, 1996).

Prices

Gemstone prices are governed by many factors and qualitative characteristics, including beauty, clarity, defects, demand, and rarity. Diamond pricing in particular is complex; values can vary significantly depending on time, place, and the subjective evaluations of buyers and sellers. There are more than 14,000 categories used to assess rough diamond and perhaps 100,000 price points for polished diamond alone (Pearson, 1998).

Colored gemstone prices are generally influenced by market supply-and-demand considerations, and diamond prices are supported by producer controls on the quantity and quality of supply. Values and prices of gemstones produced and/or sold in the United States are shown in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported and exported/reexported are shown in tables 6 through 10.

DeBeers Consolidated Mines Limited in South Africa is a significant force affecting gem diamond prices worldwide because it mines about one-half the diamonds produced each year and controls at least three-quarters of global raw diamond supply through its Central Selling Organization (CSO), which has marketing agreements with other producers. Estimates based on the reported output of major diamond mines in 1998 indicate that the average value of all diamond produced during the year was about $55 per carat; by country, the average value per carat ranged from about $10 in Australia to more than $270 in Namibia (Rombout, 1999).

Foreign Trade

Several export and import measures demonstrate the significance of the United States in world gemstone trade. During 1998, total U.S. gemstones trade with all countries and territories exceeded $11.6 billion; diamonds accounted for 96% of the total. In 1998, U.S. exports/reexports of diamond were shipped to 63 countries/territories, and imports of all gemstones were received from 98 countries/territories (tables 6-10).

During 1998, U.S. trade in cut diamonds reached unprecedented levels; the country continued to be the world's leading diamond importer and set export records as well. Record high imports were attributed to a strong U.S. economy that boosted domestic demand for diamond jewelry among consumers with increasing personal wealth and more discretionary income.

The United States is a significant international diamond transit center as well as the world's largest gem diamond market. The large volume of reexports (table 6) shipped to other centers reveals the significance that the United States has in the world's diamond supply network.

Synthetic gemstones became more prominent trade issues for the United States in 1998. Imports of synthetic gems (particularly from China, Russia, and Taiwan) reportedly increased during the year. Prices of certain synthetic gem imports, such as amethyst, were very competitive (Mike Romanella, Commercial Mineral Company, oral commun., 1999). The marketing of synthetic imports as natural gemstones has become a serious problem for some domestic producers (Tom Chatham, Chatham Created Gems, Inc., oral commun., 1998).

During 1998, the Office of the United States Trade Representative, assisted by the USGS, continued negotiations with 17 Asian and Pacific Rim Governments to reduce barriers in gemstone trade (AJM, 1998). The negotiations, still underway at yearend, focused on tariffs and other barriers to international trade.

World Review

The gemstone industry worldwide is comprised of two distinctly different sectors: (1) diamond mining and marketing, and (2) the production and sale of colored gemstones. Most diamond supplies are controlled by a few major mining companies; prices are supported by managing the quantity and quality of the gems relative to demand, a function performed by DeBeers through its CSO. Unlike diamonds, colored gemstones are primarily produced at relatively small, low-cost operations with few dominant producers; prices are influenced by consumer demand in addition to supply availability.

In 1998, world diamond production totaled at least 115 million carats with an estimated value of more than $7 billion (table 11). Some estimates of worldwide diamond mine output (including industrial-quality diamonds) in 1998 ranged up to 126 million carats (Mining Journal, 1999). Most production was concentrated in a few regions—Africa (Angola, Botswana, Namibia, South Africa, and Zaire); Asia (northeastern Siberia and Yakutia in Russia); Australia; and South America (Brazil and Venezuela). In 1998, Botswana was the world's leading diamond producer in terms of output value; Australia, which increased its output significantly during the year, led in quantity of production (Diamond Registry Bulletin, 1998a).

Sales of rough diamond by the CSO in 1998 were only $3.3 billion, 28% below sales during 1997 and almost one-third less than the record high sales of 1996 (Diamond Registry Bulletin, 1999a). The sales loss reflected reduced demand in the markets of Japan and several Southeast Asian countries, which experienced severe declines in their national economies. In order to stabilize and support prices, the CSO reduced its supply of diamonds for worldwide markets to its lowest level in 6 years (Jewellery News Asia, 1999c). Strong market demand in the United States helped the CSO and other suppliers compensate for the Asian decline; domestic diamond jewelry sales alone grew by 9% and reached a record high in 1998, the seventh consecutive year sales have risen (Jewelers' Circular Keystone, 1999b; Rapaport Diamond Report, 1999). Demand in the United States for rough diamond equated to almost one-fifth of CSO sales during the year.

Additional events in 1998 significant to diamond mining and marketing worldwide include the following:

! Russia extended its diamond supply contract (covering 8% to 15% of world production) with DeBeers for three more years (Diamond Registry Bulletin, 1998c).

! Canada's first commercial diamond mine opened amid expectations that it would make Canada a major diamond producer (Diamond Registry Bulletin, 1998b). The new mine is expected to account for about 6% of world diamond output value when it reaches full production levels in 1999 (Diamond Registry Bulletin, 1998b). One-third of the mine's output will be marketed by DeBeers through the CSO (Jewellery News Asia, 1999a).

! Civil wars afflicting several nations in central Africa continued to threaten the viability of significant diamond-producing areas in the region. In 1998, the USGS helped the U.S. Department of State assess issues concerning diamond mining and the hostilities in central Africa.

! China, with a potential market of more than 1 billion consumers, began to establish its first international diamond exchange and a free trade zone for diamonds (Jewellery News Asia, 1998c and 1999b).

! Some governments (e.g., Belgium's parliament) considered stronger regulatory regimes for their diamond industries (Diamond International, 1998).

Worldwide production of natural gemstones other than diamond was estimated to have exceeded $2 billion per year in the late 1990's. Most nondiamond gemstone mines are small, low-cost, and widely dispersed operations in remote regions of developing nations. Foreign countries with major gemstone deposits other than diamond are Afghanistan (beryl, ruby, and tourmaline); Australia (beryl, opal, and sapphire); Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline); Burma (beryl, jade, ruby, sapphire, and topaz); Colombia (beryl, emerald, and sapphire); Kenya (beryl, garnet, and sapphire); Madagascar (beryl, rose quartz, sapphire, and tourmaline); Mexico (agate, opal, and topaz); Sri Lanka (beryl, ruby, sapphire, and topaz); Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline); and Zambia (amethyst and beryl). In addition, pearls are cultured throughout the South Pacific and in other equatorial waters; Australia, China, and Japan are key producers.

Like the diamond industry, colored gemstone producers attempted to recover from the weakened markets created by the Asian economic crisis of 1997-98. Mining and sales reportedly were disrupted in many nations, particularly in southeast Asia. Prices of high-quality colored gemstones, however, did not decline dramatically (Cavey, 1998).

Additional noteworthy events in the colored gemstone industry during 1998 included the following:

! Proposals to establish the world's first emerald exchange were considered at a Government-sponsored conference in Colombia (Mining Journal, 1998).

! Like diamonds, the introduction and proliferation of new synthetic gem-quality materials and simulants—as well as treatment processes to enhance gemstone attributes artificially—continued to raise issues and controversies regarding standards for disclosure to consumers.

! As the Japanese pearl industry continued to suffer losses, a potentially significant cultured pearl industry that emerged in China during the 1990's was able to maintain its 10% annual growth rate (Jewelers' Circular Keystone, 1998a; Jewellery News Asia, 1998a).

Outlook

The collapse of several important diamond markets in recent years reminds gemstone industry forecasters that market strength ultimately is sustained by consumer demand, not supply constraints. Because gemstone markets are concerned with luxury merchandise, they must rely on the growth of personal wealth and discretionary income levels among consumers who make choices among nonessential goods in the marketplace.[1] Fortunately for producers of precious gems, long-term economic forecasts predict continued growth of discretionary income in the industrialized world, and anticipate even higher growth rates in developing countries, such as China and other Asian nations.

The recovery of diamond markets in the next few years, however, may be slow. Buoyed by U.S. demand, CSO sales are expected to rebound and reach $3.8 billion in 1999 (Paribas Group, 1998). Nevertheless, this achievement is well below the successes enjoyed by DeBeers in recent years. Diversification of markets, with less reliance on U.S. consumption, will be the key to long-term, steady growth in world demand.

The ability of the CSO to manage the flow of diamonds to world markets also will be a greater challenge for DeBeers in the coming decade. Independent producers, such as Argyle Diamond Mines in Australia and new mines in Canada, will bring a greater measure of competition to global markets. More competition presumably will bring more supplies and lower prices; at present, however, the actual impact of such competition is uncertain.

Demand for gemstones other than diamond will depend on how successfully jewelers promote their alternatives. As the jewelry industry consolidates toward fewer, larger companies and turns more to mass merchandizing, smaller dealers will need to focus on niche markets and target specific demographic groups to remain competitive. Numerous synthetics, simulants, and treated gems will enter the marketplace and necessitate more transparent trade industry standards to maintain customer confidence. Russia is expected to become a major source of synthetic gems for U.S. markets within a few years. Much greater volumes of gem jewelry will be sold via telemarketing programs and new electronic media, such as the internet.

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[1]Other important factors that will drive market demand include consumer confidence and interest rates.

[2]Prior to January 1996, published by the U.S. Bureau of Mines.

TABLE 1

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characters
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0-2.5	1.0-1.1	Single	1.54	Synthetic or pressed plastics	Fossil resin, soft.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	Small to medium	High	6.0-6.5	3.64-3.68	Double	1.76-1.80	Sapphire, tanzanite, blue diamond, blue tourmaline	Strong blue in ultraviolet light.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5-8.0	2.63-2.80	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	do.	Small	Very high	7.5-8.0	2.63-2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald	do.	Green	Medium	do.	7.5	2.63-2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5-8.0	2.63-2.80	do.	1.58	Genuine emerald	Flaws, brilliant, fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5-8.0	2.63-2.80	do.	1.58	Citrine, topaz, glass, doublets	Weak-colored.
Goshenite	do.	do.	do.	Low	7.5-8.0	2.63-2.80	do.	1.58	Quartz, glass, white sapphire, white topaz.	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5-8.0	2.63-2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49-1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.60	do.	Banded, translucent.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day, red by artificial light	Small (Former U.S.S.R.) Medium (Sri Lanka)	High	8.5	3.50-3.84	Double	1.75	Synthetic	Dichroism, inclusions in synthetic sapphire.
Cats-eye	do.	Greenish to brownish	Small to large	do.	8.5	3.50-3.84	do.	1.75	Synthetic, shell	Gravity and translucence.
Chrysolite	do.	Yellow, green, and/or brown	Medium	Medium	8.5	3.50-3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Coral	Calcium carbonate	Orange, red, white, black, or green	Branching, medium	Low	3.5-4.0	2.6-2.7	do.	1.49-1.66	False coral	Dull translucent.

See footnotes at end of table.

TABLE 1--Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characters
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95-4.10	Double	1.78	Synthetics, including spinel	Inclusions, fluorescence.
Sapphire	do.	Blue	Medium	High	9.0	3.95-4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, white, orange, green, or violet	Medium to large	Medium	9.0	3.95-4.10	do.	1.78	Synthetics, glass and doublets	Inclusions, double refraction, refractive index.
Sapphire and ruby, stars	do.	Red, pink, violet, blue, or gray	do.	High to low	9.0	3.95-4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.
Sapphire or ruby, synthetic	do.	Yellow, pink, or blue	Up to 20 carats	Low	9.0	3.95-4.10	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Diamond	Carbon	White, blue-white, yellow, brown, green, pink, blue	Any	Very high	10.0	3.516-3.525	Single	2.42	Zircon, titania, cubic zirconia	High index, dispersion, hardness, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green	Large	Low	6.0-6.5	2.56	--	1.52	Jade	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play	do.	do.	6.0-6.5	2.56	--	1.56	do.	Do.
Moonstone	do.	Colorless or yellow	do.	do.	6.0-6.5	2.77	--	1.52-1.54	Glass	Pale sheen, opalescent.
Garnet	Complex silicate	Brown, black, yellow, green, ruby red, or orange	Small to medium	Low to high	6.5-7.5	3.15-4.30	Single strained	1.79-1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Jade:										
Jadeite	do.	Green, yellow, black, white, or mauve	Large	Low to very high	6.5-7.0	3.3-3.5	Cryptocry-stalline	1.65-1.68	Onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent, to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0-6.5	2.96-3.10	do.	1.61-1.63	do.	Do.
Opal	Hydrous silica	Colors flash in white, gray, black, red, or yellow	do.	Low to high	5.5-6.5	1.9-2.3	Single	1.45	Glass, synthetics, triplets	Play of color.
Pearl	Calcium carbonate	White, pink, or black	Small	do.	2.5-4.0	2.6-2.85	--	--	Cultured and imitation	Luster, structure, X-ray.
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5-7.0	3.27-3.37	Double (strong)	1.65-1.69	Tourmaline chrysoberyl	Strong double refraction, low dichroism.

See footnotes at end of table.

TABLE 1--Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characters
Quartz:										
Agate	Silica	Any color	Large	Low	7.0	2.58-2.64	--	--	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65-2.66	Double	1.55	do.	Refractive index, double refraction, transparent.
Cairngorm	do.	Smoky	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Citrine	do.	Yellow	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Do.
Crystal, rock	do.	Colorless	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Do.
Jasper	do.	Uniform or spotted red, yellow, or green	do.	do.	7.0	2.58-2.66	--	--	do.	Opaque, vitreous.
Onyx	do.	Many colors	do.	do.	7.0	2.58-2.64	--	--	do.	Uniformly banded.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65-2.66	Double	1.55	do.	Refractive index, double refraction, translucent.
Spinel	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5-3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5-3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5-7.0	3.13-3.20	do.	1.66	Synthetic spinel	Refractive index.
Kunzite	do.	Pink to lilac	do.	do.	6.5-7.0	3.13-3.20	do.	1.66	Amethyst, morganite	Do.
Tanzanite	Complex silicate	Blue	Small	High	6.0-7.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism.
Topaz	do.	White, blue, green	Medium	Low to medium	8.0	3.4-3.6	do.	1.62	Beryl, quartz	Refractive index.
Tourmaline	do.	All, including mixed	do.	do.	7.0-7.5	2.98-3.20	do.	1.63	Peridot, beryl, corundum, glass	Double refraction, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green	Large	Low	6.0	2.60-2.83	do.	1.63	Glass, plastics	Difficult if matrix not present, matrix usually limonitic.
Zircon	Zirconium silicate	White, blue, or brown, yellow, or green	Small to medium	Low to medium	6.0-7.5	4.0-4.8	Double (strong)	1.79-1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

1/ Small, up to 5 carats; medium, up to 50 carats; large, more than 50 carats.

2/ Low, up to $25 per carat; medium, up to $200 per carat; high, more than $200 per carat.

TABLE 2
SYNTHETIC GEMSTONE PRODUCTION METHODS

Gemstone	Production methods	Company/producer	Date of first production
Alexandrite	Flux	Creative Crystals Inc.	1970's
Do.	Melt pulling	J.O. Crystal Co., Inc.	1990's
Do.	do.	Kyocera Corporation	1980's
Do.	Zone melt	Seiko Corp.	1980's
Cubic zirconia	Skull melt	Various producers	1970's
Emerald	Flux	Chatham Created Gems, Inc.	1930's
Do.	do.	Gilson	1960's
Do.	do.	Kyocera Corporation	1970's
Do.	do.	Seiko Corp.	1980's
Do.	do.	Lennix	1980's
Do.	do.	Russia	1980's
Do.	Hydrothermal	Lechleitner	1960's
Do.	do.	Regency	1980's
Do.	do.	Biron	1980's
Do.	do.	Russia	1980's
Ruby	Flux	Chatham Created Gems, Inc.	1950's
Do.	do.	Kashan	1960's
Do.	do.	J.O. Crystal Co., Inc.	1980's
Do.	do.	Douras	1990's
Do.	Zone melt	Seiko Corp.	1980's
Do.	Melt pulling	Kyocera Corporation	1970's
Do.	Verneuil	Various producers	1900's
Sapphire	Flux	Chatham Created Gems, Inc.	1970's
Do.	Zone melt	Seiko Corp.	1980's
Do.	Melt pulling	Kyocera Corporation	1980's
Do.	Verneuil	Various producers	1900's
Star ruby	do.	Linde Air Products Co.	1940's
Do.	Melt pulling	Kyocera Corporation	1980's
Do.	do.	Nakazumi Crystal Laboratory	1980's
Star sapphire	Verneuil	Linde Air Products Co.	1940's

TABLE 3
VALUE OF U.S. GEMSTONE PRODUCTION, BY GEMSTONE 1/

(Thousand dollars)

Gem materials	1997	1998
Agate	218	128
Beryl	901	1,060
Coral (all types)	65	76
Diamond	W	(2/)
Garnet	35	66
Gem feldspar	579	378
Geode/nodules	100	46
Opal	341	769
Quartz	1,130	768
Sapphire/ruby	964	369
Shell	11,700	1,150
Topaz	8	8
Tourmaline	16	49
Turquoise	976	837
Other	7,990	8,610
Total	25,000	14,300

W Withheld to avoid disclosing company proprietary data.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Included in "Other."

TABLE 4

PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY 1/

			Representative prices		
Carat weight	Description, color 3/	Clarity 2/ (GIA terms)	January 1998 4/	June 1998 5/	December 1998 6/
0.25	G	VS1	$1,500	$1,500	$1,500
.25	G	VS2	1,380	1,380	1,380
.25	G	SI1	1,130	1,130	1,130
.25	H	VS1	1,400	1,400	1,400
.25	H	VS2	1,250	1,250	1,250
.25	H	SI1	1,050	1,050	1,050
.50	G	VS1	3,300	3,400	3,400
.50	G	VS2	2,900	3,000	3,000
.50	G	SI1	2,500	2,500	2,500
.50	H	VS1	2,900	3,000	3,000
.50	H	VS2	2,600	2,700	2,700
.50	H	SI1	2,400	2,400	2,400
.75	G	VS1	3,800	3,800	3,800
.75	G	VS2	3,600	3,600	3,600
.75	G	SI1	3,300	3,300	3,300
.75	H	VS1	3,650	3,650	3,650
.75	H	VS2	3,450	3,450	3,450
.75	H	SI1	3,100	3,100	3,100
1.00	G	VS1	5,500	5,500	5,700
1.00	G	VS2	5,200	5,200	5,300
1.00	G	SI1	4,700	4,700	4,800
1.00	H	VS1	5,100	5,100	5,200
1.00	H	VS2	4,900	4,900	4,900
1.00	H	SI1	4,500	4,500	4,500

1/ Data are rounded to three significant digits.

2/ Clarity: IF, no blemishes; VVS1, very, very slightly included; VS1, very slightly included; VS2, very slightly included, but not visible; SI1, slightly included.

3/ Gemological Institute of America (GIA) color grades: D, colorless; E, rare white; G - H - I , traces of color.

4/ Jewelers' Circular Keystone, v. 169, no. 2, February 1998, p. 196.

5/ Jewelers' Circular Keystone, v. 169, no. 7, July 1998, p. 74.

6/ Jewelers' Circular Keystone, v. 170, no. 1, January 1999, p. 42.

TABLE 5

PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES

	Price range per carat 1/	
Gemstone	January 1998	December 1998
Amethyst	$7-$16	$7-$16
Aquamarine	75-190	75-190
Emerald	750-1,900	900-2,000
Ruby	1,800-2,900	1,800-2,800
Sapphire	800-1,800	800-1,800
Tanzanite	130-200	180-300

1/ Jewelers' Circular Keystone, v. 169, no. 2, February 1998, p. 196 and v. 170, no. 1, January 1999, p. 42. These figures represent a sampling of net prices that wholesale colored stone dealers in various U.S. cities charged their cash customers during the month for fine-quality stones.

TABLE 6
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY 1/

Country	1997 Quantity (carats)	1997 Value 2/ (millions)	1998 Quantity (carats)	1998 Value 2/ (millions)
Exports:				
Belgium	20,500	$2	14,800	$6
Canada	77,500	29	67,100	25
France	586	2	180	10
Hong Kong	7,670	20	22,300	5
India	1,080	1	29,000	2
Israel	7,890	2	2,770	7
Japan	5,540	15	7,750	17
Singapore	1,940	2	409	(3/)
Switzerland	9,860	26	5,480	28
Thailand	616	(3/)	200	(3/)
United Arab Emirates	2,440	(3/)	--	--
United Kingdom	2,860	(3/)	6,590	6
Other	13,900	7	52,500	15
Total	152,000	108	209,000	123
Reexports:				
Bahrain	40	(3/)	--	--
Belgium	822,000	612	852,000	676
Canada	73,900	32	81,300	39
France	25,600	30	16,600	27
Hong Kong	570,000	380	567,000	272
India	187,000	23	401,000	42
Israel	768,000	732	846,000	960
Japan	74,000	55	76,800	58
Singapore	16,000	42	14,600	27
Switzerland	52,400	159	56,000	164
Thailand	101,000	24	137,000	22
United Arab Emirates	57,300	13	22,700	12
United Kingdom	24,400	86	79,100	97
Other	28,100	26	52,800	39
Total	2,800,000	2,210	3,200,000	2,430
Grand total	2,950,000	2,320	3,410,000	2,560

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Customs value.
3/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY 1/

Kind, range, and country of origin	1997 Quantity (carat)	1997 Value 2/ (millions)	1998 Quantity (carat)	1998 Value 2/ (millions)
Rough or uncut, natural: 3/				
Australia	1,320	(4/)	13,000	(4/)
Belgium	585,000	$110	306,000	$111
Brazil	26,000	11	8,990	1
Congo (Brazzaville)	11,600	13	1,820	2
Congo (Kinshasa) 5/	87,100	88	66,300	72
Ghana	195,000	97	59,900	61
Guinea	8,170	10	16,800	11
India	110,000	4	5,320	(4/)
Israel	60,500	47	30,500	34
Russia	29,800	1	112,000	(4/)
Sierra Leone	13,900	16	7,450	10
South Africa	120,000	40	109,000	61
Switzerland	7,360	12	1,030	3
United Kingdom	652,000	186	609,000	206
Venezuela	13,300	3	13,800	2
Other	17,300	9	79,600	14
Total	1,940,000	646	1,440,000	588
Cut but unset, not more than 0.5 carat:				
Belgium	779,000	213	1,110,000	261
Brazil	2,960	2	14,100	2
Canada	5,050	1	676	(4/)
Germany	5,370	4	11,400	4
Hong Kong	419,000	77	378,000	61
India	7,790,000	1,320	9,820,000	1,560
Israel	1,010,000	568	1,010,000	521
Japan	7,000	4	7,190	2
South Africa	4,480	4	8,600	5
Switzerland	23,600	6	7,330	2
Thailand	57,100	11	70,400	10
United Kingdom	1,200	1	1,150	1
Other	51,100	12	73,200	24
Total	10,200,000	2,230	12,500,000	2,450
Cut but unset, more than 0.5 carat:				
Belgium	989,000	1,470	1,050,000	1,490
Botswana	15,200	9	1,690	1
Canada	2,660	7	880	3
France	1,760	8	1,780	16
Hong Kong	62,900	83	92,200	105
India	375,000	260	556,000	306
Israel	1,690,000	2,390	2,040,000	2,990
Japan	5,800	17	3,920	8
Russia	44,100	41	20,000	57
Singapore	575	4	3,860	15
South Africa	25,200	106	21,200	92
Switzerland	30,400	235	24,900	239
Thailand	11,000	11	10,700	14
United Kingdom	12,300	32	5,670	77
Other	22,300	37	25,400	39
Total	3,280,000	4,720	3,860,000	5,440

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Customs value.
3/ Includes some natural advanced diamond.
4/ Less than 1/2 unit.
5/ Formerly Zaire.

Source: Bureau of the Census.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND,
BY KIND AND COUNTRY 1/

Kind and country	1997 Quantity (carats)	1997 Value 2/ (millions)	1998 Quantity (carats)	1998 Value 2/ (millions)
Emerald:				
Belgium	10,500	$3	20,700	$2
Brazil	493,000	6	499,000	5
Canada	1,950	(3/)	5,750	1
China	32	(3/)	5,120	(3/)
Colombia	1,430,000	80	1,500,000	68
France	4,380	1	588	(3/)
Germany	30,500	3	33,500	4
Hong Kong	356,000	18	350,000	10
India	2,830,000	45	2,730,000	50
Israel	162,000	23	243,000	24
Japan	4,590	(3/)	399	(3/)
South Africa	17,700	(3/)	7,790	(3/)
Switzerland	71,300	25	67,800	21
Taiwan	247	(3/)	377	(3/)
Thailand	448,000	7	434,000	6
United Kingdom	3,600	2	3,090	1
Other	96,900	3	31,100	4
Total	5,960,000	217	5,930,000	195
Ruby:				
Belgium	2,100	1	2,610	(3/)
Brazil	5,550	(3/)	4,520	(3/)
Burma	29,700	3	1,090	7
Canada	1,010	(3/)	24	(3/)
China	14,200	(3/)	3,080	(3/)
Colombia	613	(3/)	4,300	(3/)
France	366	(3/)	2,440	1
Germany	71,000	2	15,700	1
Hong Kong	404,000	11	287,000	15
India	1,480,000	8	970,000	10
Israel	218,000	1	21,400	1
Japan	1,140	(3/)	3,730	(3/)
Switzerland	69,400	30	66,300	29
Thailand	2,830,000	48	2,370,000	47
United Kingdom	5,780	4	8,440	4
Other	233,000	2	50,800	3
Total	5,360,000	111	3,810,000	119
Sapphire:				
Australia	103,000	2	37,000	(3/)
Belgium	3,480	(3/)	29,000	1
Brazil	5,470	(3/)	5,770	(3/)
Burma	331	1	824	1
Canada	1,680	(3/)	283	(3/)
China	64,100	(3/)	6,700	(3/)
Colombia	3,690	(3/)	2,400	(3/)
France	337	(3/)	250	(3/)
Germany	101,000	2	59,900	2
Hong Kong	246,000	7	244,000	6
India	354,000	3	757,000	4
Israel	99,600	2	96,300	2
Japan	6,220	(3/)	3,550	(3/)
Singapore	36	(3/)	2,270	(3/)
Sri Lanka (Ceylon)	616,000	12	346,000	17
Switzerland	349,000	20	137,000	16
Tanzania	--	--	7,030	(3/)
Thailand	4,450,000	64	4,900,000	66
United Kingdom	8,990	$6	23,400	$5
Other	243,000	3	16,800	3
Total	6,660,000	124	6,670,000	123

See footnotes at end of table.

TABLE 8--Continued
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND,
BY KIND AND COUNTRY 1/

	1997		1998	
Kind and country	Quantity (carats)	Value 2/ (millions)	Quantity (carats)	Value 2/ (millions)
Other:				
Rough, uncut:				
Australia	NA	3	NA	3
Brazil	NA	23	NA	19
China	NA	8	NA	1
Colombia	NA	1	NA	1
Fiji	NA	1	NA	2
Hong Kong	NA	1	NA	1
India	NA	1	NA	2
Kenya	NA	1	NA	(3/)
Nigeria	NA	(3/)	NA	(3/)
Pakistan	NA	1	NA	1
Philippines	NA	1	NA	1
Russia	NA	(3/)	NA	(3/)
South Africa	NA	1	NA	1
Switzerland	NA	1	NA	(3/)
Taiwan	NA	12	NA	(3/)
Tanzania	NA	2	NA	1
Thailand	NA	1	NA	1
United Kingdom	NA	1	NA	1
Zambia	NA	3	NA	1
Other	NA	8	NA	9
Total	NA	70	NA	45
Cut, set and unset:				
Australia	NA	8	NA	8
Brazil	NA	10	NA	10
Canada	NA	(3/)	NA	1
China	NA	7	NA	8
French Polynesia	NA	5	NA	7
Germany	NA	9	NA	9
Hong Kong	NA	31	NA	35
India	NA	26	NA	37
Israel	NA	5	NA	4
Japan	NA	10	NA	14
Kenya	NA	2	NA	1
Sri Lanka (Ceylon)	NA	3	NA	4
Switzerland	NA	2	NA	2
Taiwan	NA	2	NA	2
Tanzania	NA	3	NA	5
Thailand	NA	28	NA	24
United Kingdom	NA	2	NA	3
Other	NA	4	NA	4
Total	NA	155	NA	178

NA Not available.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Customs value.
3/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 9
VALUE OF U.S. IMPORTS OF SYNTHETIC AND IMITATION
GEMSTONES, BY COUNTRY 1/

(Thousand dollars) 2/

Country	1997	1998
Synthetic, cut but unset:		
Australia	386	187
Austria	6,250	6,770
Brazil	176	205
China	10,100	11,300
France	1,120	720
Germany	11,500	10,800
Hong Kong	2,010	2,240
India	1,130	1,640
Italy	123	32
Japan	138	25
Korea, Republic of	1,710	1,990
Spain	123	47
Sri Lanka (Ceylon)	674	444
Switzerland	4,930	3,670
Taiwan	519	926
Thailand	6,100	4,280
Other	475	560
Total	47,400	45,900
Imitation: 3/		
Austria	40,000	37,100
China	609	1,320
Czech Republic	10,500	7,880
Germany	2,430	1,880
Japan	1,190	765
Spain	317	212
Taiwan	304	284
Other	1,240	908
Total	56,600	50,400

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Customs value.
3/ Includes pearls.

Source: Bureau of the Census.

TABLE 10
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES 1/

(Thousand carats and thousand dollars)

Stones	1997 Quantity	1997 Value 2/	1998 Quantity	1998 Value 2/
Diamonds:				
Rough or uncut	1,940	646,000	1,440	588,000
Cut but unset	13,400	6,950,000	16,400	7,900,000
Emeralds, cut but unset	5,960	217,000	5,930	195,000
Coral and similar materials, unworked	NA	6,080	NA	7,640
Rubies and sapphires, cut but unset	12,000	235,000	10,500	242,000
Pearls:				
Natural	NA	785	NA	1,090
Cultured	NA	34,000	NA	36,900
Imitation	NA	2,210	NA	1,530
Other precious and semiprecious stones:				
Rough, uncut	1,180,000	57,900	883,000	31,100
Cut, set and unset	NA	120,000	NA	140,000
Other	NA	5,640	NA	6,330
Synthetic:				
Cut but unset	230,000	47,400	275,000	45,900
Other	NA	6,040	NA	7,770
Imitation gemstone 3/	NA	54,400	NA	48,800
Total	XX	8,380,000	XX	9,250,000

NA Not available. XX Not applicable.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Customs value.
3/ Does not include pearls.

Source: Bureau of the Census.

TABLE 11
NATURAL DIAMOND: ESTIMATED WORLD PRODUCTION, BY TYPE AND COUNTRY 1/ 2/

(Thousand carats)

Country	1994	1995	1996	1997	1998
Gemstones: 3/					
Angola	270	2,600	2,250	1,110	2,400
Australia	19,500	18,300	18,897 4/	18,100	18,400
Botswana	10,550 4/	11,500	12,400 r/	15,100 r/	13,500
Brazil	300	676 4/	200	300	300
Canada	--	--	--	--	278
Central African Republic	401	400	350	400	330
China	230	230	230	230	230
Congo (Kinshasa) 5/	4,000	4,000	3,600	3,300 r/	2,000
Cote d' Ivoire	80	53	202	207	207
Ghana	118 4/	126	142	664 r/	640
Guinea	306	274	165	165 r/	165
Liberia	40	60	60	60	60
Namibia	1,312 4/	1,382 4/	1,400 r/	1,420 r/	1,600
Russia	10,000 r/	10,500 r/	10,500 r/	10,500 r/	10,500
Sierra Leone	155	113	162 4/	64 r/	50
South Africa	5,050	5,070	4,280	4,380	4,100
Venezuela	380	125	99 r/	158 r/	100
Zimbabwe	104	114	300	321 r/	40
Other	99 r/	119 r/	165 r/	121 r/	126
Total	52,900 r/	55,700 r/	55,400 r/	56,600 r/	55,000
Industrial:					
Angola	30	300	250	124	364
Australia	23,800	22,400	23,096 4/	22,100	22,500
Botswana	5,000	5,300	5,000	5,000	5,000
Brazil	600	600	600	600	600
Central African Republic	131	130	120	100	200
China	850	900	900	900	900
Congo (Kinshasa) 5/	13,000	13,000	17,000	18,900 r/	13,000
Cote d' Ivoire	4	22	100	100	100
Ghana	473 4/	505	573	166 r/	160
Guinea	75	91	40	40	40
Liberia	60	90	90	90	90
Russia	10,000 r/	10,500 r/	10,500 r/	10,500 r/	10,500
Sierra Leone	100	101	108	40 r/	30
South Africa	5,800	5,880	5,670	5,790	6,200
Venezuela	203	66	73 r/	90 r/	150
Zimbabwe	69	90	137	100	30
Other	92 r/	101 r/	120 r/	105 r/	106
Total	60,300 r/	60,100 r/	64,400 r/	64,700 r/	59,900
Grand total	113,000 r/	116,000 r/	120,000 r/	121,000 r/	115,000

r/ Revised.

1/ World totals and estimated data are rounded to three significant digits; may not add to totals shown.

2/ Table includes data available through May 27, 1999.

3/ Includes near- and cheap-gem qualities.

4/ Reported figure.

5/ Formerly Zaire.

GEMSTONES

By Donald W. Olson

Domestic survey data and tables were prepared by Christine K. Pisut, statistical assistant, and the world production table was prepared by Regina R. Coleman, international data coordinator.

Gemstones have been used as symbols of wealth and status since prehistoric times. For example, amber has been mined for use as a gem since before 25,000 B.C. For this report, the terms "gem" and "gemstone" mean any mineral or organic material (e.g., pearl and petrified wood) used for personal adornment, display, or object of art because it possesses beauty, rarity, and durability. Of the 2,700 mineral species, only about 100 possess all these attributes. Silicates compose the largest group of gemstones; oxides and quartz compose the second largest (table 1). A further refinement of "gemstone" is "colored gemstone," which in this report designates all nondiamond gems, including amber, coral, and shell. In addition, synthetic gems, cultured pearl, and gem simulants are discussed but are treated separately from natural gemstones (table 2).

Production

Commercial mining of gemstones has never been extensive in the United States. More than 60 different gemstones have been produced commercially from domestic mines, but most of the deposits have been relatively small compared with other mining operations. In many instances, contemporary gemstone mining in the country is conducted by hobbyists, collectors, and gem clubs rather than business organizations.

The commercial gemstone industry in the United States consists of several distinct sectors: (1) individuals and companies that mine gemstones or harvest shell and pearl, (2) firms that manufacture synthetic gemstones, and (3) individuals and companies that cut natural and synthetic gemstones. The domestic gemstone industry is focused on the production of colored gemstones and on the cutting of large diamonds. Industry employment is estimated to range from 1,000 to 1,500 workers (U.S. International Trade Commission, 1997, p. 1).

Most natural gemstone producers in the United States are small businesses that are widely dispersed and operate independently. The small producers probably have an average of less than three employees, including those who only work part-time. The number of gemstone mines operating from year to year fluctuates because the inherent uncertainty associated with the discovery and marketing of gem-quality minerals makes it difficult to obtain financing for developing and sustaining economically viable deposits (U.S. International Trade Commission, 1997, p. 23).

The total value of natural gemstones produced in the United States during 1999 was estimated to be at least $16.1 million (table 3). This production value was 12.6% greater than the preceding year. This increase was primarily because of the discovery of an emerald deposit of significant value in North Carolina (Jewelers' Circular Keystone, 1999a) and because of increased foreign markets for U.S. shell material as the demand from Southeast Asia cultured pearl producers increased (Jewellery News Asia, 2000).

The estimate of 1999 U.S. gemstone production was based on a survey of more than 200 domestic gemstone producers conducted by the U.S. Geological Survey (USGS). The survey provided a foundation for projecting the scope and level of domestic gemstone production during the year. However, the USGS survey did not represent all gemstone activity in the United States, including thousands of professional and amateur collectors. Consequently, the USGS supplemented its survey with estimates of domestic gemstone production from related published data, contacts with gem dealers and collectors, and information garnered at gem and mineral shows.

Natural gem materials indigenous to the United States are collected, produced, and/or marketed in every State. During 1999, all 50 States produced at least $1,000 worth of gem materials. Six States accounted for more than 81% of the total value, as reported by survey respondents. These States, in order of declining value of production, were Tennessee, North Carolina, Arizona, California, Utah, and Oregon. Some States were known for the production of a single gem material—Tennessee for freshwater pearls and Arkansas for quartz. Other States produced a variety of gemstones. For example, Arizona gemstone deposits include agate, amethyst, azurite, chrysocolla, fire agate, garnet, jade, malachite, obsidian, onyx, peridot, petrified wood, opal, smithsonite, and turquoise. A wide variety of gemstones also were found in California, Idaho, Montana, and North Carolina. More than 3,000 carats of high-quality emeralds have been recovered since they were discovered in North Carolina in late 1998 (Jewelers' Circular Keystone, 1999a).

The only operation on a significant diamond-bearing area known in the United States is in Crater of Diamonds Park near Murfreesboro, AR, where a dig-for-fee operation for tourists is maintained by the State. An Arkansas law prohibiting commercial diamond mining in the park was debated in the State legislature during 1998 and was enacted early in 1999 (Diamond Registry Bulletin, 1999c).

In addition to natural gemstones, synthetic gems and gemstone simulants are produced in the United States. Synthetic gemstones have the same optical, physical, and chemical properties as the natural materials that they appear to be. Simulants have an appearance similar to that of a natural gem material, but they have different optical, physical, and chemical properties. Synthetic gemstones produced in the

United States include alexandrite, emerald, moissanite, ruby, sapphire, turquoise, and zirconia. Simulants of coral, lapis lazuli, malachite, and turquoise also are manufactured. In addition, certain colors of synthetic sapphire and spinel, used to represent other gemstones, are classified as simulants.

Synthetic gem production in the United States exceeded $47 million during 1999; simulant gemstone output was even greater—estimated to be well over $100 million. Five firms in four States, representing virtually all the U.S. synthetic gem industry, reported production to the USGS in 1999. In descending order of production value, the States with reported synthetic output were North Carolina, California, New York, and Arizona. Some of the producers are attempting to produce synthetic gem-quality diamond (Tom Chatham, Chatham Created Gems, oral commun., 1999).

In 1999, a North Carolina firm entered its second year marketing moissanite, a gem-quality silicon carbide that it produces. Moissanite is an excellent diamond simulant, but it is being marketed for its other gem qualities as well.

Consumption

Although the United States accounts for less than 1% of total global gem production, it is the world's leading gemstone market. On the basis of indicators, such as trade data and income growth rates, U.S. gemstone markets—bolstered by strong demand among consumers with increasing personal wealth and growing discretionary income—apparently accounted for at least 35% of world gem demand in 1999. The U.S. market for unset gem diamonds during the year was estimated to have exceeded $9 billion, the largest in the world. Domestic markets for natural, unset nondiamond gemstones totaled more than $720 million.

In addition to jewelry, gemstones are used for collections, exhibits, and decorative art objects. According to a poll conducted by a U.S. jewelry retailers association in the mid-1990's, about two-thirds of domestic consumers who were surveyed preferred diamond as their favorite gemstone; most others chose, in descending order, emeralds, sapphires, and rubies (ICA Gazette, 1996).

Prices

Gemstone prices are governed by many factors and qualitative characteristics, including beauty, clarity, defects, demand, and rarity. Diamond pricing in particular is complex; values can vary significantly depending on time, place, and the subjective evaluations of buyers and sellers. There are more than 14,000 categories used to assess rough diamond and more than 100,000 different combinations of cut, carat, clarity, and color values used to assess polished diamond (Pearson, 1998).

Colored gemstone prices are generally influenced by market supply-and-demand considerations, and diamond prices are supported by producer controls on the quantity and quality of supply. Values and prices of gemstones produced and/or sold in the United States are shown in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported and exported/reexported are shown in tables 6 through 10.

De Beers Consolidated Mines Limited in South Africa is a significant force affecting gem diamond prices worldwide because it mines about one-half the diamonds produced each year and controls about 70% of global raw diamond supply through its Central Selling Organization (CSO), which has marketing agreements with other producers. Estimates based on the reported output of major diamond mines in 1999 indicate that the average value of all diamond produced during the year was about $65 per carat; by country, the average value per carat ranged from about $15 in Australia to more than $257 in Namibia (Rombouts, Luc, May 12, 2000, Diamond mining and exploration overview—1999, accessed May 30, 2000, at http://www.terraconsult.be/overview.htm).

Foreign Trade

Several export and import measures demonstrate the significance of the United States in world gemstone trade. During 1999, total U.S. gemstones trade with all countries and territories exceeded $14.3 billion; diamonds accounted for 91% of the total. In 1999, U.S. exports/reexports of diamond were shipped to 67 countries/territories, and imports of all gemstones were received from 123 countries/territories (tables 6-10).

During 1999, U.S. trade in cut diamonds reached unprecedented levels; the country continued to be the world's leading diamond importer and set export records as well. Record high imports were attributed to a strong U.S. economy that boosted domestic demand for diamond jewelry among consumers with increasing personal wealth and more discretionary income.

The United States is a significant international diamond transit center as well as the world's largest gem diamond market. The large volume of reexports (table 6) shipped to other centers reveals the significance that the United States has in the world's diamond supply network.

Synthetic gemstones trade continued to increase for the United States in 1999. Imports of synthetic gems (particularly from Brazil, China, and Switzerland) reportedly increased during the year. Prices of certain synthetic gem imports, such as amethyst, were very competitive (Mike Romanella, Commercial Mineral Company, oral commun., 1999). The marketing of synthetic imports as natural gemstones and the mixing of synthetic materials with natural stones in imported parcels have become problems for some domestic producers.

During late 1999, the Asia-Pacific Economic Cooperation (APEC) countries (of which the United States is a member), presented the World Trade Organization (WTO) with an "Accelerated Trade Liberalization" proposal that would create a level playing field for world trade of goods, including gemstones. The APEC proposal, if enacted, would create a single global tariff rate of 5% and eliminate non-tariff barriers. WTO support for the proposed policy is expected and the new policy should be in effect by 2002 (AJM, 1999).

World Review

The gemstone industry worldwide has two distinctly different sectors: (1) diamond mining and marketing, and (2) the production and sale of colored gemstones. Most diamond supplies are controlled by a few major mining companies; prices are supported by managing the quantity and quality of the gems relative to demand, a function performed by De Beers through its CSO. Unlike diamonds, colored gemstones are primarily produced at relatively small, low-cost operations with few dominant producers; prices are influenced by consumer demand in addition to supply availability.

In 1999, world diamond production totaled at least 112 million carats with an estimated value of more than $7 billion (table 11). Most production was concentrated in a few regions—Africa (Angola, Botswana, Congo [Kinshasa], Namibia, and South Africa), Asia (northeastern Siberia and Yakutia in Russia), Australia, North America (Northwest Territories in Canada), and South America (Brazil and Venezuela). In 1999, Botswana was the world's leading diamond producer in terms of output value and quantity (Diamond Registry Bulletin, 2000a).

Record sales of rough diamond by the CSO in 1999 reached $5.24 billion, 57% higher than the 1998 total of $3.3 billion. The sales record reflected the improvement in major retail markets—continuing strength in the U.S. market, increased polished diamond imports into Japan, some recovery of the market in Southeast Asian countries, and steady growth in the European market (Diamond Registry Bulletin, 1999a). Diamond jewelry sales in the United States grew by 12% in 1999—the largest jump of the 1990's and the eighth consecutive year sales have risen (Jewelers' Circular Keystone, 2000b).

Additional events in 1999 significant to diamond mining and marketing worldwide include the following:

! Canada's first commercial diamond mine, the Ekati Mine, completed its first full year of production. The Ekati Mine is in the Northwest Territories and is a joint venture between BHP Diamonds Inc. (BHP) and Dia Met Minerals Ltd. It produced 2.5 million carats valued at $422 million. Ekati diamonds are sold by the BHP sales office in Antwerp (65%) and by the CSO (35%) (Rombouts, Luc, May 12, 2000, Diamond mining and exploration overview—1999, accessed May 30, 2000, at http://www.terraconsult.be/overview.htm).
! The Diavik Project, which will be Canada's second commercial diamond mine (also located in the Northwest Territories), had some delays in development because of slow permitting. Diavik is a joint venture between Rio Tinto Plc. (60%) and Aber Resources Ltd. (40%), and it is expected to come on-stream in 2003. The capital cost will be about $900 million, but the mine is expected to produce 6 to 8 million carats per year worth about $60 per carat.
! A large part of the artisanal production in Angola comes from deposits controlled by the National Union for the Total Independence of Angola (UNITA). UNITA used the revenue of their diamond sales to finance their civil war effort. The United Nations declared a ban on trade with UNITA. Diamonds were used to finance warfare also in Congo (Kinshasa) and Sierra Leone. These "conflict diamonds" have become a public relations nightmare for reputable producers elsewhere in the world.
! De Beers decreased its diamond inventory by 18% to $3.957 billion, compared with $4.8 billion in 1998. The company's long-term goal is a one-half reduction (Diamond Registry Bulletin, 2000b).
! The Gemesis Corp. in Sarasota, FL, announced that it has developed technology sufficient to produce consistent quality and quantities of synthetic diamonds and plans to start selling them in 2000. The stones will range mostly from 1.5 to 2 carats (Jewelers' Circular Keystone, 1999b).
! E-commerce in diamonds and gemstone jewelry grew during 1999, but a 100% jump in Internet jewelry website sales still adds up to less than 5% of the total market. E-commerce is still a small, but growing part of the overall retail market (Diamond Registry Bulletin, 1999d). It was reported also that some diamond sightholders sold over the Internet to consumers (Diamond Registry Bulletin, 1999e).

Worldwide production of natural gemstones other than diamond was estimated to have exceeded $2 billion per year in the late 1990's. Most nondiamond gemstone mines are small, low-cost, and widely dispersed operations in remote regions of developing nations. Foreign countries with major gemstone deposits other than diamond are Afghanistan (beryl, ruby, and tourmaline); Australia (beryl, opal, and sapphire); Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline); Burma (beryl, jade, ruby, sapphire, and topaz); Colombia (beryl, emerald, and sapphire); Kenya (beryl, garnet, and sapphire); Madagascar (beryl, rose quartz, sapphire, and tourmaline); Mexico (agate, opal, and topaz); Sri Lanka (beryl, ruby, sapphire, and topaz); Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline); and Zambia (amethyst and beryl). In addition, pearls are cultured throughout the South Pacific and in other equatorial waters; Australia, China, French Polynesia, and Japan are key producers.

Colored gemstone producers continued their recovery from the weakened markets created by the Asian economic crisis of 1997-98. Mining and sales reportedly were disrupted in many nations, particularly in southeast Asia. Prices of high-quality colored gemstones, however, did not decline dramatically (Cavey, 1998).

Additional noteworthy events in the colored gemstone industry during 1999 included the following:

! Like diamonds, the introduction and proliferation of new synthetic gem-quality materials and simulants—as well as treatment processes to enhance gemstone attributes artificially—continued to raise issues and controversies regarding standards for disclosure to consumers.
! During 1999, cultured pearl sales continued to rise, even though the Japanese pearl industry was still suffering from high mortality of pearl-producing oysters. To compensate for the shortage of Japanese akoyas, manufacturers promoted Chinese freshwater pearls, abalone pearls, and other new varieties and colors of pearls. Approximately 15% of all 1999 cultured pearl sales were freshwater Chinese pearls (Jewelers' Circular Keystone, 1999c;

Jewelers' Circular Keystone, 2000a).

Outlook

It appears that the year 2000 will be another good year for the U.S. economy, which is good for the diamond and gemstone industry as a whole. Because gemstone markets are concerned with luxury merchandise, they must rely on the growth of personal wealth and discretionary income levels among consumers who make choices among nonessential goods in the marketplace. Other important factors that will drive market demand include consumer confidence and interest rates. Long-term economic forecasts predict continued growth of discretionary income throughout the world, and anticipate even higher growth rates in developing countries, such as China and other Asian nations, which bodes well for producers of precious gems.

The recovery of diamond and nondiamond gem markets in the Far East and Japan is progressing slowly, and this trend is expected to continue for the next few years. De Beers sales are expected to reach new records in 2000, as evidenced by the tripling of first-half earnings over those of 1999 (Mallet, Victor, August 16, 2000, De Beers triples earnings, accessed August 17, 2000, at http://news.ft.com/ft/gx.cgi/ftc?pagename=View&c=Article&cid=FT37MGHRYBC&live=true&useoverridetemplate=IXLZHNNP94C).

After a century of the diamond industry's reliance on De Beers, the CSO will be dismantled. In its place will be the Diamond Trading Company (DTC), which will strive to be the "supplier of choice" by supplying "value added" services like marketing advice. The DTC will "encourage the development of a competitive and growth-oriented 21st century industry" (Diamond Registry Bulletin, 2000c). Independent producers, such as Argyle Diamond Mines in Australia and new mines in Canada, will continue to bring a greater measure of competition to global markets. More competition presumably will bring more supplies and lower prices.

Demand for gemstones other than diamond will depend on how successfully jewelers promote their alternatives. As the jewelry industry consolidates toward fewer, larger companies and turns more to mass merchandizing, smaller dealers will need to focus on niche markets and target specific demographic groups to remain competitive. Numerous synthetics, simulants, and treated gems will enter the marketplace and necessitate more transparent trade industry standards to maintain customer confidence. A Florida firm will start selling synthetic diamonds ranging from 1.5 to 2 carats in 2000 (Jewelers' Circular Keystone, 1999b).

Greater volumes of diamonds, gemstones, and jewelry will be sold through the continued growth of telemarketing programs and e-commerce, but established retailers won't be hurt for many years (Diamond Registry Bulletin, 1999b).

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TABLE 1
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characters
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0-2.5	1.0-1.1	Single	1.54	Synthetic or pressed plastics	Fossil resin, soft.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	Small to medium	High	6.0-6.5	3.64-3.68	Double	1.76-1.80	Sapphire, tanzanite, blue diamond, blue tourmaline	Strong blue in ultraviolet light.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5-8.0	2.63-2.80	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	do.	Small	Very high	7.5-8.0	2.63-2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald	do.	Green	Medium	do.	7.5	2.63-2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5-8.0	2.63-2.80	do.	1.58	Genuine emerald	Flaws, brilliant, fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5-8.0	2.63-2.80	do.	1.58	Citrine, topaz, glass, doublets	Weak-colored.
Goshenite	do.	do.	do.	Low	7.5-8.0	2.63-2.80	do.	1.58	Quartz, glass, white sapphire, white topaz	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5-8.0	2.63-2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49-1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.60	do.	Banded, translucent.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day, red by artificial light	Small (Former U.S.S.R.) Medium (Sri Lanka)	High	8.5	3.50-3.84	Double	1.75	Synthetic	Dichroism, inclusions in synthetic sapphire.
Cats-eye	do.	Greenish to brownish	Small to large	do.	8.5	3.50-3.84	do.	1.75	Synthetic, shell	Gravity and translucence.
Chrysolite	do.	Yellow, green, and/or brown	Medium	Medium	8.5	3.50-3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Coral	Calcium carbonate	Orange, red, white, black, or green	Branching, medium	Low	3.5-4.0	2.6-2.7	do.	1.49-1.66	False coral	Dull translucent.

See footnotes at end of table.

TABLE 1--Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characters
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95-4.10	Double	1.78	Synthetics, including spinel	Inclusions, fluorescence.
Sapphire	do.	Blue	Medium	High	9.0	3.95-4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, white, orange, green, or violet	Medium to large	Medium	9.0	3.95-4.10	do.	1.78	Synthetics, glass and doublets	Inclusions, double refraction, refractive index.
Sapphire and ruby, stars	do.	Red, pink, violet, blue, or gray	do.	High to low	9.0	3.95-4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.
Sapphire or ruby, synthetic	do.	Yellow, pink, or blue	Up to 20 carats	Low	9.0	3.95-4.10	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Diamond	Carbon	White, blue-white, yellow, brown, green, pink, blue	Any	Very high	10.0	3.516-3.525	Single	2.42	Zircon, titania, cubic zirconia	High index, dispersion, hardness, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green	Large	Low	6.0-6.5	2.56	XX	1.52	Jade	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play	do.	do.	6.0-6.5	2.56	XX	1.56	do.	Do.
Moonstone	do.	Colorless or yellow	do.	do.	6.0-6.5	2.77	XX	1.52-1.54	Glass	Pale sheen, opalescent.
Garnet	Complex silicate	Brown, black, yellow, green, ruby red, or orange	Small to medium	Low to high	6.5-7.5	3.15-4.30	Single strained	1.79-1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Jade:										
Jadeite	do.	Green, yellow, black, white, or mauve	Large	Low to very high	6.5-7.0	3.3-3.5	Cryptocry-stalline	1.65-1.68	Onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent, to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0-6.5	2.96-3.10	do.	1.61-1.63	do.	Do.
Opal	Hydrous silica	Colors flash in white gray, black, red, or yellow	do.	Low to high	5.5-6.5	1.9-2.3	Single	1.45	Glass, synthetics, triplets	Play of color.
Pearl	Calcium carbonate	White, pink, or black	Small	do.	2.5-4.0	2.6-2.85	XX	XX	Cultured and imitation	Luster, structure, X-ray.
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5-7.0	3.27-3.37	Double (strong)	1.65-1.69	Tourmaline chrysoberyl	Strong double refraction, low dichroism.

See footnotes at end of table.

TABLE 1--Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characters
Quartz:										
Agate	Silica	Any color	Large	Low	7.0	2.58-2.64	XX	XX	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65-2.66	Double	1.55	do.	Refractive index, double refraction, transparent.
Cairngorm	do.	Smoky	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Citrine	do.	Yellow	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Do.
Crystal, rock	do.	Colorless	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Do.
Jasper	do.	Uniform or spotted red, yellow, or green	do.	do.	7.0	2.58-2.66	XX	XX	do.	Opaque, vitreous.
Onyx	do.	Many colors	do.	do.	7.0	2.58-2.64	XX	XX	do.	Uniformly banded.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65-2.66	Double	1.55	do.	Refractive index, double refraction, translucent.
Spinel	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5-3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5-3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5-7.0	3.13-3.20	do.	1.66	Synthetic spinel	Refractive index.
Kunzite	do.	Pink to lilac	do.	do.	6.5-7.0	3.13-3.20	do.	1.66	Amethyst, morganite	Do.
Tanzanite	Complex silicate	Blue	Small	High	6.0-7.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism.
Topaz	do.	White, blue, green	Medium	Low to medium	8.0	3.4-3.6	do.	1.62	Beryl, quartz	Refractive index.
Tourmaline	do.	All, including mixed	do.	do.	7.0-7.5	2.98-3.20	do.	1.63	Peridot, beryl, corundum, glass	Double refraction, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green	Large	Low	6.0	2.60-2.83	do.	1.63	Glass, plastics	Difficult if matrix not present, matrix usually limonitic.
Zircon	Zirconium silicate	White, blue, or brown, yellow, or green	Small to medium	Low to medium	6.0-7.5	4.0-4.8	Double (strong)	1.79-1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

XX Not applicable.

1/ Small, up to 5 carats; medium, 5 to 50 carats; large, more than 50 carats.

2/ Low, up to $25 per carat; medium, up to $200 per carat; high, more than $200 per carat.

TABLE 2
SYNTHETIC GEMSTONE PRODUCTION METHODS

Gemstone	Production methods	Company/producer	Date of first production
Alexandrite	Flux	Creative Crystals	1970's
Do.	Melt pulling	J.O. Crystal	1990's
Do.	do.	Kyocera	1980's
Do.	Zone melt	Seiko	1980's
Cubic zirconia	Skull melt	Various producers	1970's
Emerald	Flux	Chatham	1930's
Do.	do.	Gilson	1960's
Do.	do.	Kyocera	1970's
Do.	do.	Seiko	1980's
Do.	do.	Lennix	1980's
Do.	do.	Russia	1980's
Do.	Hydrothermal	Lechleitner	1960's
Do.	do.	Regency	1980's
Do.	do.	Biron	1980's
Do.	do.	Russia	1980's
Ruby	Flux	Chatham	1950's
Do.	do.	Kashan	1960's
Do.	do.	J.O. Crystal	1980's
Do.	do.	Douras	1990's
Do.	Zone melt	Seiko	1980's
Do.	Melt pulling	Kyocera	1970's
Do.	Verneuil	Various producers	1900's
Sapphire	Flux	Chatham	1970's
Do.	Zone melt	Seiko	1980's
Do.	Melt pulling	Kyocera	1980's
Do.	Verneuil	Various producers	1900's
Star ruby	do.	Linde	1940's
Do.	Melt pulling	Kyocera	1980's
Do.	do.	Nakazumi	1980's
Star sapphire	Verneuil	Linde	1940's

TABLE 3
VALUE OF U.S. GEMSTONE PRODUCTION, BY TYPE 1/

(Thousand dollars)

Gem materials	1998	1999
Agate	128	96
Beryl	1,060	3,360 e/
Coral (all types)	76	54
Diamond	(2/)	(2/)
Garnet	66	90
Gem feldspar	378	187
Geode/nodules	46	69
Opal	769	147
Quartz	768	674
Sapphire/ruby	369	117
Shell	1,150	2,600
Topaz	8	8
Tourmaline	49	W
Turquoise	837	860
Other	8,610	7,820
Total	14,300	16,100

e/ Estimated. W Withheld to avoid disclosing company proprietary data.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Included with "Other."

TABLE 4
PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY 1/

Carat weight	Description, color 3/	Clarity 2/ (GIA terms)	Representative prices January 1999 4/	June 1999 5/	December 1999 6/
0.25	G	VS1	$1,500	$1,500	$1,500
.25	G	VS2	1,380	1,380	1,380
.25	G	SI1	1,130	1,130	1,130
.25	H	VS1	1,400	1,400	1,400
.25	H	VS2	1,250	1,250	1,250
.25	H	SI1	1,050	1,050	1,050
.50	G	VS1	3,400	3,400	3,400
.50	G	VS2	3,000	3,000	3,000
.50	G	SI1	2,500	2,500	2,500
.50	H	VS1	3,000	3,000	3,000
.50	H	VS2	2,700	2,700	2,700
.50	H	SI1	2,400	2,400	2,400
.75	G	VS1	3,800	3,800	3,800
.75	G	VS2	3,600	3,600	3,600
.75	G	SI1	3,300	3,300	3,300
.75	H	VS1	3,650	3,650	3,650
.75	H	VS2	3,450	3,450	3,450
.75	H	SI1	3,100	3,100	3,100
1.00	G	VS1	5,700	5,700	5,700
1.00	G	VS2	5,300	5,300	5,300
1.00	G	SI1	4,800	4,800	4,800
1.00	H	VS1	5,200	5,200	5,200
1.00	H	VS2	4,900	4,900	4,900
1.00	H	SI1	4,500	4,500	4,500

1/ Data are rounded to no more than three significant digits.
2/ Clarity: IF, no blemishes; VVS1, very, very slightly included; VS1, very slightly included; VS2, very slightly included, but not visible; SI1, slightly included.
3/ Gemological Institute of America (GIA) color grades: D, colorless; E, rare white; G - H - I , traces of color.
4/ Jewelers' Circular Keystone, v. 170, no. 2, February 1999, p. 44.
5/ Jewelers' Circular Keystone, v. 170, no. 7, July 1999, p. 38.
6/ Jewelers' Circular Keystone, v. 171, no. 1, January 2000, p. 48.

TABLE 5
PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES

Gemstone	Price range per carat January 1999 1/	December 1999 2/
Amethyst	$7-$16	$7-$14
Aquamarine	75-190	75-200
Emerald	900-2,000	1,000-2,400
Ruby	1,800-2,800	1,800-2,800
Sapphire	800-1,800	650-1,850
Tanzanite	180-300	250-350

1/ Jewelers' Circular Keystone, v. 170, no. 2, February 1999, p. 44. These figures represent a sampling of net prices that wholesale colored stone dealers in various U.S. cities charged their cash customers during the month for fine-quality stones.
2/ Jewelers' Circular Keystone, v. 171, no. 1, January 2000, p. 48. Amethyst and aquamarine prices are from The Guide, Fall/Winter 1999-2000, p. 12 and p. 72. These figures represent a sampling of net prices that wholesale colored stone dealers in various U.S. cities charged their their cash customers during the month for fine-quality stones.

TABLE 6
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY 1/

Country	1998 Quantity (carats)	1998 Value 2/ (millions)	1999 Quantity (carats)	1999 Value 2/ (millions)
Exports:				
Belgium	14,800	$6	9,260	$10
Canada	67,100	25	81,700	30
France	180	10	16,700	10
Hong Kong	22,300	5	29,600	34
India	29,000	2	56,200	13
Israel	2,770	7	14,600	28
Japan	7,750	17	5,460	22
Singapore	409	(3/)	11,400	5
Switzerland	5,480	28	42,000	79
Thailand	200	(3/)	102	1
United Arab Emirates	--	--	1,360	3
United Kingdom	6,590	6	20,200	21
Other	52,500	15	199,000	47
Total	209,000	123	487,000	303
Reexports:				
Belgium	852,000	676	980,000	669
Canada	81,300	39	97,400	41
France	16,600	27	40,800	40
Hong Kong	567,000	272	822,000	308
India	401,000	42	902,000	134
Israel	846,000	960	1,120,000	1,020
Japan	76,800	58	109,000	62
Singapore	14,600	27	43,100	27
Switzerland	56,000	164	184,000	265
Thailand	137,000	22	177,000	22
United Arab Emirates	22,700	12	25,300	10
United Kingdom	79,100	97	111,000	97
Other	52,800	39	346,000	75
Total	3,200,000	2,430	4,950,000	2,770
Grand total	3,410,000	2,560	5,440,000	3,080

-- Zero.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Customs value.
3/ Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY 1/

	1998		1999	
Kind, range, and country of origin	Quantity (carat)	Value 2/ (millions)	Quantity (carat)	Value 2/ (millions)
Rough or uncut, natural: 3/				
Australia	13,000	(4/)	945	$1
Belgium	306,000	$111	118,000	121
Brazil	8,990	1	11,600	5
Congo (Brazzaville)	1,820	2	25,500	2
Congo (Kinshasa) 5/	66,300	72	53,200	74
Ghana	59,900	61	110,000	102
Guinea	16,800	11	10,100	16
India	5,320	(4/)	18,600	(4/)
Israel	30,500	34	38,000	25
Russia	112,000	(4/)	3,080,000	4
Sierra Leone	7,450	10	4,420	6
South Africa	109,000	61	40,500	73
Switzerland	1,030	3	2,520	18
United Kingdom	609,000	206	663,000	229
Venezuela	13,800	2	3,290	1
Other	79,600	14	88,900	56
Total	1,440,000	588	4,270,000	734
Cut but unset, not more than 0.5 carat:				
Belgium	1,110,000	261	771,000	208
Brazil	14,100	2	3,720	2
Canada	676	(4/)	1,260	1
Germany	11,400	4	6,290	1
Hong Kong	378,000	61	289,000	47
India	9,820,000	1,560	12,400,000	1,900
Israel	1,010,000	521	1,080,000	608
Japan	7,190	2	12,100	3
South Africa	8,600	5	3,280	3
Switzerland	7,330	2	36,400	10
Thailand	70,400	10	103,000	14
United Kingdom	1,150	1	1,650	1
Other	73,200	24	245,000	42
Total	12,500,000	2,450	14,900,000	2,840
Cut but unset, more than 0.5 carat:				
Belgium	1,050,000	1,490	1,030,000	1,630
Botswana	1,690	1	--	--
Canada	880	3	1,780	6
France	1,780	16	2,530	6
Hong Kong	92,200	105	81,000	117
India	556,000	306	664,000	383
Israel	2,040,000	2,990	2,290,000	3,650
Japan	3,920	8	1,910	7
Russia	20,000	57	29,000	44
Singapore	3,860	15	2,210	7
South Africa	21,200	92	24,800	67
Switzerland	24,900	239	35,100	254
Thailand	10,700	14	16,700	18
United Kingdom	5,670	77	20,800	75
Other	25,400	39	34,100	55
Total	3,860,000	5,440	4,230,000	6,320

-- Zero.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

2/ Customs value.

3/ Includes some natural advanced diamond.

4/ Less than 1/2 unit.

5/ Formerly Zaire.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND,
BY KIND AND COUNTRY 1/

Kind and country	1998 Quantity (carats)	1998 Value 2/ (millions)	1999 Quantity (carats)	1999 Value 2/ (millions)
Emerald:				
Belgium	20,700	$2	14,000	$2
Brazil	499,000	5	601,000	6
Canada	5,750	1	803	(3/)
China	5,120	(3/)	955	(3/)
Colombia	1,500,000	68	601,000	59
France	588	(3/)	7,040	1
Germany	33,500	4	25,800	3
Hong Kong	350,000	10	252,000	10
India	2,730,000	50	2,860,000	35
Israel	243,000	24	272,000	26
Japan	399	(3/)	8,370	(3/)
South Africa	7,790	(3/)	183	(3/)
Switzerland	67,800	21	34,300	27
Taiwan	377	(3/)	3,760	(3/)
Thailand	434,000	6	201,000	4
United Kingdom	3,090	1	52,800	3
Other	31,100	4	102,000	6
Total	5,930,000	195	5,040,000	183
Ruby:				
Belgium	2,610	(3/)	6,120	1
Brazil	4,520	(3/)	7,350	(3/)
Burma	1,090	7	4,290	14
Canada	24	(3/)	373	(3/)
China	3,080	(3/)	3,260	(3/)
Colombia	4,300	(3/)	2,140	(3/)
France	2,440	1	1,790	(3/)
Germany	15,700	1	54,400	7
Hong Kong	287,000	15	270,000	6
India	970,000	10	1,320,000	4
Israel	21,400	1	24,000	3
Japan	3,730	(3/)	3,160	(3/)
Switzerland	66,300	29	46,200	20
Thailand	2,370,000	47	2,250,000	48
United Kingdom	8,440	4	29,300	3
Other	50,800	3	59,800	2
Total	3,810,000	119	4,080,000	110
Sapphire:				
Australia	37,000	(3/)	8,540	(3/)
Belgium	29,000	1	12,500	2
Brazil	5,770	(3/)	6,920	(3/)
Burma	824	1	1,830	2
Canada	283	(3/)	44	(3/)
China	6,700	(3/)	15,200	(3/)
Colombia	2,400	(3/)	2,110	(3/)
France	250	(3/)	815	(3/)
Germany	59,900	2	143,000	3
Hong Kong	244,000	6	301,000	9
India	757,000	4	862,000	3
Israel	96,300	2	100,000	6
Japan	3,550	(3/)	16,300	(3/)
Singapore	2,270	(3/)	285	(3/)
Sri Lanka (Ceylon)	346,000	17	480,000	19
Switzerland	137,000	16	38,600	15
Tanzania	7,030	(3/)	822	(3/)
Thailand	4,900,000	66	5,080,000	64

See footnotes at end of table.

TABLE 8--Continued
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND,
BY KIND AND COUNTRY 1/

	1998		1999	
Kind and country	Quantity (carats)	Value 2/ (millions)	Quantity (carats)	Value 2/ (millions)
Sapphire-Continued:				
United Kingdom	23,400	$5	14,100	$4
Other	16,800	3	81,700	2
Total	6,670,000	123	7,160,000	129
Other:				
Rough, uncut:				
Australia	NA	3	NA	4
Brazil	NA	19	NA	26
China	NA	1	NA	1
Colombia	NA	1	NA	2
Fiji	NA	2	NA	2
Hong Kong	NA	1	NA	1
India	NA	2	NA	1
Kenya	NA	(3/)	NA	(3/)
Nigeria	NA	(3/)	NA	(3/)
Pakistan	NA	1	NA	(3/)
Philippines	NA	1	NA	1
Russia	NA	(3/)	NA	(3/)
South Africa	NA	1	NA	1
Switzerland	NA	(3/)	NA	(3/)
Taiwan	NA	(3/)	NA	(3/)
Tanzania	NA	1	NA	(3/)
Thailand	NA	1	NA	7
United Kingdom	NA	1	NA	(3/)
Zambia	NA	1	NA	2
Other	NA	9	NA	11
Total	NA	45	NA	57
Cut, set and unset:				
Australia	NA	8	NA	8
Brazil	NA	10	NA	10
Canada	NA	1	NA	1
China	NA	8	NA	11
French Polynesia	NA	7	NA	5
Germany	NA	9	NA	14
Hong Kong	NA	35	NA	44
India	NA	37	NA	66
Israel	NA	4	NA	6
Japan	NA	14	NA	16
Kenya	NA	1	NA	2
Sri Lanka (Ceylon)	NA	4	NA	3
Switzerland	NA	2	NA	2
Taiwan	NA	2	NA	3
Tanzania	NA	5	NA	8
Thailand	NA	24	NA	30
United Kingdom	NA	3	NA	6
Other	NA	4	NA	7
Total	NA	178	NA	243

NA Not available.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Customs value.
3/ Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 9
VALUE OF U.S. IMPORTS OF SYNTHETIC AND IMITATION
GEMSTONES, BY COUNTRY 1/

(Thousand dollars) 2/

Country	1998	1999
Synthetic, cut but unset:		
Australia	187	488
Austria	6,770	7,180
Brazil	205	2,110
China	11,300	13,300
France	720	500
Germany	10,800	10,500
Hong Kong	2,240	2,110
India	1,640	971
Italy	32	104
Japan	25	6
Korea, Republic of	1,990	2,720
Spain	47	39
Sri Lanka (Ceylon)	444	89
Switzerland	3,670	4,260
Taiwan	926	828
Thailand	4,280	4,490
Other	560	331
Total	45,900	50,100
Imitation: 3/		
Austria	37,100	50,800
China	1,320	1,180
Czech Republic	7,880	11,700
Germany	1,880	1,710
Japan	765	495
Spain	212	36
Taiwan	284	336
Other	908	1,090
Total	50,400	67,300

1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Customs value.
3/ Includes pearls.

Source: U.S. Census Bureau.

TABLE 10
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES 1/

(Thousand carats and thousand dollars)

Stones	1998 Quantity	1998 Value 2/	1999 Quantity	1999 Value 2/
Diamonds:				
Rough or uncut	1,440	588,000	4,270	734,000
Cut but unset	16,400	7,900,000	19,200	9,160,000
Emeralds, cut but unset	5,930	195,000	5,040	183,000
Coral and similar materials, unworked	NA	7,640	NA	7,090
Rubies and sapphires, cut but unset	10,500	242,000	11,200	239,000
Pearls:				
Natural	NA	1,090	NA	2,120
Cultured	NA	36,900	NA	44,800
Imitation	NA	1,530	NA	1,420
Other precious and semiprecious stones:				
Rough, uncut	883,000	31,100	1,330,000	43,500
Cut, set and unset	NA	140,000	NA	196,000
Other	NA	6,330	NA	6,110
Synthetic:				
Cut but unset	275,000	45,900	287,000	50,100
Other	NA	7,770	NA	7,370
Imitation gemstone 3/	NA	48,800	NA	65,900
Total	XX	9,250,000	XX	10,700,000

NA Not available. XX Not applicable.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Customs value.
3/ Does not include pearls.

Source: U.S. Census Bureau.

TABLE 11

NATURAL DIAMOND: ESTIMATED WORLD PRODUCTION, BY TYPE AND COUNTRY 1/ 2/

(Thousand carats)

Country	1995	1996	1997	1998	1999
Gemstones: 3/					
Angola	2,600	2,250	1,110	2,400	1,080
Australia	18,300	18,897 4/	18,100	18,400	13,403 4/
Botswana	11,500	12,400	15,100	14,800 r/	15,000
Brazil	676 4/	200	300	300	300
Canada	--	--	--	300 r/	2,000 p/
Central African Republic	400	350	400	330	400
China	230	230	230	230	230
Congo (Kinshasa) 5/	4,000	3,600	3,000 r/	3,300 r/	3,500
Cote d' Ivoire	53	202	207	210 r/	210
Ghana	126	142	664	649 r/	649
Guinea	274	165	165	300 r/	300
Liberia	60	60	80 r/	150 r/	600
Namibia	1,382 4/	1,402 r/ 4/	1,345 r/	1,394 r/	1,995
Russia	10,500	10,500	10,500	11,500 r/	11,500
Sierra Leone	113	162 4/	300 r/	200 r/	225
South Africa	5,070	4,400 r/	4,500 r/	4,300 r/	4,000
Venezuela	125	99	158	100	100
Zimbabwe	114	300	321	10 r/	--
Other	119	165	123 r/	106 r/	107
Total	55,700	55,500 r/	56,600	58,900 r/	55,600
Industrial:					
Angola	300	250	124	364	120
Australia	22,400	23,096 4/	22,100	22,500	16,381 4/
Botswana	5,300	5,000	5,000	5,000	5,000
Brazil	600	600	600	600	600
Central African Republic	130	120	100	200	150
China	900	900	900	900	920
Congo (Kinshasa) 5/	13,000	17,000	17,600 r/	18,900 r/	14,500
Cote d' Ivoire	22	100	100	100	100
Ghana	505	573	166	160	160
Guinea	91	40	40	100 r/	100
Liberia	90	90	120 r/	150 r/	400
Namibia	--	--	71	73	105
Russia	10,500	10,500	10,500	11,500 r/	11,500
Sierra Leone	101	108	100 r/	50 r/	75
South Africa	5,880	5,550 r/	5,540 r/	6,460 r/	6,000
Venezuela	66	73	90	150	150
Zimbabwe	90	137	100	19 r/	--
Other	101	120	105	97 r/	68
Total	60,100	64,300 r/	63,400 r/	67,300 r/	56,300
Grand total	116,000	120,000	120,000 r/	126,000 r/	112,000

p/ Preliminary. r/ Revised. -- Zero.

1/ World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

2/ Table includes data available through May 26, 2000.

3/ Includes near- and cheap-gem qualities.

4/ Reported figure.

5/ Formerly Zaire.

GEMSTONES

By Donald W. Olson

Domestic survey data and tables were prepared by Christine K. Pisut, statistical assistant, and the world production table was prepared by Regina R. Coleman, international data coordinator.

Humans have been intrigued by gems since prehistoric times. They have been valued as treasured objects throughout history by all societies in all parts of the world. The first stones known to have been used for making jewelry include amber, amethyst, coral, diamond, emerald, garnet, jade, jasper, lapis lazuli, pearl, rock crystal, ruby, serpentine, and turquoise. These stones served as status symbols for the wealthy. Today, gems are not worn to demonstrate wealth as much as they are for pleasure or in appreciation of their beauty (Schumann, 1998, p. 8). In this report, the terms "gem" and "gemstone" mean any mineral or organic material (such as amber, pearl, and petrified wood) used for personal adornment, display, or object of art because it possesses beauty, rarity, and durability. Of the 2,700 mineral species, only about 100 possess all these attributes. Silicates compose the largest group of gemstones; oxides and quartz compose the second largest (table 1). A further subcategory of gemstones is "colored gemstone," which in this report designates all nondiamond gemstones, including amber, coral, and shell. In addition, synthetic gemstones, cultured pearls, and gemstone simulants are discussed but are treated separately from natural gemstones (table 2). Current information on industrial-grade diamond can be found in the U.S. Geological Survey minerals yearbook chapter on industrial diamond.

Production

Commercial mining of gemstones has never been extensive in the United States. More than 60 varieties of gemstones have been produced commercially from domestic mines, but most of the deposits have been relatively small compared with other mining operations. In many instances, contemporary gemstone mining in the United States is conducted by hobbyists, collectors, and gem clubs rather than business organizations.

The commercial gemstone industry in the United States consists of several distinct sectors: (1) individuals and companies that mine gemstones or harvest shell and pearl, (2) firms that manufacture synthetic gemstones, and (3) individuals and companies that cut natural and synthetic gemstones. The domestic gemstone industry is focused on the production of colored gemstones and on the cutting of large diamonds. Industry employment is estimated to range from 1,000 to 1,500 workers (U.S. International Trade Commission, 1997, p. 1).

Most natural gemstone producers in the United States are small businesses that are widely dispersed and operate independently. The small producers probably have an average of less than three employees, including those who only work part time. The number of gemstone mines operating from year to year fluctuates, because the inherent uncertainty associated with the discovery and marketing of gem-quality minerals makes it difficult to obtain financing for developing and sustaining economically viable deposits (U.S. International Trade Commission, 1997, p. 23).

The total value of natural gemstones produced in the United States during 2000 was estimated to be at least $17.2 million (table 3). The production value was 6.9% greater than the preceding year. The production growth was mostly because the

Gemstones in the 20th Century

In 1900, U.S. production of gemstones was valued at about $233,000. The top five gemstone types, in descending order of production value, were turquoise, sapphire, rhodolite (garnet), aquamarine, and quartz crystal; these accounted for about 85% of total domestic production. Turquoise was produced primarily in Nevada and New Mexico. Sapphire production was in Montana, rhodolite and beryl production occurred in North Carolina, and quartz crystal production was in California and Montana. In 1900, the United States also imported diamond and other gemstones valued at about $13.6 million. Nearly $4 million worth of these imports were rough South African diamonds that were all cut in the United States. Opals from Australia that were cut in the United States were also a significant portion of these imports.

In 2000, domestic gemstone production was estimated to be $74.3 million, of which an estimated $57.1 million was synthetic gemstone and $17.2 million was natural gemstone. The top seven natural gemstone types, in descending order of production value, were shell, beryl, agate, turquoise, quartz, coral, and gem feldspars; these accounted for about 47% of the total natural gemstone production. Output of natural gemstones was primarily from Tennessee, Arizona, California, Nevada, and Utah, in decreasing order. Reported output of synthetic gemstones was from five firms in North Carolina, New York, Florida, California, and Arizona, in decreasing order of production. There was notable production of freshwater pearl in Tennessee, turquoise in Arizona, and beryl in North Carolina and Utah. In 2000, the United States also imported diamond and other gemstones valued at about $12.9 billion. Of these imports, 79% was from Israel, India, and Belgium, in descending order of gemstone import value. Diamond imports accounted for 93% of the total value of gemstone imports, and slightly more than 10.4% by weight of those diamonds was cut in the United States.

2000 shell harvest was 42% larger than in 1999 and foreign markets for U.S. shell material grew as the demand from Southeast Asia cultured pearl producers increased (Jewellery News Asia, 2000b).

The estimate of 2000 U.S. gemstone production was based on a survey of more than 200 domestic gemstone producers conducted by the U.S. Geological Survey (USGS). The survey provided a foundation for projecting the scope and level of domestic gemstone production during the year. However, the USGS survey did not represent all gemstone activity in the United States, which includes thousands of professional and amateur collectors. Consequently, the USGS supplemented its survey with estimates of domestic gemstone production from related published data, contacts with gemstone dealers and collectors, and information garnered at gem and mineral shows.

Natural gemstone materials indigenous to the United States are collected, produced, and/or marketed in every State. During 2000, all 50 States produced at least $1,000 worth of gemstone materials. Five States accounted for about than 75% of the total value, as reported by survey respondents. These States, in order of declining value of production, were Tennessee, Arizona, California, Nevada, and Utah. Some States were known for the production of a single gemstone material, Tennessee for freshwater pearls and Arkansas for quartz, for example. Other States produced a variety of gemstones, like Arizona, whose gemstone deposits included agate, amethyst, azurite, chrysocolla, fire agate, garnet, jade, malachite, obsidian, onyx, peridot, petrified wood, opal, smithsonite, and turquoise. A wide variety of gemstones also were found in California, Idaho, Montana, and North Carolina.

There were only two operations on significant known diamond-bearing areas in the United States during 2000. The first is the Kelsey Lake Diamond Mine, which straddles the Colorado-Wyoming State line. Kelsey Lake is now the only commercial producing diamond mine in the United States. It is operated by Great Western Diamond Company, a wholly-owned subsidiary of McKenzie Bay International Ltd., who purchased the property from Redaurum Limited in April 2000 (McKenzie Bay International Ltd., May 1, 2000, Kelsey Lake Diamond Mine released from bankruptcy proceedings Yes International to perform investor relations, accessed November 20, 2000, at URL http://www.mckenziebay.com/news/archive/000501.htm). Diamonds are present in three of the nine known kimberlite pipes on the Kelsey Lake property. The remaining six kimberlites have yet to be fully explored and tested for their diamond potential. Of diamonds recovered, 50% to 65% were clear gem quality, and almost a third were one carat or larger in size. The identified resources are at least 17 million tons (Mt) grading at an average of 4 carats per hundred tons (J. Taylor, April 11, 2000, McKenzie Bay International Ltd., accessed July 16, 2001, at URL http://www.mckensiebay.com/reports/jt000411.htm). Kelsey Lake was reopened and began production again in September 2000, after installing new equipment in the main processing and recovery plant. Maximum diamond recovery rates are expected in 2001 (McKenzie Bay International Ltd., September 6, 2000, Diamond production begins at Kelsey Lake Diamond Mine, accessed November 20, 2000, at URL http://www.mckenziebay.com/news/archive/000906.htm). The second operation was in Crater of Diamonds State Park near Murfreesboro in Pike County, AR, where a dig-for-fee operation for tourists and rockhounds is maintained by the State. Crater of Diamonds is the only diamond mine in the world that is open to the public. The diamonds occur in a lamproite breccia tuff associated with an extinct volcanic pipe and in the soil developed from the lamproite breccia tuff. Since the diamond-bearing pipe and the adjoining area became a State park in 1972, over 21,000 diamonds have been recovered. Recent exploration demonstrated that there are some 78.5 Mt of diamond-bearing rock in this diamond deposit (Howard, 1999, p. 62). An Arkansas law, enacted early in 1999, prohibits commercial diamond mining in the park (Diamond Registry Bulletin, 1999).

In addition to natural gemstones, synthetic gemstones and gemstone simulants are produced in the United States. Synthetic gemstones have the same optical, physical, and chemical properties as the natural materials that they appear to be. Simulants have an appearance similar to that of a natural gemstone material, but they have different optical, physical, and chemical properties. Synthetic gemstones produced in the United States include alexandrite, diamond, emerald, moissanite, ruby, sapphire, turquoise, and zirconia. Simulants of coral, lapis lazuli, malachite, and turquoise also are manufactured. In addition, certain colors of synthetic sapphire and spinel, used to represent other gemstones, are classified as simulants.

Synthetic gemstone production in the United States exceeded $57 million during 2000; simulant gemstone output was even greater and was estimated to be more than $100 million. Five firms in five States, representing virtually all the U.S. synthetic gemstone industry, reported production to the USGS. The States with reported synthetic gemstone production were Arizona, California, Florida, New York, and North Carolina. At least one U.S. company has developed technology to produce consistent quality and quantities of synthetic diamond and has reported production during 2000. The synthetic diamond stones weight ranged from 1.5 to 2 carats.

In 2000, a North Carolina firm entered its third year of marketing moissanite, a gem-quality synthetic silicon carbide that it produces. Moissanite is also an excellent diamond simulant, but it is being marketed for its own gem qualities.

Consumption

Although the United States accounts for less than 1% of total global gemstone production, it is the world's leading gemstone market. On the basis of indicators, such as trade data and income growth rates, U.S. gemstone markets—bolstered by strong demand among consumers with more personal wealth and more discretionary income—apparently accounted for at least 35% of world gemstone demand in 2000. The U.S. market for unset gem-quality diamonds during the year was estimated to have exceeded $9 billion, the largest in the world. Domestic markets for natural, unset nondiamond gemstones totaled about $770 million.

According to a poll conducted by a U.S. jewelry retailers association in the mid-1990s, about two-thirds of domestic consumers who were surveyed preferred diamond as their favorite gemstone (ICA Gazette, 1996). In 2000, the top-selling colored gemstones, in descending order, were blue sapphire, ruby, emerald, amethyst, tanzanite, tourmaline, garnet, fancy sapphire, pearl, and blue topaz (Prost, 2001). In addition to jewelry, gemstones are used for collections, exhibits, and decorative art objects.

Prices

Gemstone prices are governed by many factors and qualitative characteristics, including beauty, clarity, defects, demand, and rarity. Diamond pricing, in particular, is complex; values can vary significantly depending on time, place, and the subjective evaluations of buyers and sellers. There are more than 14,000 categories used to assess rough diamond and more than 100,000 different combinations of carat, clarity, color, and cut values used to assess polished diamond (Pearson, 1998).

Colored gemstone prices are generally influenced by market supply and demand considerations, and diamond prices are supported by producer controls on the quantity and quality of supply. Values and prices of gemstones produced and/or sold in the United States are listed in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported, exported, or reexported are listed in tables 6 through 10.

De Beers Consolidated Mines Ltd. in South Africa is a significant force affecting gem diamond prices worldwide because it mines about one-half of the diamonds produced each year and sorts and values about two-thirds (by value) of the world's annual supply of rough diamonds through its Diamond Trading Company (DTC), which has marketing agreements with other producers. Estimates based on the reported output of major diamond mines in 2000 indicate that the average value of all diamond produced during the year was about $71 per carat; by country, the average value per carat ranged from about $14 in Australia to more than $276 in Namibia (Luc Rombouts, Terraconsult bvba, May 2, 2001, Diamond annual review—2000, accessed June 19, 2001, at URL http://www.terraconsult.be/overview.htm).

Foreign Trade

During 2000, total U.S. gemstone trade with all countries and territories exceeded $17.4 billion; diamonds accounted for about 92% of the total. In 2000, U.S. exports and reexports of diamond were shipped to 72 countries and territories, and imports of all gemstones were received from 112 countries and territories (tables 6-10).

During 2000, U.S. trade in cut diamonds reached unprecedented levels; the country continued to be the world's leading diamond importer and set export records as well. Record high imports were attributed to a relatively strong U.S. economy that boosted domestic demand for diamond jewelry among consumers with more personal wealth and discretionary income.

The United States is a significant international diamond transit center, as well as the world's largest gem diamond market. The large volume of reexports (table 6) shipped to other centers reveals the significance that the United States has in the world's diamond supply network.

Synthetic gemstone trade continued to increase for the United States in 2000. Imports of synthetic gems increased slightly during the year. Synthetic gemstone imports from Austria, China, Germany, Switzerland, and Thailand made up about 80% of the total domestic imports of synthetic gemstones during the year. Prices of certain synthetic gemstone imports, such as amethyst, were very competitive. The marketing of synthetic imports and enhanced gemstones as natural gemstones and the mixing of synthetic materials with natural stones in imported parcels continued to be problems for some domestic producers in 2000. Another problem during the year was that some simulants were being marketed as synthetic gemstones.

World Review

The gemstone industry worldwide has two distinct sectors: (1) diamond mining and marketing, and (2) the production and sale of colored gemstones. Most diamond supplies are controlled by a few major mining companies; prices are supported by managing the quantity and quality of the gemstones relative to demand, a function performed by De Beers through DTC. Unlike diamonds, colored gemstones are primarily produced at relatively small, low-cost operations with few dominant producers; prices are influenced by consumer demand in addition to supply availability.

In 2000, world diamond production totaled at least 118 million carats with an estimated value of more than $7.86 billion (table 11). Most production was concentrated in a few regions—Africa [Angola, Botswana, Congo (Kinshasa), Namibia, and South Africa], Asia (northeastern Siberia and Yakutia in Russia), Australia, North America (Northwest Territories in Canada), and South America (Brazil and Venezuela). In 2000, Botswana was the world's leading diamond producer in terms of output value and quantity (Luc Rombouts, Terraconsult bvba, May 2, 2001, Diamond annual review—2000, accessed June 19, 2001, at URL http://www.terraconsult.be/overview.htm).

Global diamond sales hit a record high of $25.8 billion, nearly 9% higher than 1999, according to figures released by the Diamond High Council (CNN.com, January 30, 2001, Diamond sales enjoy record year, accessed February 2, 2001, at http://www.cnn.com/2001/WORLD/europe/01/30/belgium.diamonds/index.html). Record sales of rough diamond by DTC in 2000 reached $5.67 billion, 8.2% higher than the 1999 total of $5.24 billion. The sales record was primarily the result of very strong sales in the first half of the year. Sales in the second half of the year actually dropped by 23% compared with the second half of 1999 (The Diamond Registry, January 2001, U.S. market drives De Beers to record sales increase in 2000, accessed April 25, 2001, at URL http://www.diamondregistry.com/News/sales_record.htm). Retail diamond jewelry sales in the United States grew by 6% in 2000, the ninth consecutive year sales have risen (Diamond Registry Bulletin, 2001a).

Additional events significant to diamond mining and marketing worldwide in 2000 include the following:

! The Ekati Mine, Canada's first commercial diamond mine, completed its second full year of production. The Ekati Mine, located in the Northwest Territories, was a joint venture between BHP Diamonds Inc. (BHP) and Dia Met Minerals Ltd., but in June 2001, BHP purchased Dia Met Minerals Ltd. (BHP Diamonds Inc., 2001). Ekati has estimated reserves of 60.3 Mt of ore in kimberlite pipes, containing 54.3 million carats of diamonds, and the mine life is projected to be 25 years. In 2000, Ekati produced 2.63 million carats valued at $454 million, which reflected a record sales price of $172.52 per carat. Ekati diamonds are sold by the BHP sales office in Antwerp (65%) and by DTC (35%) (Luc Rombouts, Terraconsult bvba, May 2, 2001, Diamond annual review—2000, accessed June 19, 2001, at URL http://www.terraconsult.be/overview.htm).

! The Diavik diamonds project is located in the Northwest Territories. Diavik has estimated reserves of 25.6 Mt of ore in kimberlite pipes, containing 102 million carats of diamonds, and the mine life is projected to be 20 years. Diavik received the required permits and regulatory approval in 2000 and began site infrastructure development and project construction. Diavik is an unincorporated joint venture between Diavik Diamond Mines Inc. (60%) and Aber Diamond Mines Ltd. (40%), and it is expected to commence diamond production in the first half of 2003. The mine is expected to produce about 102 million carats of diamond at a rate of 6 million carats per year worth about $63 per carat (Diavik Diamond Mines Inc., 2000, p. 10-12).

! "Conflict diamonds" continued to partially finance warfare in Angola, Congo (Kinshasa), and Sierra Leone. In 2000, these "conflict diamonds" were discussed in the United Nations (U.N.), the U.S. Congress, the World Diamond Council, and the news media. The U.N. adopted a resolution on the role of diamonds in fueling conflict. A bill that was introduced, but not passed, in the 106th U.S. Congress would have required jewelry retailers to reveal the country of origin for all diamonds sold in the United States. In 2001, a revised version of this bill was reintroduced in the 107th U.S. Congress. The revised bill calls for a comprehensive diamond certification program and says that the United States can only import rough diamond from countries with the proper controls to ensure against importation of "conflict diamonds." "Conflict diamonds" were also the subject of much television and other media coverage in 2000. Despite all of this discussion and media attention, surveys indicate that during 2000, most diamond jewelry consumers did not ask for the country of origin when making their diamond buying decisions (Diamond Registry Bulletin, 2000a). One survey in 2000 indicated that 93% of consumers who were surveyed had never heard of "conflict diamonds," but 76% of consumers said that they would not purchase diamonds or diamond jewelry knowing that it came from a country where social injustice had occurred as a result of its production (Diamond Registry Bulletin, 2000c).

! De Beers Canada Mining Inc. acquired the Snap Lake diamond project from Winspear Diamonds Inc. and Aber Diamond Corporation in 2000. Snap Lake is located in the Northwest Territories and will be De Beers' first mine outside of southern Africa and the first underground diamond mine in Canada. Snap Lake has estimated reserves of 22.8 Mt of ore in a kimberlite dike, containing 38.8 million carats of diamonds, and the mine life is projected to be 20 years or more. Snap Lake is in its development phase and is scheduled to begin diamond production in the first half of 2003 (De Beers Canada Mining Inc., 2000, Snap Lake diamond project fact sheet, accessed June 13, 2001, at URL http://www.debeerscanada.com/files_new/snap/infrastruct.html).

! E-commerce in diamond and gemstone jewelry continued to grow during 2000. While more jewelry websites started operating online, many of the dot-com businesses overspent on advertizing and went out of business as a result. Preholiday season surveys indicated that the vast majority of 1999 online holiday customers also shopped online in 2000, and they spent more. The entire sum of online holiday sales, however, only amounted to about 1.5% of overall retail jewelry sales in 2000 (Diamond Registry Bulletin, 2000b).

Worldwide production of natural gemstones other than diamond was estimated to have exceeded $2 billion per year in the late 1990s. Most nondiamond gemstone mines are small, low-cost, and widely dispersed operations in remote regions of developing nations. Foreign countries with major gemstone deposits other than diamond are Afghanistan (beryl, ruby, and tourmaline); Australia (beryl, opal, and sapphire); Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline); Burma (beryl, jade, ruby, sapphire, and topaz); Colombia (beryl, emerald, and sapphire); Kenya (beryl, garnet, and sapphire); Madagascar (beryl, rose quartz, sapphire, and tourmaline); Mexico (agate, opal, and topaz); Sri Lanka (beryl, ruby, sapphire, and topaz); Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline); and Zambia (amethyst and beryl). In addition, pearls are cultured throughout the South Pacific and in other equatorial waters; Australia, China, French Polynesia, and Japan are key producers.

Colored gemstone producers continued their recovery from the weakened markets created by the Asian economic crisis of 1997-98. Mining and sales reportedly were disrupted in many nations, particularly in Southeast Asia. Prices of high-quality colored gemstones, however, did not decline dramatically (Cavey, 1998).

Additional noteworthy items in the colored gemstone industry during 2000 included the following:

! Owing to the increased misuse of the terms like "synthetic" and "laboratory-created" in deceptive advertizing and owing to the proliferation of treatment processes to enhance gemstone attributes artificially without disclosure, the Federal Trade Commission has modified its "Guides for the Jewelry, Precious Metals, and Pewter Industries." The modified regulations went into effect April 10, 2001.

! During 2000, the popularity of colorful gemstones, colored synthetic gemstones, and "fancy" colored diamonds (even black diamonds) increased, as was evidenced by increased sales that are expected to continue in 2001 (Jewelers' Circular Keystone, 2000; Jewellery News Asia, 2000a, 2000c, 2001).

Outlook

It appears that the 2001 U.S. economy will not be a continuation of the good times we have enjoyed for the last few years. The U.S. diamond industry can take comfort in the fact that the value of their inventory is holding much better than the stock market (Diamond Registry Bulletin, 2001b). Historically, diamonds have proven to hold their value despite wars or depressions in the economy (Schumann, 1998, p. 8).

Diamond exploration is continuing in Canada, and many new deposits are being found. There have been additional discoveries in both the core and buffer zones of the Ekati lease. At least 35 kimberlites have been discovered in north-central Alberta, 70 large kimberlites have been found in Saskatchewan, and additional discoveries have been made in Ontario and Quebec (Luc Rombouts, Terraconsult bvba, May 2, 2001, Diamond annual review—2000, accessed June 19, 2001, at URL http://www.terraconsult.be/overview.htm). When the Diavik and Snap Lake mines begin production, Canada will be producing at least 15% to 20% of the total world diamond production.

Independent producers, such as Argyle Diamond Mines in Australia and new mines in Canada, will continue to bring a greater measure of competition to global markets. More competition presumably will bring more supplies and lower prices.

Numerous synthetics, simulants, and treated gemstones will enter the marketplace and necessitate more transparent trade industry standards to maintain customer confidence.

More diamonds, gemstones, and jewelry will be sold through online marketplaces and other forms of e-commerce that emerge to serve the diamond and gemstone industry. This will take place as the industry and its customers become more comfortable with and learn the best applications of new e-commerce tools for the gemstone industry (Authority on Jewelry Manufacturing, 2001).

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TABLE 1
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characters
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0-2.5	1.0-1.1	Single	1.54	Synthetic or pressed plastics	Fossil resin, soft.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	Small to medium	High	6.0-6.5	3.64-3.68	Double	1.76-1.80	Sapphire, tanzanite, blue diamond, blue tourmaline	Strong blue in ultraviolet light.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5-8.0	2.63-2.80	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	do.	Small	Very high	7.5-8.0	2.63-2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald	do.	Green	Medium	do.	7.5	2.63-2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5-8.0	2.63-2.80	do.	1.58	Genuine emerald	Flaws, brilliant, fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5-8.0	2.63-2.80	do.	1.58	Citrine, topaz, glass, doublets	Weak-colored.
Goshenite	do.	do.	do.	Low	7.5-8.0	2.63-2.80	do.	1.58	Quartz, glass, white sapphire, white topaz	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5-8.0	2.63-2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49-1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.60	do.	Banded, translucent.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day, red by artificial light	Small (former U.S.S.R.) Medium (Sri Lanka)	High	8.5	3.50-3.84	Double	1.75	Synthetic	Dichroism, inclusions in synthetic sapphire.
Cats-eye	do.	Greenish to brownish	Small to large	do.	8.5	3.50-3.84	do.	1.75	Synthetic, shell	Gravity and translucence.
Chrysolite	do.	Yellow, green, and/or brown	Medium	Medium	8.5	3.50-3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Coral	Calcium carbonate	Orange, red, white, black, or green	Branching, medium	Low	3.5-4.0	2.6-2.7	do.	1.49-1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95-4.10	do.	1.78	Synthetics, including spinel	Inclusions, fluorescence.
Sapphire	do.	Blue	Medium	High	9.0	3.95-4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, white, orange, green, or violet	Medium to large	Medium	9.0	3.95-4.10	do.	1.78	Synthetics, glass and doublets	Inclusions, double refraction, refractive index.
Sapphire and ruby, stars	do.	Red, pink, violet, blue, or gray	do.	High to low	9.0	3.95-4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characters
Corundum:										
Sapphire or ruby, synthetic	Aluminum oxide	Yellow, pink, or blue	Up to 20 carats	Low	9.0	3.95-4.10	Double	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Diamond	Carbon	White, blue-white, yellow, brown, green, pink, blue	Any	Very high	10.0	3.516-3.525	Single	2.42	Zircon, titania, cubic zirconia	High index, dispersion, hardness, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green	Large	Low	6.0-6.5	2.56	XX	1.52	Jade	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play	do.	do.	6.0-6.5	2.56	XX	1.56	do.	Do.
Moonstone	do.	Colorless or yellow	do.	do.	6.0-6.5	2.77	XX	1.52-1.54	Glass	Pale sheen, opalescent.
Garnet	Complex silicate	Brown, black, yellow, green, ruby red, or orange	Small to medium	Low to high	6.5-7.5	3.15-4.30	Single strained	1.79-1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Jade:										
Jadeite	do.	Green, yellow, black, white, or mauve	Large	Low to very high	6.5-7.0	3.3-3.5	Crypto-crystalline	1.65-1.68	Onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent, to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0-6.5	2.96-3.10	do.	1.61-1.63	do.	Do.
Opal	Hydrous silica	Colors flash in white gray, black, red, or yellow	do.	Low to high	5.5-6.5	1.9-2.3	Single	1.45	Glass, synthetics, triplets	Play of color.
Pearl	Calcium carbonate	White, pink, or black	Small	do.	2.5-4.0	2.6-2.85	XX	XX	Cultured and imitation	Luster, structure, x ray.
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5-7.0	3.27-3.37	Double (strong)	1.65-1.69	Tourmaline chrysoberyl	Strong double refraction, low dichroism.
Quartz:										
Agate	Silica	Any	Large	Low	7.0	2.58-2.64	XX	XX	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65-2.66	Double	1.55	do.	Refractive index, double refraction, transparent.
Cairngorm	do.	Smoky orange or yellow	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Citrine	do.	Yellow	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Do.
Crystal, rock	do.	Colorless	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Do.
Jasper	do.	Any, striped, spotted, or sometimes uniform	do.	do.	7.0	2.58-2.66	XX	XX	do.	Opaque, vitreous.
Onyx	do.	Many colors	do.	do.	7.0	2.58-2.64	XX	XX	do.	Uniformly banded.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65-2.66	Double	1.55	do.	Refractive index, double refraction, translucent.
Spinel	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5-3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5-3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5-7.0	3.13-3.20	do.	1.66	Synthetic spinel	Refractive index.
Kunzite	do.	Pink to lilac	do.	do.	6.5-7.0	3.13-3.20	do.	1.66	Amethyst, morganite	Do.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characters
Tanzanite	Complex silicate	Blue	Small	High	6.0-7.0	3.30	Double	1.69	Sapphire, synthetics	Strong trichroism.
Topaz	do.	White, blue, green	Medium	Low to medium	8.0	3.4-3.6	do.	1.62	Beryl, quartz	Refractive index.
Tourmaline	do.	Any, including mixed	do.	do.	7.0-7.5	2.98-3.20	do.	1.63	Peridot, beryl, corundum, glass	Double refraction, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green	Large	Low	6.0	2.60-2.83	do.	1.63	Glass, plastics	Difficult if matrix not present, matrix usually limonitic.
Zircon	Zirconium silicate	White, blue, or brown, yellow, or green	Small to medium	Low to medium	6.0-7.5	4.0-4.8	Double (strong)	1.79-1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

XX Not applicable.

1/ Small: up to 5 carats; medium: 5 to 50 carats; large: more than 50 carats.

2/ Low: up to $25 per carat; medium: up to $200 per carat; high: more than $200 per carat.

TABLE 2
SYNTHETIC GEMSTONE PRODUCTION METHODS

Gemstone	Production methods	Company/ producer	Date of first production
Alexandrite	Flux	Creative Crystals	1970s
Do.	Melt pulling	J.O. Crystal	1990s
Do.	do.	Kyocera	1980s
Do.	Zone melt	Seiko	1980s
Cubic zirconia	Skull melt	Various producers	1970s
Emerald	Flux	Chatham	1930s
Do.	do.	Gilson	1960s
Do.	do.	Kyocera	1970s
Do.	do.	Seiko	1980s
Do.	do.	Lennix	1980s
Do.	do.	Russia	1980s
Do.	Hydrothermal	Lechleitner	1960s
Do.	do.	Regency	1980s
Do.	do.	Biron	1980s
Do.	do.	Russia	1980s
Ruby	Flux	Chatham	1950s
Do.	do.	Kashan	1960s
Do.	do.	J.O. Crystal	1980s
Do.	do.	Douras	1990s
Do.	Zone melt	Seiko	1980s
Do.	Melt pulling	Kyocera	1970s
Do.	Verneuil	Various producers	1900s
Sapphire	Flux	Chatham	1970s
Do.	Zone melt	Seiko	1980s
Do.	Melt pulling	Kyocera	1980s
Do.	Verneuil	Various producers	1900s
Star ruby	do.	Linde	1940s
Do.	Melt pulling	Kyocera	1980s
Do.	do.	Nakazumi	1980s
Star sapphire	Verneuil	Linde	1940s

TABLE 3
VALUE OF U.S. GEMSTONE PRODUCTION, BY TYPE 1/

(Thousand dollars)

Gem materials	1999	2000
Agate	47 r/	(2/)
Beryl	3,360 e/	(2/)
Coral (all types)	54	(2/)
Diamond	(3/)	(3/)
Garnet	90	78
Gem feldspar	187	314
Geode/nodules	69	59
Jasper	49	30
Opal	147	219
Quartz	674	416
Sapphire/ruby	117	65
Shell	2,600	3,270
Topaz	8	8
Tourmaline	W	54
Turquoise	860	(2/)
Other	7,820	9,210
Total	16,100	17,200

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Included in "Total."
3/ Included with "Other."

TABLE 4
PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY 1/

			Representative prices		
Carat weight	Description, color 3/	Clarity 2/ (GIA terms)	January 2000 4/	June 2000 5/	December 2000 6/
0.25	G	VS1	$1,500	$1,500	$1,500
.25	G	VS2	1,380	1,380	1,380
.25	G	SI1	1,130	1,130	1,130
.25	H	VS1	1,400	1,400	1,400
.25	H	VS2	1,250	1,250	1,250
.25	H	SI1	1,050	1,050	1,050
.50	G	VS1	3,400	3,400	3,400
.50	G	VS2	3,000	3,000	3,000
.50	G	SI1	2,500	2,500	2,500
.50	H	VS1	3,000	3,000	3,000
.50	H	VS2	2,700	2,700	2,700
.50	H	SI1	2,400	2,400	2,400
.75	G	VS1	3,800	3,800	3,800
.75	G	VS2	3,600	3,600	3,600
.75	G	SI1	3,300	3,300	3,300
.75	H	VS1	3,650	3,650	3,650
.75	H	VS2	3,450	3,450	3,450
.75	H	SI1	3,100	3,100	3,100
1.00	G	VS1	5,700	5,800	5,900
1.00	G	VS2	5,300	5,400	5,700
1.00	G	SI1	4,800	4,900	5,000
1.00	H	VS1	5,200	5,300	5,500
1.00	H	VS2	4,900	5,000	5,300
1.00	H	SI1	4,500	4,600	4,800

1/ Data are rounded to no more than three significant digits.
2/ Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; G, H, I— traces of color
3/ Clarity: IF—no blemishes; VVS1—very, very slightly included; VS1—very slightly included; VS2—very slightly included, but not visible; SI1—slightly included.
4/ Source: Jewelers' Circular Keystone, v. 171, no. 2, February 2000, p. 58.
5/ Source: Jewelers' Circular Keystone, v. 171, no. 7, July 2000, p. 46.
6/ Source: Jewelers' Circular Keystone, v. 172, no. 1, January 2001, p. 52.

TABLE 5
PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES

	Price range per carat	
Gemstone	January 2000 1/	December 2000 2/
Amethyst	$7-$14	$7-$14
Aquamarine	75-200	75-250
Emerald	1,000-2,400	1,000-2,400
Ruby	1,800-2,800	1,800-2,800
Sapphire	650-1,800	450-1,450
Tanzanite	250-350	325-400

1/ Source: Jewelers' Circular Keystone, v. 171, no. 2, February 2000, p. 58. Amethyst and aquamarine prices are from The Guide, Spring/Summer 2000, p. 12, 72. These figures represent a sampling of net prices that wholesale colored stone dealers in various U.S. cities charged their cash customers during the month for fine-quality stones.
2/ Source: Jewelers' Circular Keystone, v. 172, no. 1, January 2001, p. 52. Amethyst, aquamarine, and tanzanite prices are from The Guide, Fall/Winter 2000-2001, p. 12, 72, 104. These figures represent a sampling of net prices that wholesale colored stone dealers in various U.S. cities charged their cash customers during the month for fine-quality stones.

TABLE 6
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY 1/

	1999		2000	
Country	Quantity (carats)	Value 2/ (millions)	Quantity (carats)	Value 2/ (millions)
Exports:				
Belgium	9,260	$10	114,000	$248
Canada	81,700	30	123,000	39
France	16,700	10	30,300	67
Hong Kong	29,600	34	111,000	150
India	56,200	13	109,000	36
Israel	14,600	28	268,000	354
Japan	5,460	22	23,100	60
Singapore	11,400	5	15,000	14
Switzerland	42,000	79	73,100	143
Thailand	102	1	13,100	12
United Arab Emirates	1,360	3	1,540	6
United Kingdom	20,200	21	74,600	64
Other	199,000	47	319,000	89
Total	487,000	303	1,270,000	1,280
Reexports:				
Belgium	980,000	669	3,850,000	666
Canada	97,400	41	105,000	49
France	40,800	40	75,100	21
Hong Kong	822,000	308	3,260,000	396
India	902,000	134	600,000	79
Israel	1,120,000	1,020	4,770,000	1,010
Japan	109,000	62	259,000	34
Singapore	43,100	27	259,000	32
Switzerland	184,000	265	477,000	187
Thailand	177,000	22	247,000	28
United Arab Emirates	25,300	10	72,100	13
United Kingdom	111,000	97	455,000	94
Other	346,000	75	551,000	89
Total	4,950,000	2,770	15,000,000	2,700
Grand total	5,440,000	3,080	16,300,000	3,980

1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Customs value.

Source: U.S. Census Bureau.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY 1/

	1999		2000	
Kind, range, and country of origin	Quantity (carat)	Value 2/ (millions)	Quantity (carat)	Value 2/ (millions)
Rough or uncut, natural: 3/				
Australia	945	$1	12	(4/)
Belgium	118,000	121	431,000	$190
Brazil	11,600	5	29,500	9
Congo (Brazzaville)	25,500	2	7,860	15
Congo (Kinshasa)	53,200	74	2,290	10
Ghana	110,000	102	699,000	36
Guinea	10,100	16	4,390	8
India	18,600	(4/)	276,000	(4/)
Israel	38,000	25	19,200	20
Russia	3,080,000	4	4,240	1
Sierra Leone	4,420	6	668	1
South Africa	40,500	73	136,000	194
Switzerland	2,520	18	5,200	23
United Kingdom	663,000	229	538,000	185
Venezuela	3,290	1	6,870	2

See footnotes at end of table.

TABLE 7--Continued

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY 1/

Kind, range, and country of origin	1999 Quantity (carat)	1999 Value 2/ (millions)	2000 Quantity (carat)	2000 Value 2/ (millions)
Rough or uncut, natural--Continued: 3/				
Other	88,900	$56	116,000	$47
Total	4,270,000	734	2,280,000	741
Cut but unset, not more than 0.5 carat:				
Belgium	771,000	208	769,000	221
Brazil	3,720	2	13,400	3
Canada	1,260	1	2,070	1
Germany	6,290	1	4,590	1
Hong Kong	289,000	47	466,000	79
India	12,400,000	1,900	11,600,000	2,050
Israel	1,080,000	608	1,150,000	693
Japan	12,100	3	3,950	2
South Africa	3,280	3	1,480	2
Switzerland	36,400	10	133,000	9
Thailand	103,000	14	127,000	18
United Kingdom	1,650	1	11,700	3
Other	245,000	42	217,000	42
Total	14,900,000	2,840	14,500,000	3,120
Cut but unset, more than 0.5 carat:				
Belgium	1,030,000	1,630	1,330,000	2,170
Botswana	--	--	2	(4/)
Canada	1,780	6	2,830	9
France	2,530	6	2,110	16
Hong Kong	81,000	117	105,000	139
India	664,000	383	639,000	461
Israel	2,290,000	3,650	2,740,000	4,630
Japan	1,910	7	14,800	13
Russia	29,000	44	45,100	61
Singapore	2,210	7	4,180	14
South Africa	24,800	67	34,100	140
Switzerland	35,100	254	34,200	263
Thailand	16,700	18	23,800	27
United Kingdom	20,800	75	22,100	100
Other	34,100	55	48,500	90
Total	4,230,000	6,320	5,040,000	8,140

-- Zero.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

2/ Customs value.

3/ Includes some natural advanced diamond.

4/ Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 8

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY 1/

Kind and country	1999 Quantity (carats)	1999 Value 2/ (millions)	2000 Quantity (carats)	2000 Value 2/ (millions)
Emerald:				
Belgium	14,000	$2	10,600	$2
Brazil	601,000	6	6,750,000	8
Canada	803	(3/)	1,120	1
China	955	(3/)	1,060	(3/)
Colombia	601,000	59	11,300,000	66
France	7,040	1	3,180	1
Germany	25,800	3	40,700	2
Hong Kong	252,000	10	240,000	9
India	2,860,000	35	3,110,000	32

See footnotes at end of table.

TABLE 8--Continued
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY 1/

Kind and country	1999 Quantity (carats)	1999 Value 2/ (millions)	2000 Quantity (carats)	2000 Value 2/ (millions)
Emerald--Continued:				
Israel	272,000	$26	181,000	$30
Japan	8,370	(3/)	48	(3/)
South Africa	183	(3/)	78	(3/)
Switzerland	34,300	27	137,000	15
Taiwan	3,760	(3/)	526	(3/)
Thailand	201,000	4	258,000	4
United Kingdom	52,800	3	3,630	1
Other	102,000	6	76,400	5
Total	5,040,000	183	22,100,000	176
Ruby:				
Belgium	6,120	1	2,120	1
Brazil	7,350	(3/)	6,020	(3/)
Burma	4,290	14	55,900	4
Canada	373	(3/)	120	(3/)
China	3,260	(3/)	1,170	(3/)
Colombia	2,140	(3/)	1,840	(3/)
France	1,790	(3/)	1,710	(3/)
Germany	54,400	7	16,300	1
Hong Kong	270,000	6	253,000	10
India	1,320,000	4	1,600,000	5
Israel	24,000	3	37,800	3
Japan	3,160	(3/)	9,280	(3/)
Switzerland	46,200	20	32,100	7
Thailand	2,250,000	48	2,450,000	46
United Kingdom	29,300	3	5,590	4
Other	59,800	2	31,200	4
Total	4,080,000	110	4,500,000	85
Sapphire:				
Australia	8,540	(3/)	7,320	1
Belgium	12,500	2	3,000	1
Brazil	6,920	(3/)	6,590	(3/)
Burma	1,830	2	8,720	2
Canada	44	(3/)	699	1
China	15,200	(3/)	30,000	(3/)
Colombia	2,110	(3/)	43,100	(3/)
France	815	(3/)	1,740	1
Germany	143,000	3	53,700	1
Hong Kong	301,000	9	326,000	11
India	862,000	3	1,160,000	4
Israel	100,000	6	63,100	5
Japan	16,300	(3/)	105,000	1
Singapore	285	(3/)	147	(3/)
Sri Lanka	480,000	19	492,000	25
Switzerland	38,600	15	50,400	17
Tanzania	822	(3/)	238	(3/)
Thailand	5,080,000	64	6,000,000	81
United Kingdom	14,100	4	13,800	3
Other	81,700	2	28,900	4
Total	7,160,000	129	8,400,000	156
Other:				
Rough, uncut:				
Australia	NA	4	NA	4
Brazil	NA	26	NA	15
China	NA	1	NA	1
Colombia	NA	2	NA	2
Fiji	NA	2	NA	2
Hong Kong	NA	1	NA	1
India	NA	1	NA	1
Kenya	NA	(3/)	NA	(3/)
Nigeria	NA	(3/)	NA	(3/)
Pakistan	NA	(3/)	NA	1

See footnotes at end of table.

TABLE 8--Continued
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND,
BY KIND AND COUNTRY 1/

Kind and country	1999 Quantity (carats)	1999 Value 2/ (millions)	2000 Quantity (carats)	2000 Value 2/ (millions)
Other--Continued:				
Rough, uncut--Continued:				
Philippines	NA	$1	NA	$1
Russia	NA	(3/)	NA	(3/)
South Africa	NA	1	NA	2
Switzerland	NA	(3/)	NA	(3/)
Taiwan	NA	(3/)	NA	(3/)
Tanzania	NA	(3/)	NA	1
Thailand	NA	7	NA	11
United Kingdom	NA	(3/)	NA	1
Zambia	NA	2	NA	5
Other	NA	11	NA	9
Total	NA	57	NA	56
Cut, set and unset:				
Australia	NA	8	NA	18
Brazil	NA	10	NA	10
Canada	NA	1	NA	1
China	NA	11	NA	13
French Polynesia	NA	5	NA	5
Germany	NA	14	NA	17
Hong Kong	NA	44	NA	56
India	NA	66	NA	81
Israel	NA	6	NA	11
Japan	NA	16	NA	10
Kenya	NA	2	NA	1
Sri Lanka	NA	3	NA	6
Switzerland	NA	2	NA	3
Taiwan	NA	3	NA	2
Tanzania	NA	8	NA	13
Thailand	NA	30	NA	33
United Kingdom	NA	6	NA	6
Other	NA	7	NA	9
Total	NA	243	NA	294

NA Not available.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Customs value.
3/ Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 9
VALUE OF U.S. IMPORTS OF SYNTHETIC AND IMITATION
GEMSTONES, BY COUNTRY 1/

(Thousand dollars) 2/

Country	1999	2000
Synthetic, cut but unset:		
Australia	488	97
Austria	7,180	6,670
Brazil	2,110	136
China	13,300	13,500
France	500	1,020
Germany	10,500	10,300
Hong Kong	2,110	2,990
India	971	795
Italy	104	289
Japan	6	69
Korea, Republic of	2,720	2,510

See footnotes at end of table.

TABLE 9--Continued
VALUE OF U.S. IMPORTS OF SYNTHETIC AND IMITATION
GEMSTONES, BY COUNTRY 1/

(Thousand dollars) 2/

Country	1999	2000
Synthetic, cut but unset--Continued:		
Spain	39	10
Sri Lanka	89	612
Switzerland	4,260	6,410
Taiwan	828	708
Thailand	4,490	3,820
Other	331	1,000
Total	50,100	50,900
Imitation: 3/		
Austria	50,800	59,100
China	1,180	990
Czech Republic	11,700	11,200
Germany	1,710	1,250
Japan	495	756
Spain	36	45
Taiwan	336	274
Other	1,090	2,580
Total	67,300	76,200

1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Customs value.
3/ Includes pearls.

Source: U.S. Census Bureau.

TABLE 10
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES 1/

(Thousand carats and thousand dollars)

	1999		2000	
Stones	Quantity	Value 2/	Quantity	Value 2/
Diamonds:				
Rough or uncut	4,270	734,000	2,280	741,000
Cut but unset	19,200	9,160,000	19,500	11,300,000
Emeralds, cut but unset	5,040	183,000	22,100	176,000
Coral and similar materials, unworked	NA	7,090	NA	8,920
Rubies and sapphires, cut but unset	11,200	239,000	12,900	241,000
Pearls:				
Natural	NA	2,120	NA	960
Cultured	NA	44,800	NA	46,100
Imitation	NA	1,420	NA	2,020
Other precious and semiprecious stones:				
Rough, uncut	1,330,000	43,500	1,070,000	39,400
Cut, set and unset	NA	196,000	NA	247,000
Other	NA	6,110	NA	7,840
Synthetic:				
Cut but unset	287,000	50,100	329,000	50,900
Other	NA	7,370	NA	6,190
Imitation gemstone 3/	NA	65,900	NA	74,200
Total	XX	10,700,000	XX	12,900,000

NA Not available. XX Not applicable.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Customs value.
3/ Does not include pearls.

Source: U.S. Census Bureau.

TABLE 11
NATURAL DIAMOND: ESTIMATED WORLD PRODUCTION, BY TYPE AND COUNTRY 1/ 2/

(Thousand carats)

Country	1996	1997	1998	1999	2000
Gemstones: 3/					
Angola	2,250	1,110	2,400	3,700 r/	5,400
Australia	18,897 4/	18,100	18,400	13,403 4/	12,014 4/
Botswana	12,388 r/ 4/	15,111 r/ 4/	14,772 r/ 4/	16,000 r/	19,700
Brazil	200	300	300	300	300
Canada	--	--	300	2,000	2,000
Central African Republic	350	400	330	400	400
China	230	230	230	230	230
Congo (Kinshasa)	3,300 r/	3,300 r/	5,080 r/	4,120 r/	3,500
Cote d' Ivoire	202	207	210	210	200
Ghana	142	664	649	518 r/	178
Guinea	165	165	300	410 r/	410
Liberia	60	80	150	120 r/	120
Namibia	1,402 4/	1,350 r/	1,390 r/	1,550 r/	1,520
Russia	10,500	11,200 r/	11,500	11,500	11,600
Sierra Leone	162 4/	300	200	450 r/	450
South Africa	4,400	4,500	4,300	4,000	4,300
Venezuela	99	158	80 r/	59 r/	60
Zimbabwe	300	321	10	15 r/	7
Other	165	124 r/	106	207 r/	258
Total	55,200 r/	57,600 r/	60,800 r/	59,200 r/	62,600
Industrial:					
Angola	250	124	364	400 r/	600
Australia	23,096 4/	22,100	22,500	16,381 4/	14,684 4/
Botswana	5,000	5,000	5,000	5,350 r/	4,950
Brazil	600	600	600	600	600
Central African Republic	120	100	200	150	150
China	900	900	900	920	920
Congo (Kinshasa)	18,940 r/ 4/	18,677 r/ 4/	21,000 r/	16,000 r/	14,200
Cote d' Ivoire	100	100	100	100	100
Ghana	573	166	160	128 r/	712
Guinea	40	40	100	140 r/	140
Liberia	90	120	150	80 r/	80
Namibia	--	71	73	89 r/	80
Russia	10,500	11,200 r/	11,500	11,500	11,600
Sierra Leone	108	100	50	150 r/	150
South Africa	5,550	5,540	6,460	6,020 r/	6,480
Venezuela	73	90	17 r/	36 r/	40
Zimbabwe	137	100	19	30 r/	13
Other	120	105	97	141 r/	143
Total	66,200 r/	65,100 r/	69,300 r/	58,200 r/	55,600
Grand total	121,000 r/	123,000 r/	130,000 r/	117,000 r/	118,000

r/ Revised. -- Zero.
1/ World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.
2/ Table includes data available through May 25, 2001.
3/ Includes near- and cheap-gem qualities.
4/ Reported figure.

GEMSTONES

By Donald W. Olson

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Gemstones have fascinated humans since prehistoric times. They have been valued as treasured objects throughout history by all societies in all parts of the world. The first stones known to have been used for making jewelry include amber, amethyst, coral, diamond, emerald, garnet, jade, jasper, lapis lazuli, pearl, rock crystal, ruby, serpentine, and turquoise. These stones served as status symbols for the wealthy. Today, gems are not worn to demonstrate wealth as much as they are for pleasure or in appreciation of their beauty (Schumann, 1998, p. 8). In this report, the terms "gem" and "gemstone" mean any mineral or organic material (such as amber, pearl, and petrified wood) used for personal adornment, display, or object of art because it possesses beauty, durability, and rarity. Of more than 4,000 mineral species, only about 100 possess all these attributes and are considered to be gemstones. Silicates other than quartz compose the largest group of gemstones; oxides and quartz compose the second largest (table 1). A further subcategory of gemstones is colored gemstone, which in this report designates all nondiamond gemstones, including amber, coral, and shell. In addition, synthetic gemstones, cultured pearls, and gemstone simulants are discussed but are treated separately from natural gemstones (table 2). Current information on industrial-grade diamond can be found in the U.S. Geological Survey (USGS) Minerals Yearbook chapter on industrial diamond.

Production

Commercial mining of gemstones has never been extensive in the United States. More than 60 varieties of gemstones have been produced commercially from domestic mines, but most of the deposits have been relatively small compared with other mining operations. In the United States, much of the current gemstone mining is conducted by hobbyists, collectors, and gem clubs rather than business organizations.

The commercial gemstone industry in the United States consists of (1) individuals and companies that mine gemstones or harvest shell and pearl, (2) firms that manufacture synthetic gemstones, and (3) individuals and companies that cut natural and synthetic gemstones. The domestic gemstone industry is focused on the production of colored gemstones and on the cutting of large diamonds. Industry employment is estimated to range from 1,000 to 1,500 workers (U.S. International Trade Commission, 1997, p. 1).

Most natural gemstone producers in the United States are small businesses that are widely dispersed and operate independently. The small producers probably have an average of less than three employees, including those who only work part time. The number of gemstone mines operating from year to year fluctuates because the inherent uncertainty associated with the discovery and marketing of gem-quality minerals makes it difficult to obtain financing for developing and sustaining economically viable deposits (U.S. International Trade Commission, 1997, p. 23).

The total value of natural gemstones produced in the United States during 2001 was estimated to be at least $15.1 million (table 3). The production value was 12% less than the preceding year. The production decrease was mostly because the 2001 shell harvest was 13% less than in 2000.

The estimate of 2001 U.S. gemstone production was based on a survey of more than 200 domestic gemstone producers conducted by the USGS. The survey provided a foundation for projecting the scope and level of domestic gemstone production during the year. However, the USGS survey did not represent all gemstone activity in the United States, which includes thousands of professional and amateur collectors. Consequently, the USGS supplemented its survey with estimates of domestic gemstone production from related published data, contacts with gemstone dealers and collectors, and information garnered at gem and mineral shows.

Natural gemstone materials indigenous to the United States are collected, produced, and/or marketed in every State. During 2001, all 50 States produced at least $1,000 worth of gemstone materials. Six States accounted for nearly 80% of the total value, as reported by survey respondents. These States, in order of declining value of production, were Tennessee, Arizona, California, Oregon, Utah, and Arkansas. Some States were known for the production of a single gemstone material—Tennessee for freshwater pearls and Arkansas for quartz, for example. Other States produced a variety of gemstones, like Arizona, whose gemstone deposits included agate, amethyst, azurite, chrysocolla, fire agate, garnet, jade, malachite, obsidian, onyx, peridot, petrified wood, opal, smithsonite, and turquoise. A wide variety of gemstones also are found in California, Idaho, Montana, and North Carolina.

There were only two operations in significant known diamond-bearing areas in the United States during 2001. The first, the Kelsey Lake Diamond Mine, is the only U.S. commercial diamond mine and is near Fort Collins, CO, in Colorado, close to the Wyoming State line. The mine is owned and operated by Great Western Diamond Co. (a subsidiary of McKenzie Bay International, Ltd., of Canada). The Kelsey Lake property includes nine known kimberlite pipes, of which three have been tested and have shown that diamonds are present. The remaining six pipes have yet to be fully explored and tested for their diamond potential. Of diamonds recovered, 50% to 65% were clear gem quality, and almost one-third were one carat or larger in size. The identified resources are at least 17 million metric tons (Mt) grading an average of 4 carats per hundred metric tons (Taylor Hard Money Advisers, 2000§[1])

[1]References that include a section twist (§) are found in the Internet References Cited section.

The second operation was in Crater of Diamonds State Park near Murfreesboro in Pike County, AR, where a dig-for-fee operation for tourists and rockhounds is maintained by the State. Crater of Diamonds is the only diamond mine in the world that is open to the public. The diamonds occur in a lamproite breccia tuff associated with an extinct volcanic pipe and in the soil developed from the lamproite breccia tuff. Since the diamond-bearing pipe and the adjoining area became a State park in 1972, over 21,000 diamonds have been recovered. Recent exploration demonstrated that there is about 78.5 Mt of diamond-bearing rock in this diamond deposit (Howard, 1999, p. 62). An Arkansas law, enacted early in 1999, prohibits commercial diamond mining in the park (Diamond Registry Bulletin, 1999).

Studies done by the Wyoming Geological Survey have shown that Wyoming has the potential for a $1 billion diamond mining business. Wyoming has many of the same geologic conditions as Canada, and there is evidence of hundreds of kimberlite pipes in the State. Twenty diamondiferous kimberlite pipes and one diamondiferous mafic breccia pipe have been identified in southern Wyoming. Two of the largest kimberlite fields, State Line and Iron Mountain, and the largest lamproite field, Leucite Hills, in the United States are located in Wyoming. There has been slight interest in the southern Wyoming and northern Colorado area by several diamond mining firms, but the only diamond mine developed in the area thus far is the Kelsey Lake mine. Individual diamond gems worth $89,000 and $300,000 have been found there (Montana Forum.com, 2002§).

In addition to natural gemstones, synthetic gemstones and gemstone simulants are produced in the United States. Synthetic gemstones have the same optical, physical, and chemical properties as the natural materials that they appear to be. Simulants have an appearance similar to that of a natural gemstone material, but they have different optical, physical, and chemical properties. Synthetic gemstones produced in the United States include alexandrite, diamond, emerald, moissanite, ruby, sapphire, turquoise, and zirconia. Simulants of coral, lapis lazuli, malachite, and turquoise also are manufactured in the United States. In addition, certain colors of synthetic sapphire and spinel, used to represent other gemstones, are classified as simulants.

Synthetic gemstone production in the United States was more than $24.7 million during 2001; simulant gemstone output was even greater and was estimated to be more than $100 million. Five firms in five States, representing virtually the entire U.S. synthetic gemstone industry, reported production to the USGS. The States with reported synthetic gemstone production were Arizona, California, Florida, New York, and North Carolina.

At least one U.S. company, Gemesis Corp., produces consistent quality and quantities of synthetic gem diamond and reported a second year of production in 2001. The synthetic diamonds are produced using technology, equipment, and expertise developed by a team of scientists from Russia and the University of Florida. The weight of the synthetic diamond stones ranged from 1.5 to 2 carats, and the stones are yellow, brownish yellow, colorless, and green (Weldon, 1999§).

In 2001, a North Carolina firm entered its fourth year of marketing moissanite, a gem-quality synthetic silicon carbide it produces. Moissanite is also an excellent diamond simulant, but it is being marketed for its own gem qualities.

Consumption

Although the United States accounts for less than 1% of total global gemstone production, it is the world's leading gemstone market. U.S. gemstone markets apparently accounted for about 35% of world gemstone demand in 2001. The U.S. market for unset gem-quality diamonds during the year was estimated to have exceeded $10.5 billion, the largest in the world. Domestic markets for natural, unset nondiamond gemstones totaled about $696 million.

A poll conducted by a U.S. jewelry retailers association in the mid-1990s showed that about two-thirds of domestic consumers who were surveyed designated diamond as their favorite gemstone (ICA Gazette, 1996). In 2001, the top-selling colored gemstones, in descending order, were blue sapphire, pearl, tanzanite, ruby, emerald, amethyst, green tourmaline, rhodolite garnet, fancy sapphire and pink tourmaline (tied), and blue topaz. During 2001, there was a shift in the price ranges of retail gemstone jewelry purchases from the $500 to $2,000 price range down to purchases in the under $500 price range (Wade, 2002§). Following terrorist attacks on September 11, consumer confidence was shaken, but the fourth quarter U.S. retail sales were up by 4% (by value), and Christmas season retail jewelry sales showed a 0.6% increase over Christmas 2000 (Diamond Registry Bulletin, 2002c; Donahue, 2002§). An unexpected effect on diamond and jewelry sales of the September 11 terrorist attacks was that purchases of engagement rings shot up enormously, and that trend continued through the end of 2001 (Diamond Registry Bulletin, 2001e). Despite the economic slowdown of the first half of 2001 and the economic effects of the events of September 11, the overall U.S. diamond jewelry sales for the year were $26.1 billion, down by only 1% from those of 2000. The small size of this drop was due to the stronger than expected fourth quarter (Diamond Registry Bulletin, 2002d; Donahue, 2002§).

In addition to jewelry, gemstones are used for collections, exhibits, and decorative art objects.

Prices

Gemstone prices are governed by many factors and qualitative characteristics, including beauty, clarity, defects, demand, durability, and rarity. Diamond pricing, in particular, is complex; values can vary significantly depending on time, place, and the subjective evaluations of buyers and sellers. There are more than 14,000 categories used to assess rough diamond and more than 100,000 different combinations of carat, clarity, color, and cut values used to assess polished diamond (Pearson, 1998).

Colored gemstone prices are generally influenced by market supply and demand considerations, and diamond prices are supported by producer controls on the quantity and quality of supply. Values and prices of gemstones produced and/or sold in the United States are listed in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported, exported, or reexported are listed in tables 6 through 10.

De Beers Group companies are a significant force affecting gem diamond prices worldwide because they mine about one-half of the diamonds produced each year. The companies also sort and valuate about two-thirds (by value) of the world's annual supply of rough diamonds through De Beers' subsidiary

Diamond Trading Co. (DTC), which has marketing agreements with other producers.

Foreign Trade

During 2001, total U.S. gemstone trade with all countries and territories exceeded $15.5 billion, which was approximately 11% less (by value) than gemstone trade of the previous year. Diamonds accounted for about 94% of the 2001 gemstone trade total. In 2001, U.S. exports and reexports of diamond were shipped to 61 countries and territories, and imports of all gemstones were received from 107 countries and territories (tables 6-10).

During 2001, U.S. trade in cut diamonds decreased by about 8% compared with the previous year; however, the United States remained the world's leading diamond importer. These decreases in trade amounts were attributed to the slowdown in the economy and the economic effects of the September 11 terrorist attacks.

The United States is a significant international diamond transit center as well as the world's largest gem diamond market. The large volume of reexports shipped to other centers reveals the significance that the United States has in the world's diamond supply network (table 6).

Synthetic gemstone trade also decreased for the United States in 2001. Imports of synthetic gems decreased by almost 13% during the year. Synthetic gemstone imports from Austria, China, Germany, Hong Kong, and Switzerland made up almost 83% (by value) of the total domestic imports of synthetic gemstones during the year. Prices of certain synthetic gemstone imports, such as amethyst, were very competitive. The marketing of synthetic imports and enhanced gemstones as natural gemstones and the mixing of synthetic materials with natural stones in imported parcels continued to be problems for some domestic producers in 2001. There were also problems with some simulants being marketed as synthetic gemstones during the year.

World Review

The gemstone industry worldwide has two distinct sectors—(1) diamond mining and marketing and (2) the production and sale of colored gemstones. Most diamond supplies are controlled by a few major mining companies; prices are supported by managing the quantity and quality of the gemstones relative to demand, a function performed by De Beers through DTC. Unlike diamonds, colored gemstones are primarily produced at relatively small, low-cost operations with few dominant producers; prices are influenced by consumer demand in addition to supply availability.

In 2001, world diamond production totaled about 117 million carats (table 11). Most production was concentrated in a few regions—Africa [Angola, Botswana, Congo (Kinshasa), Namibia, and South Africa], Asia (northeastern Siberia and Yakutia in Russia), Australia, North America (Northwest Territories in Canada), and South America (Brazil and Venezuela). In 2001, Botswana was the world's leading diamond producer in terms of output value and quantity.

De Beers reported that its sales of rough diamonds for 2001 were $4.45 billion, which was down by 21.5% from $5.7 billion in 2000. De Beers officials said that global retail diamond sales decreased by 5% in 2001 from those of the previous year. This consumption figure was higher than initially had been expected following events on September 11 (Weldon and Donahue, 2002§).

Statistics of the Diamond High Council of Belgium show that sales in the Antwerp diamond sector suffered a 12% drop in 2001 to $25.8 billion. Imports of diamonds into Antwerp decreased by 17% to $6.15 billion, and exports decreased by 18% to $5.72 billion (Diamond Registry Bulletin, 2002a).

Additional events in 2001 significant to diamond mining, production, and marketing worldwide include the following:

- The Ekati Diamond Mine, Canada's first and only operating commercial diamond mine, completed its third full year of production. In 2001, Ekati produced 3.7 million carats of diamonds from 3.3 Mt of ore mined (Darren R. Dyck, senior project geoscientist, BHP Billiton Diamonds Inc., written commun., 2002). The mine, located in the Northwest Territories in Canada, was a joint venture between BHP Diamonds Inc. (BHP) and Dia Met Minerals Ltd. In June, BHP's parent company BHP Ltd., merged with Billiton plc to create BHP Billiton Ltd., the world's largest mining company (BHP Billiton Ltd., 2001a; Diamond Registry Bulletin, 2001b). In July, BHP Billiton announced that it had agreed to purchase Dia Met (BHP Billiton Ltd., 2001b). Buying out Dia Met gave BHP Billiton an 80%, controling ownership of the Ekati mine (Diamond Registry Bulletin, 2001c). Ekati has estimated reserves of 60.3 Mt of ore in kimberlite pipes, containing 54.3 million carats of diamonds, and the mine life is projected to be 25 years. Operating at full capacity, Ekati production is expected to range from 3.5 to 4.5 million carats per year. Ekati diamonds are sold by the BHP Billiton Diamonds Inc. sales office in Antwerp (65%) and by DTC (35%) (Rombouts, 2001§). Near the end of 2001, BHP Billiton Diamonds started producing from the Misery kimberlite pipe (BHP Billiton Ltd., 2001c). The Ekati already accounts for 4% of the world market by weight and 6% by value (Law-West, 2002). In 2002, BHP Billiton will begin using underground mining techniques to recover diamonds from deeper portions of two of the Ekati kimberlite pipes— Koala and Panda—which were first open pit mined (Diamond Registry Bulletin, 2002b).
- The Diavik Diamonds Project also is located in the Northwest Territories. Diavik has estimated reserves of 25.6 Mt of ore in kimberlite pipes, containing 102 million carats of diamonds, and the mine life is projected to be 20 years. Diavik received the required permits and regulatory approval in 2000 and began site infrastructure development and project construction. Diavik is an unincorporated joint venture between Diavik Diamond Mines Inc. (60%) and Aber Diamond Mines Ltd. (40%), and it is expected to commence diamond production in the first half of 2003. The mine is expected to produce about 102 million carats of diamond at a rate of 6 million carats per year worth about $63 per carat (Diavik Diamond Mines Inc., 2000, p. 10-12).
- There is another Canadian commercial diamond project located in the Northwest Territories—the Snap Lake diamond project. De Beers Canada Mining Inc. acquired a 68% interest in the Snap Lake diamond project from Winspear Diamonds Inc. in 2000, and in early 2001, De Beers acquired the remaining 32% interest in the project from Aber Diamond Corp. Snap Lake will be De Beers' first mine outside southern Africa and the first underground diamond mine in Canada. In August, De Beers Canada announced that Snap Lake would begin

production in 2006 (Law-West, 2002; De Beers Canada Mining Inc., 2001§). Snap Lake has estimated reserves of 22.8 Mt of ore in a kimberlite dike, containing 38.8 million carats of diamonds, and the mine life is projected to be 20 years or more (De Beers Canada Mining Inc., [2000]§; Jack T. Haynes, assistant site manager, De Beers Canada Mining Inc., oral commun., 2001).

Another Canadian commercial diamond project is the Jericho diamond project located in Nunavut. In 2000, Tahera Corp. completed a feasibility study that indicated that Jericho will produce 3 million carats over an 8-year mine life. Tahera has discovered five kimberlite pipes, of which three are landbased. Geological models indicate a resource of approximately 17 Mt to a depth of 300 meters, with grades ranging from 0.3 carats per metric ton to 1.0 carats per ton for the kimberlite pipes. In early 2001, Tahera filed a formal project proposal and a draft environmental impact statement for the Jericho project. These filings marked the beginning of the environmental assessment and regulatory approval process for the proposed Jericho diamond mine (Law-West, 2002; Tahera Corp., 2002§).

- In May, De Beers Consolidated Mines Ltd. completed its privatization and was delisted from the Johannesburg Stock Exchange. The company was purchased by a consortium that included the Oppenheimer family, Anglo American plc, and Debswana Diamond Co. (Pty) Ltd. The company is now the world's largest private diamond mining company. The privatization left De Beers heavily in debt, made the company much less transparent, and had no effect on the company's antitrust issues (Diamond Registry Bulletin, 2001d).
- In 2001, conflict diamonds—those rough diamonds used by rebel forces and their allies to help finance warfare aimed at subverting governments recognized as legitimate by the United Nations (U.N.)—continued to partially finance conflicts in Angola, Congo (Kinshasa), and Sierra Leone.

The United Nations Security Council (UNSC) has enacted sanctions against exports of diamonds from Angola and Sierra Leone without official government-issued certificates of origin into U.N. member countries. Any export of rough diamonds from Liberia also is currently under UNSC sanction because Liberia was allowing the export of conflict diamonds through their country.

In November, an international diamond certification system called the Kimberley process was mandated by the U.N. to deal with the problem of conflict diamonds (Diamond Registry Bulletin, 2001f). The Kimberley process was acceptable to the U.N., the U.S. Congress, the diamond industry, and involved nongovernmental organizations (Diamond Registry Bulletin, 2001a). The certification system includes the following key elements: the use of forgery-resistant certificates and tamper-proof containers for shipments of rough diamonds; internal controls and procedures that provide credible assurance that conflict diamonds do not enter the legitimate diamond market; a certification process for all exports of rough diamonds; the gathering, organizing, and sharing of import and export data on rough diamonds with other participants of relevant production; credible monitoring and oversight of the international certification scheme for rough diamonds; effective enforcement of the provisions of the certification scheme through dissuasive and proportional penalties for violations; self-regulation by the diamond industry that fulfills minimum requirements; and the sharing of information with all other participants on relevant rules, procedures, and legislation as well as examples of national certificates used to accompany shipments of rough diamonds (Weldon, 2001§). The Kimberley process will be fully implemented by the end of 2002 (Law-West, 2002).

- In the United States, the Clean Diamond Trade Act, which will implement effective measures to stop trade in conflict diamonds, was introduced in the House of Representatives on August 2, and passed on November 28. The act has already been introduced in the Senate and is expected to pass in the fall of 2002.
- Gemesis Corp., a synthetic gem diamond producer based in Florida, announced that it will be opening a $25 million manufacturing plant in the summer of 2002. In 2½ years, the plant could house 300 diamond-producing machines and could produce 30,000 to 40,000 stones each year. Gemesis' revenues could reach $70 to $80 million per year (Diamond Registry Bulletin, 2001g).
- Towards the end of 2001, De Beers quietly settled private civil class actions related to the industrial diamonds case in Ohio against De Beers Industrial Diamonds Division (Pty) Ltd. and General Electric Co. The settlement establishes a $20 million cash fund plus interest and also provides for payment of an in-kind rebate of industrial diamonds that "class members" purchase from the plaintiffs during the period from January 1, 2002, to December 31, 2003; such a settlement does not legally constitute a formal admission of guilt. The settlement covered an alleged illegal price fixing that took place during a period from November 1, 1987, through May 23, 1994. The timing of the settlement should be viewed in the context of the current policy of De Beers to conform with local laws of each jurisdiction in which the company conducts business. This settlement might be used as a precedent for a present gem-quality diamond class action still before courts in New York (Tacy Diamond Intelligence, 2002§).

Worldwide production of natural gemstones other than diamond was estimated to have exceeded $2 billion per year in the late 1990s. Most nondiamond gemstone mines are small, low-cost, and widely dispersed operations in remote regions of developing nations. Foreign countries with major gemstone deposits other than diamond are Afghanistan (aquamarine, beryl, emerald, kunzite, lapis lazuli, ruby, and tourmaline); Australia (beryl, opal, and sapphire); Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline); Burma (beryl, jade, ruby, sapphire, and topaz); Colombia (beryl, emerald, and sapphire); Kenya (beryl, garnet, and sapphire); Madagascar (beryl, rose quartz, sapphire, and tourmaline); Mexico (agate, opal, and topaz); Sri Lanka (beryl, ruby, sapphire, and topaz); Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline); and Zambia (amethyst and beryl). In addition, pearls are cultured throughout the South Pacific and in other equatorial waters; Australia, China, French Polynesia, and Japan are key producers.

Colored gemstone producers continued their recovery from the weakened markets created by the Asian economic crisis of 1997 through 1998. Mining and sales reportedly were disrupted in many nations, particularly in Southeast Asia. Prices of high-quality colored gemstones, however, did not decline dramatically (Cavey, 1998).

Additional noteworthy items in the colored gemstone industry during 2001 included the following:

● The fighting and political chaos that followed September 11 disrupted the production and supply of gemstones in Afghanistan. Gem dealers are optimistic that the interim government will stabilize Afghanistan and the disruption will be temporary. Many Afghani gemstones mentioned above are mined in the northern areas of the country (Prost, 2001§).
● The popularity of colorful gemstones, colored synthetic gemstones, and "fancy" colored diamonds (even black diamonds) continued to increase. This was evidenced by increased sales in 2001 (Jewelers' Circular Keystone, 2001).

Outlook

While it is hard to determine from the mixed indicators whether or not the 2002 U.S. economy is in recovery, there are early indications that there will be growth in U.S. diamond and jewelry markets in 2002 (Diamond Registry Bulletin, 2002e). Historically, diamonds have proven to hold their value despite wars or depressions in the economy (Schumann, 1998, p. 8).

Diamond exploration is continuing in Canada, and many new deposits are being found. There have been additional discoveries in both the core and buffer zones of the Ekati lease as well as additional discoveries in the Northwest Territories and Nunavut. Many diamond-bearing deposits also have been discovered in Alberta, Ontario, Quebec, and Saskatchewan (Rombouts, 2001§). When the Diavik, Snap Lake, and Jericho mines begin production, Canada will be producing at least 15% to 20% of the total world diamond production. This means that Canada will probably eclipse South Africa's diamond production within a decade.

Independent producers, such as Argyle Diamond Mines in Australia and new mines in Canada, will continue to bring a greater measure of competition to global markets. More competition presumably will bring more supplies and lower prices. Further consolidation of diamond producers and larger amounts of rough diamond being sold outside the DTC will continue as the diamond industry continues to adjust to De Beers giving up its control of the industry.

Numerous synthetics, simulants, and treated gemstones will enter the marketplace and necessitate more transparent trade industry standards to maintain customer confidence.

Pending enactment of the Clean Diamond Trade Act by the U.S. Congress by the end of 2002 and the final outcome of the Kimberley process and its international certification scheme, the way business is done in the diamond industry will be impacted so that conflict diamonds hopefully will no longer be a problem for the industry.

More diamonds, gemstones, and jewelry will be sold through online marketplaces and other forms of e-commerce that emerge to serve the diamond and gemstone industry. This will take place as the industry and its customers become more comfortable with and learn the best applications of new e-commerce tools for the gemstone industry (Authority on Jewelry Manufacturing, 2001).

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TABLE 1
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0-2.5	1.0-1.1	Single	1.54	Synthetic or pressed plastics, kaurigum	Fossil resin, color, low density, soft and trapped insects.
Apatite	Chloro-calcium phosphate	Colorless, pink, yellow, green, blue, violet	Small	Low	5.0	3.16-3.23	Double	1.63-1.65	Amblygonite, andalusite, brazilianite, precious beryl, titanite, topaz, tourmaline	Crystal habit, color, hardness, and appearance.
Azurite	Copper carbonate hydroxide	Azure, dark blue, pale blue	Small to medium	do.	3.5-4.0	3.7-3.9	do.	1.72-1.85	Dumortierite, hauynite, lapis lazuli, lazulite, sodalite	Color, softness, crystal habits and associated minerals.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	do.	High	6.0-6.5	3.64-3.68	do.	1.76-1.80	Sapphire, tanzanite, blue diamond, blue tourmaline, cordierite	Strong blue in ultraviolet light.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5-8.0	2.63-2.80	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	Red	Small	Very high	7.5-8.0	2.63-2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald	do.	Green	Medium	do.	7.5	2.63-2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5-8.0	2.63-2.80	do.	1.58	Genuine emerald	Lack of flaws, brilliant fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5-8.0	2.63-2.80	do.	1.58	Citrine, topaz, glass, doublets	Weak-colored.
Goshenite	do.	Colorless	do.	Low	7.5-8.0	2.63-2.80	do.	1.58	Quartz, glass, white sapphire, white topaz	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5-8.0	2.63-2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49-1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.60	do.	Banded, translucent.
Charoite	Hydrated sodium calcium hydroxi-fluoro-silicate	Lilac, violet, or white	Small to medium	do.	5.0-6.0	2.54-2.78	XX	1.55-1.56	Purple marble	Color, locality
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day light, red by artificial light	Small (former U.S.S.R.) Medium (Sri Lanka)	High	8.5	3.50-3.84	Double	1.75	Synthetic	Strong dichroism, color varies from red to green, hardness.
Cats-eye	do.	Greenish to brownish	Small to large	do.	8.5	3.50-3.84	do.	1.75	Synthetic, shell	Density, translucence, chatoyance.
Chrysolite	Beryllium aluminate	Yellow, green, and/or brown	Medium	Medium	8.5	3.50-3.84	Double	1.75	Tourmaline, peridot	Refractive index, silky.

See footnotes at end of table.

TABLE 1--Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Chrysoberyl--Continued:										
Chrysocolla	Hydrated copper silicate	Green, blue	Any	Low	2.0-4.0	2.0-2.4	XX	1.46-1.57	Azurite, dyed chalcedony, malachite, turquoise, variscite	Lack of crystals, color, fracture, low density and softness.
Coral	Calcium carbonate	Orange, red, white, black, purple, or green	Branching, medium	do.	3.5-4.0	2.6-2.7	Double	1.49-1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95-4.10	do.	1.78	Synthetics, including spinel, garnet	Inclusions, fluorescence.
Sapphire, blue	do.	Blue	Medium	High	9.0	3.95-4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, colorless, orange, green, or violet	Medium to large	Medium	9.0	3.95-4.10	do.	1.78	Synthetics, glass and doublets, morganite	Inclusions, double refraction, refractive index.
Sapphire and ruby, stars	do.	Red, pink, violet, blue, or gray	do.	High to low	9.0	3.95-4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.
Sapphire or ruby, synthetic	do.	Yellow, pink, or blue	Up to 20 carats	Low	9.0	3.95-4.10	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Cubic zirconia	Zirconium and yttrium oxides	Colorless, pink, blue, lavender, yellow	Small	do.	8.25-8.5	5.8	Single	2.17	Diamond, zircon, titania, moissanite	Hardness, density, refractive index, lack of flaws and inclusions.
Diamond	Carbon	White, blue-white, yellow, brown, green, red, pink, blue	Any	Very high	10.0	3.516-3.525	do.	2.42	Zircon, titania, cubic zirconia, moissanite	High index, dispersion, hardness, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green-blue	Large	Low	6.0-6.5	2.56	XX	1.52	Jade, turquoise	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play (schiller)	do.	do.	6.0-6.5	2.56	XX	1.56	do.	Do.
Moonstone	do.	Colorless, white, gray, or yellow with white, blue, or bronze schiller	do.	do.	6.0-6.5	2.77	XX	1.52-1.54	Glass, chalcedony, opal	Pale sheen, opalescent.
Sunstone	do.	Orange, red brown, colorless with gold or red glittery schiller	Small to medium	do.	6.0-6.5	2.77	XX	1.53-1.55	Aventurine, glass	Red glittery schiller.
Garnet	Complex silicate	Brown, black, yellow, green, red, or orange	do.	Low to high	6.5-7.5	3.15-4.30	Single strained	1.79-1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Hematite	Iron oxide	Black, black-gray, brown-red	Medium to large	Low	5.5-6.5	5.12-5.28	XX	2.94-3.22	Davidite, cassiterite, magnetite, neptunite, pyrolusite, wolframite	Crystal habit, streak and hardness.
Jade:										
Jadeite	Complex silicate	Green, yellow, black, white, or mauve	Large	Low to very high	6.5-7.0	3.3-3.5	Crypto-crystalline	1.65-1.68	Nephrite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.

See footnotes at end of table.

TABLE 1--Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Jade--Continued:										
Nephrite	Complex hydrous silicate	Green, yellow, black, white, or mauve	Large	Low to very high	6.0-6.5	2.96-3.10	Crypto-crystalline	1.61-1.63	Jadeite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.
Jet (gagate)	Lignite	Deep black, dark brown	do.	Low	2.5-4.0	1.19-1.35	XX	1.64-1.68	Anthracite, asphalt, cannel coal, onyx, schorl, glass, rubber	Luster, color.
Lapis lazuli	Sodium calcium aluminum silicate	Dark azure-blue to bright indigo blue or even a pale sky blue.	do.	do.	5.0-6.0	2.50-3.0	XX	1.50	Azurite, dumortierite, dyed howlite, lazulite, sodalite, glass	Color, crystal habit, associated minerals, luster, and localities.
Malachite	Hydrated copper carbonate	Light to black-green banded	do.	do.	3.5-4.0	3.25-4.10	XX	1.66-1.91	Brochantite, chrysoprase, opaque green gemstones	Color banding, softness, associated minerals.
Moissanite	Silicon carbide	Colorless and pale shades of green, blue, yellow	Small	Low to medium	9.25	3.21	Double	2.65-2.69	Diamond, zircon, titania, cubic zirconia	Hardness, dispersion, refractive index, lack of flaws and inclusions.
Obsidian	Amorphous, variable (usually felsic)	Black, gray, brown, dark green, white, transparent	Large	Low	5.0-5.5	2.35-2.60	XX	1.45-1.55	Aegirine-augite, gadolinite gagate, hematite, pyrolusite, wolframite	Color, conchoidal fracture, flow bubbles, softness, and lack of crystal faces.
Opal	Hydrated silica	Reddish orange, colors flash in white gray, black, red, or yellow	do.	Low to high	5.5-6.5	1.9-2.3	Single	1.45	Glass, synthetics, triplets, chalcedony	Color play (opalescence).
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5-7.0	3.27-3.37	Double (strong)	1.65-1.69	Tourmaline, chrysoberyl	Strong double refraction, low dichroism.
Quartz:										
Agate	Silicon dioxide	Any	Large	Low	7.0	2.58-2.64	XX	XX	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65-2.66	Double	1.55	Glass, plastic, fluorite	Macrocrystalline, refractive index, color, transparent, hardness.
Aventurine	do.	Green, red-brown, gold-brown, with metallic iridescent reflection	do.	Low	7.0	2.64-2.69	do.	1.54-1.55	Iridescent analcime, aventurine feldspar, emerald, aventurine glass	Macrocrystalline, color, metallic iridescent flake reflections, hardness.
Cairngorm	do.	Smoky orange or yellow	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Macrocrystalline, refractive index, color, transparent, hardness.
Carnelian	do.	Flesh red to brown red	do.	do.	6.5-7.0	2.58-2.64	do.	1.53-1.54	Jasper	Cryptocrystalline, color, hardness.
Chalcedony	do.	Bluish, white, gray	do.	do.	6.5-7.0	2.58-2.64	do.	1.53-1.54	Tanzanite	Do.
Chrysoprase	do.	Green, apple-green	do.	do.	6.5-7.0	2.58-2.64	do.	1.53-1.54	Chrome chalcedony, jade, prase opal, prehnite, smithsonite, variscite, artifically colored green chalcedony	Do.
Citrine	Silica	Yellow	Large	Low	7.0	2.65-2.66	Double	1.55	do.	Macrocrystalline, refractive index, color, transparent, hardness.
Crystal, rock	do.	Colorless	do.	do.	7.0	2.65-2.66	do.	1.55	Topaz, colorless sapphire	Do.
Jasper	Silica	Any, striped, spotted, or sometimes uniform	do.	do.	7.0	2.58-2.66	XX	XX	Topaz, colorless sapphire	Cryptocrystalline, opaque, vitreous luster, hardness.

See footnotes at end of table.

TABLE 1--Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Quartz--Continued:										
Onyx	Silica	Many colors	Large	Low	7.0	2.58-2.64	XX	XX	Topaz, colorless sapphire	Cryptocrystalline, uniformly banded, hardness.
Petrified wood	do.	Brown, gray, red, yellow	do.	do.	6.5-7.0	2.58-2.91	Double	1.54	Agate, jasper	Color, hardness, wood grain.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Macrocrystalline, refractive index, color, transparent, hardness.
Tiger's eye	do.	Golden yellow, brown, red, blue-black	do.	do.	6.5-7.0	2.58-2.64	XX	1.53-1.54	XX	Macrocrystalline, color, hardness, chatoyancy.
Rhodochrosite	Manganese carbonate	Rose-red to yellowish, stripped	do.	do.	4.0	3.45-3.7	Double	1.6-1.82	Fire opal, rhodonite, tugtupite, tourmaline	Color, crystal habit, reaction to acid, and perfect rhombohedral cleavage.
Rhodonite	Manganese iron calcium silicate	Dark red, flesh red, with dendritic inclusions of black manganese oxide	do.	do.	5.5-6.5	3.40-3.74	do.	1.72-1.75	Rhodochrosite, thulite, hessonite, pyroxmangite, spessartine, spinel, tourmaline	Color, black inclusions, lack of reaction to acid and hardness.
Shell:										
Mother-of-pearl	Calcium carbonate	White, cream, green, blue-green, with iridescent play of color	Small	Low	3.5	2.6-2.85	XX	XX	Glass and plastic imitation	Luster, iridescent play of color.
Pearl	do.	White, cream to black, sometimes with hint of pink, green, purple	do.	Low to high	2.5-4.5	2.6-2.85	XX	XX	Cultured and glass or plastic imitation	Luster, iridescence, structure, x ray.
Spinel	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5-3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5-3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5-7.0	3.13-3.20	do.	1.66	Synthetic spinel	Refractive index, color, pleochroism.
Kunzite	do.	Pink to lilac	do.	do.	6.5-7.0	3.13-3.20	do.	1.66	Amethyst, morganite	Refractive index, color, pleochroism.
Tanzanite	Complex silicate	Blue to lavender	Small	High	6.0-7.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism, color.
Topaz	do.	White, blue, green, pink, yellow, gold	Medium	Low to medium	8.0	3.4-3.6	do.	1.62	Beryl, quartz	Color, density, hardness, refractive index, perfect in basal cleavage.
Tourmaline	do.	Any, including mixed	do.	do.	7.0-7.5	2.98-3.20	do.	1.63	Peridot, beryl, garnet corundum, glass	Double refraction, color, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green with black, brown-red inclusions	Large	Low	6.0	2.60-2.83	Double	1.63	Glass, plastics, variscite, dumortierite, chrysocolla, dyed howlite	Difficult if matrix not present, matrix usually limonitic.
Unakite	Granitic rock, feldspar, epidote, quartz	Olive green, pink, and blue-gray	do.	do.	6.0-7.0	2.60-3.20	XX	XX	XX	Olive green, pink, and gray-blue colors.
Zircon	Zirconium silicate	White, blue, brown, yellow, or green	Small to medium	Low to medium	6.0-7.5	4.0-4.8	Double (strong)	1.79-1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

XX Not applicable.
1/ Small: up to 5 carats; medium: 5 to 50 carats; large: more than 50 carats.
2/ Low: up to $25 per carat; medium: up to $200 per carat; high: more than $200 per carat.

TABLE 2
SYNTHETIC GEMSTONE PRODUCTION METHODS

Gemstone	Production method	Company/producer	Date of first production
Alexandrite	Flux	Creative Crystals	1970s
Do.	Melt pulling	J.O. Crystal	1990s
Do.	do.	Kyocera	1980s
Do.	Zone melt	Seiko	1980s
Cubic zirconia	Skull melt	Various producers	1970s
Emerald	Flux	Chatham	1930s
Do.	do.	Gilson	1960s
Do.	do.	Kyocera	1970s
Do.	do.	Seiko	1980s
Do.	do.	Lennix	1980s
Do.	do.	Russia	1980s
Do.	Hydrothermal	Lechleitner	1960s
Do.	do.	Regency	1980s
Do.	do.	Biron	1980s
Do.	do.	Russia	1980s
Ruby	Flux	Chatham	1950s
Do.	do.	Kashan	1960s
Do.	do.	J.O. Crystal	1980s
Do.	do.	Douras	1990s
Do.	Zone melt	Seiko	1980s
Do.	Melt pulling	Kyocera	1970s
Do.	Verneuil	Various producers	1900s
Sapphire	Flux	Chatham	1970s
Do.	Zone melt	Seiko	1980s
Do.	Melt pulling	Kyocera	1980s
Do.	Verneuil	Various producers	1900s
Star ruby	do.	Linde	1940s
Do.	Melt pulling	Kyocera	1980s
Do.	do.	Nakazumi	1980s
Star sapphire	Verneuil	Linde	1940s

TABLE 3
VALUE OF U.S. GEMSTONE PRODUCTION, BY TYPE 1/

(Thousand dollars)

Gem materials	2000	2001
Agate	(2/)	(2/)
Beryl	(2/)	(2/)
Coral (all types)	(2/)	83
Diamond	(3/)	(3/)
Garnet	78	294
Gem feldspar	314	(2/)
Geode/nodules	59	375
Jasper	30	43
Opal	219	44
Quartz	416	308
Sapphire/ruby	65	152
Shell	3,270	2,860
Topaz	8	(2/)
Tourmaline	54	334
Turquoise	(2/)	(2/)
Other	9,210	8,350
Total	17,200	15,100

1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Included in "Total."
3/ Included with "Other."

TABLE 4
PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY IN 2001 1/

Carat weight	Description, color 3/	Clarity 2/ (GIA terms)	Representative prices January 4/	June 5/	December 6/
0.25	G	VS1	$1,500	$1,500	$1,200
.25	G	VS2	1,380	1,380	1,150
.25	G	SI1	1,130	1,130	975
.25	H	VS1	1,400	1,400	1,100
.25	H	VS2	1,250	1,250	1,000
.25	H	SI1	1,050	1,050	925
.50	G	VS1	3,400	3,400	3,200
.50	G	VS2	3,000	3,000	2,800
.50	G	SI1	2,500	2,500	2,400
.50	H	VS1	3,000	3,000	2,800
.50	H	VS2	2,700	2,700	2,400
.50	H	SI1	2,400	2,400	2,200
.75	G	VS1	3,800	3,800	3,800
.75	G	VS2	3,600	3,600	3,600
.75	G	SI1	3,300	3,300	3,300
.75	H	VS1	3,650	3,650	3,500
.75	H	VS2	3,450	3,450	3,450
.75	H	SI1	3,100	3,100	3,000
1.00	G	VS1	5,900	5,900	5,800
1.00	G	VS2	5,700	5,700	5,500
1.00	G	SI1	5,000	5,000	4,800
1.00	H	VS1	5,500	5,500	5,200
1.00	H	VS2	5,300	5,300	4,900
1.00	H	SI1	4,800	4,800	4,700

1/ Data are rounded to no more than three significant digits.
2/ Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; G, H, I—traces of color.
3/ Clarity: IF—no blemishes; VVS1—very, very slightly included; VS1—very slightly included; VS2—very slightly included, but not visible; SI1—slightly included.
4/ Source: Jewelers' Circular Keystone, v. 172, no. 2, February 2001, p. 66.
5/ Source: Jewelers' Circular Keystone, v. 172, no. 7, July 2001, p. 50.
6/ Source: Jewelers' Circular Keystone, v. 173, no. 1, January 2002, p. 49.

TABLE 5
PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES IN 2001

Gemstone	Price range per carat January 1/	December 2/
Amethyst	$7-$14	$7-$14
Blue sapphire	800-1,300	800-1,300
Blue topaz	3-5	3-5
Emerald	1,300-2,000	1,300-2,000
Green tourmaline	70-125	70-125
Pearl: 3/		
Cultured saltwater	5	5
Natural	210	210
Pink tourmaline	75-125	75-125
Rhodolite garnet	18-30	18-30
Ruby	1,700-2,200	1,700-2,200
Tanzanite	250-350	300-400

1/ Source: The Guide, spring/summer 2001, p. 14, 30, 43, 59, 71, 85, 95, 97, 103, 125, and 137. These figures are approximate current wholesale purchase prices paid by retail jewelers on a per stone basis for fine-quality stones.
2/ Source: The Guide, fall/winter 2001-2002, p. 14, 30, 43, 59, 71, 85, 95, 97, 103, 125, and 137. These figures are approximate wholesale purchase prices paid by retail jewelers on a per stone basis for fine-quality stones.
3/ Prices are per 4.6 mm pearl.

TABLE 6
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF
INDUSTRIAL DIAMOND), BY COUNTRY 1/

Country	2000 Quantity (carats)	2000 Value 2/ (millions)	2001 Quantity (carats)	2001 Value 2/ (millions)
Exports:				
Belgium	114,000	$248	573,000	$454
Canada	123,000	39	98,800	29
France	30,300	67	35,400	135
Germany	17,300	6	23,400	4
Guatemala	34,300	8	135,000	13
Hong Kong	111,000	150	336,000	125
India	109,000	36	294,000	35
Israel	268,000	354	575,000	512
Japan	23,100	60	35,400	27
Mexico	155,000	23	91,500	20
Netherlands	12,400	3	36,600	7
Switzerland	73,100	143	102,000	163
Thailand	13,100	12	85,500	15
United Kingdom	74,600	64	42,300	68
Other	117,000 r/	70 r/	133,000	96
Total	1,270,000	1,280	2,600,000	1,700
Reexports:				
Belgium	3,850,000	666	1,340,000	565
Canada	105,000	49	117,000	47
Dominican Republic	24,700	3	52,600	7
Hong Kong	3,260,000	396	1,390,000	347
India	600,000	79	723,000	92
Israel	4,770,000	1,010	1,760,000	899
Japan	259,000	34	91,100	32
Malaysia	56,800	4	16,700	4
Mexico	190,000	27	29,100	4
Singapore	259,000	32	76,400	14
Switzerland	477,000	187	277,000	130
Thailand	247,000	28	185,000	25
United Arab Emirates	72,100	13	194,000	27
United Kingdom	455,000	94	103,000	102
Other	354,000 r/	76 r/	68,100	49
Total	15,000,000	2,700	6,420,000	2,340
Grand total	16,300,000	3,980	9,010,000	4,050

r/ Revised.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Customs value.

Source: U.S. Census Bureau.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY 1/

	2000		2001	
Kind, range, and country of origin	Quantity (carat)	Value 2/ (millions)	Quantity (carat)	Value 2/ (millions)
Rough or uncut, natural: 3/				
Belgium	431,000	$190	73,800	$75
Botswana	--	--	4,880	12
Brazil	29,500	9	16,800	8
Canada	10,900	2	8,650	9
Congo (Brazzaville)	7,860	15	4,750	10
Congo (Kinshasa)	2,290	10	15,200	10
Ghana	699,000	36	20,400	3
Guinea	4,390	8	7,060	14
Guyana	14,700	1	34,500	4
Hong Kong	635	1	3,780	4
Israel	19,200	20	9,120	10
Russia	4,240	1	24,400	11
South Africa	136,000	194	297,000	290
United Kingdom	538,000	185	367,000	84
Venezuela	6,870	2	6,110	3
Other	372,000 r/	68 r/	6,880	5
Total	2,280,000	741	900,000	550
Cut but unset, not more than 0.5 carat:				
Australia	520	(4/)	3,440	(4/)
Belgium	769,000	221	731,000	216
Brazil	13,400	3	12,600	2
Canada	2,070	1	3,320	1
China	34,100	8	33,800	7
Dominican Republic	1,010	(4/)	6,970	1
Hong Kong	466,000	79	316,000	59
India	11,600,000	2,050	9,050,000	1,510
Israel	1,150,000	693	992,000	535
Japan	3,950	2	7,980	3
Mexico	3,900	3	140,000	12
Singapore	6,210	2	9,240	2
Sri Lanka	5,600	1	10,500	2
Switzerland	133,000	9	10,900	4
Thailand	127,000	18	77,700	14
United Arab Emirates	132,000	19	86,500	21
United Kingdom	11,700	3	7,490	7
Other	38,800 r/	12 r/	22,000	9
Total	14,500,000	3,120	11,500,000	2,410
Cut but unset, more than 0.5 carat:				
Belgium	1,330,000	2,170	1,100,000	1,840
Canada	2,830	9	3,910	14
France	2,110	16	7,150	31
Hong Kong	105,000	139	192,000	145
India	639,000	461	673,000	406
Israel	2,740,000	4,630	2,550,000	4,560
Japan	14,800	13	5,110	13
Mauritius	3,240	7	3,770	7
Russia	45,100	61	62,900	112
South Africa	34,100	140	24,100	161
Switzerland	34,200	263	13,700	118
Thailand	23,800	27	9,100	9
United Arab Emirates	7,190	8	19,700	17
United Kingdom	22,100	100	15,700	118
Other	42,300 r/	89 r/	23,300	72
Total	5,040,000	8,140	4,710,000	7,630

r/ Revised. -- Zero.

1/ Data are rounded to no more than three significant digits; may not add to totals shown.

2/ Customs value.

3/ Includes some natural advanced diamond.

4/ Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY 1/

Kind and country	2000 Quantity (carats)	2000 Value 2/ (millions)	2001 Quantity (carats)	2001 Value 2/ (millions)
Emerald:				
Australia	2	(3/)	161,000	(3/)
Belgium	10,600	$2	11,700	$2
Brazil	6,750,000	8	2,050,000	6
China	1,060	(3/)	2,120	(3/)
Colombia	1,620,000 r/	66	1,070,000	58
Germany	40,700	2	29,700	1
Hong Kong	240,000	9	354,000	6
India	3,110,000	32	2,040,000	20
Israel	181,000	30	127,000	26
Japan	48	(3/)	16,900	1
Sri Lanka	29,100	1	41,000	2
Switzerland	137,000	15	36,300	10
Taiwan	526	(3/)	83	(3/)
Thailand	258,000	4	287,000	5
United Kingdom	3,630	1	5,770	1
Zambia	15,300	2	106,000	1
Other	36,300 r/	5	32,000	3
Total	12,400,000 r/	176	6,370,000	141
Ruby:				
Belgium	2,120	1	500	1
Brazil	6,020	(3/)	134	(3/)
Burma	55,900	4	9,740	3
China	1,170	(3/)	8,940	(3/)
Colombia	1,840	(3/)	328	(3/)
Germany	16,300	1	24,800	(3/)
Hong Kong	253,000	10	123,000	4
India	1,600,000	5	762,000	2
Israel	37,800	3	26,500	1
Japan	9,280	(3/)	28,400	(3/)
Pakistan	6,400	(3/)	1,400	(3/)
Sri Lanka	5,660	1	4,260	1
Switzerland	32,100	7	26,400	10
Thailand	2,450,000	46	1,940,000	43
United Kingdom	5,590	4	21,800	2
Other	21,000 r/	4	25,700	2
Total	4,500,000	85	3,000,000	69
Sapphire:				
Australia	7,320	1	3,270	(3/)
Belgium	3,000	1	1,720	1
Brazil	6,590	(3/)	642	(3/)
Burma	8,720	2	395	1
Canada	699	1	250	(3/)
China	30,000	(3/)	15,100	(3/)
Colombia	43,100	(3/)	3,680	(3/)
France	1,740	1	1,670	1
Germany	53,700	1	42,500	1
Hong Kong	326,000	11	281,000	8
India	1,160,000	4	873,000	5
Israel	63,100	5	40,700	3
Sri Lanka	492,000	25	294,000	20
Switzerland	50,400	17	36,900	12
Thailand	6,000,000	81	4,470,000	66
United Kingdom	13,800	3	17,500	3
Other	134,000 r/	5 r/	65,900	2
Total	8,400,000	156	6,150,000	122

See footnotes at end of table.

TABLE 8--Continued
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY 1/

Kind and country	2000 Quantity (carats)	2000 Value 2/ (millions)	2001 Quantity (carats)	2001 Value 2/ (millions)
Other:				
Rough, uncut:				
Australia	NA	$4	NA	$4
Brazil	NA	15	NA	13
China	NA	1	NA	1
Colombia	NA	2	NA	(3/)
Fiji	NA	2	NA	2
Hong Kong	NA	1	NA	1
India	NA	1	NA	2
Indonesia	NA	2	NA	2
Kenya	NA	(3/)	NA	(3/)
Nigeria	NA	(3/)	NA	(3/)
Pakistan	NA	1	NA	1
Philippines	NA	1	NA	1
Russia	NA	(3/)	NA	(3/)
South Africa	NA	2	NA	1
Switzerland	NA	(3/)	NA	(3/)
Taiwan	NA	(3/)	NA	(3/)
Tanzania	NA	1	NA	1
Thailand	NA	11	NA	1
United Kingdom	NA	1	NA	1
Zambia	NA	5	NA	(3/)
Other	NA	9	NA	7
Total	NA	56	NA	38
Cut, set and unset:				
Australia	NA	18	NA	16
Austria	NA	1	NA	1
Brazil	NA	10	NA	7
Canada	NA	1	NA	1
China	NA	13	NA	12
Columbia	NA	(3/)	NA	1
French Polynesia	NA	5	NA	5
Germany	NA	17	NA	15
Hong Kong	NA	56	NA	44
India	NA	81	NA	82
Indonesia	NA	1	NA	1
Israel	NA	11	NA	5
Japan	NA	10	NA	20
Mexico	NA	1	NA	2
South Africa	NA	2	NA	1
Sri Lanka	NA	6	NA	6
Switzerland	NA	3	NA	2
Taiwan	NA	2	NA	1
Tanzania	NA	13	NA	10
Thailand	NA	33	NA	27
United Kingdom	NA	6	NA	8
Other	NA	4 r/	NA	3
Total	NA	294	NA	268

r/ Revised. NA Not available.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Customs value.
3/ Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 9
VALUE OF U.S. IMPORTS OF SYNTHETIC AND
IMITATION GEMSTONES, BY COUNTRY 1/

(Thousand dollars) 2/

Country	2000	2001
Synthetic, cut but unset:		
Australia	97	224
Austria	6,670	2,980
Belgium	11	80
Brazil	136	62
China	13,500	13,700
France	1,020	974
Germany	10,300	10,000
Hong Kong	2,990	2,410
India	795	819
Italy	289	43
Japan	69	53
Korea, Republic of	2,510	1,360
Netherlands	231	74
Singapore	148	157
Spain	10	31
Sri Lanka	612	1,250
Switzerland	6,410	7,530
Taiwan	708	464
Thailand	3,820	1,970
Other	610 r/	165
Total	50,900	44,300
Imitation: 3/		
Austria	59,100	64,800
China	990	1,330
Czech Republic	11,200	13,700
Germany	1,250	1,140
Hong Kong	161	255
India	850	355
Italy	167	207
Japan	756	400
Korea, Republic of	859	1,120
Spain	45	147
Taiwan	274	245
Other	540 r/	497
Total	76,200	84,300

r/ Revised.
1/ Data are rounded to no more than three significant digits;
not add to totals shown.
2/ Customs value.
3/ Includes pearls.

Source: U.S. Census Bureau.

TABLE 10
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES 1/

(Thousand carats and thousand dollars)

Stones	2000 Quantity	2000 Value 2/	2001 Quantity	2001 Value 2/
Diamonds:				
Rough or uncut	2,280	741,000	900	550,000
Cut but unset	19,500	11,300,000	16,200	10,000,000
Emeralds, cut but unset	22,100	176,000	6,370	141,000
Coral and similar materials, unworked	NA	8,920	NA	10,900
Rubies and sapphires, cut but unset	12,900	241,000	9,150	191,000
Pearls:				
Natural	NA	960	NA	8,520
Cultured	NA	46,100	NA	47,200
Imitation	NA	2,020	NA	1,290
Other precious and semiprecious stones:				
Rough, uncut	1,070,000	39,400	1,020,000	22,200
Cut, set and unset	NA	247,000	NA	213,000
Other	NA	7,840	NA	5,070
Synthetic:				
Cut but unset	329,000	50,900	345,000	44,300
Other	NA	6,190	NA	5,760
Imitation gemstone 3/	NA	74,200	NA	83,000
Total	XX	12,900,000	XX	11,400,000

NA Not available. XX Not applicable.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Customs value.
3/ Does not include pearls.

Source: U.S. Census Bureau.

TABLE 11
NATURAL DIAMOND: ESTIMATED WORLD PRODUCTION, BY TYPE AND COUNTRY 1/ 2/ 3/

(Thousand carats)

Country	1997	1998	1999	2000	2001
Gemstones: 4/					
Angola	1,110	2,400	3,360 r/	3,914 r/ 5/	4,653 5/
Australia	18,100	18,400	13,403 5/	11,992 r/ 5/	10,700
Botswana	15,111 5/	14,772 5/	16,000	19,368 r/ 5/	20,100
Brazil	100 r/	100 r/	900 r/	1,000 r/	1,000
Canada	--	203 r/ 5/	2,429 r/ 5/	2,558 r/ 5/	2,600
Central African Republic	400	330	311 r/	346 r/	360
China	230	230	230	230	235
Congo (Kinshasa)	3,300	5,080	4,120	3,500	9,100
Cote d' Ivoire	207	210	270 r/	210 r/	210
Ghana	664	649	282 r/	178	700
Guinea	165	294 r/	410	278 r/	270
Liberia	80	150	120	100 r/	100
Namibia	1,350	1,390	1,550	1,520	1,490
Russia	11,200	11,500	11,500	11,600	11,600
Sierra Leone	300	200	450	450	450
South Africa	4,500	4,300	4,000	4,300	4,470
Tanzania	82	83	200	301	302
Venezuela	-- r/ 5/	80 5/	59 5/	80 r/ 5/	85
Zimbabwe	321	10	15	7	5
Other	33 r/	32 r/	29 r/	44 r/	70
Total	57,200 r/	60,400 r/	59,600 r/	62,000 r/	68,500
Industrial:					
Angola	124	364	373 r/	435 r/	517
Australia	22,100	22,500	16,381 5/	14,700 r/	13,100
Botswana	5,000	5,000	5,350	5,850 r/	5,060
Brazil	-- r/	-- r/	-- r/	-- r/	--
Central African Republic	100	200	120 r/	115 r/	120
China	900	900	920	920	950
Congo (Kinshasa)	18,677 5/	21,000	16,000	14,200	9,100
Cote d' Ivoire	100	100	128 r/	110 r/	110
Ghana	166	160	101 r/	712	170
Guinea	40	98 r/	140	91 r/	90
Liberia	120	150	80	70 r/	70
Namibia	71	73	89	80	--
Russia	11,200	11,600	11,500	11,600	11,600
Sierra Leone	100	50	150	150	150
South Africa	5,540	6,460	6,020	6,480	6,700
Tanzania	35	15	35	55	53
Venezuela	85 r/ 5/	17 5/	36 5/	29 r/ 5/	40
Zimbabwe	100	19	30	13	10
Other	79 r/	80 r/	87 r/	126 r/	200
Total	64,500 r/	68,700 r/	57,500 r/	55,700 r/	48,000
Grand total	122,000 r/	129,000 r/	117,000	118,000	117,000

r/ Revised. -- Zero.
1/ World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.
2/ Table includes data available through May 27, 2002.
3/ In addition to the countries listed, natural diamond is produced in Nigeria, but information is inadequate to estimate output.
4/ Includes near- and cheap-gem qualities.
5/ Reported figure.

GEMSTONES

By Donald W. Olson

Domestic survey data and tables were prepared by Christine K. Pisut, statistical assistant, and the world production table was prepared by Glenn J. Wallace, international data coordinator.

In this report, the terms “gem” and “gemstone” mean any mineral or organic material (such as amber, pearl, and petrified wood) used for personal adornment, display, or object of art because it possesses beauty, durability, and rarity. Of more than 4,000 mineral species, only about 100 possess all these attributes and are considered to be gemstones. Silicates other than quartz compose the largest group of gemstones; oxides and quartz compose the second largest (table 1). A further subcategory of gemstones is colored gemstone, which in this report designates all nondiamond gemstones, including amber, coral, and shell. In addition, synthetic gemstones, cultured pearls, and gemstone simulants are discussed but are treated separately from natural gemstones (table 2). Trade data in this report are from the U.S. Census Bureau. Quantities are reported in carats, unless otherwise noted. All percentages in the report were computed based on the unrounded data. Current information on industrial-grade diamond and industrial-grade garnet can be found in the U.S. Geological Survey (USGS) Minerals Yearbook chapters on industrial diamond and industrial garnet.

Gemstones have fascinated humans since prehistoric times. They have been valued as treasured objects throughout history by all societies in all parts of the world. Amber, amethyst, coral, diamond, emerald, garnet, jade, jasper, lapis lazuli, pearl, rock crystal, ruby, serpentine, and turquoise are some of the first stones known to have been used for making jewelry. These stones served as symbols of wealth and power. Today, gems are not worn to demonstrate wealth as much as they are for pleasure or in appreciation of their beauty.

Production

Commercial mining of gemstones has never been extensive in the United States. More than 60 varieties of gemstones have been produced commercially from domestic mines, but most of the deposits have been relatively small compared with other mining operations. In the United States, much of the current gemstone mining is conducted by collectors, gem clubs, and hobbyists rather than business organizations.

The commercial gemstone industry in the United States consists of individuals and companies that mine gemstones or harvest shell and pearl, firms that manufacture synthetic gemstones, and individuals and companies that cut natural and synthetic gemstones. The domestic gemstone industry is focused on the production of colored gemstones and on the cutting of large diamonds. Industry employment is estimated to range from 1,000 to 1,500 workers (U.S. International Trade Commission, 1997, p. 1).

Most natural gemstone producers in the United States are small businesses that are widely dispersed and operate independently. The small producers probably have an average of less than three employees, including those who only work part time. The number of gemstone mines operating from year to year fluctuates because the uncertainty associated with the discovery and marketing of gem-quality minerals makes it difficult to obtain financing for developing and sustaining economically viable deposits (U.S. International Trade Commission, 1997, p. 23).

The total value of natural gemstones produced in the United States during 2002 was estimated to be at least \$12.6 million (table 3). The production value was 15% less than that of the preceding year. The production decrease was mostly because the 2002 shell harvest was 49% less than in 2001.

The estimate of 2002 U.S. gemstone production was based on a survey of more than 230 domestic gemstone producers conducted by the USGS. The survey provided a foundation for projecting the scope and level of domestic gemstone production during the year. However, the USGS survey did not represent all gemstone activity in the United States, which includes thousands of professional and amateur collectors. Consequently, the USGS supplemented its survey with estimates of domestic gemstone production from related published data, contacts with gemstone dealers and collectors, and information garnered at gem and mineral shows.

Natural gemstone materials indigenous to the United States are collected, produced, and/or marketed in every State. During 2002, all 50 States produced at least \$1,000 worth of gemstone materials. Seven States accounted for nearly 80% of the total value, as reported by survey respondents. These States, in order of declining value of production, were Tennessee, Arizona, Oregon, California, Arkansas, Idaho, and Montana. Some States were known for the production of a single gemstone material—Tennessee for freshwater pearls and Arkansas for quartz, for example. Other States produced a variety of gemstones, like Arizona, whose gemstone deposits included agate, amethyst, azurite, chrysocolla, garnet, jade, jasper, malachite, obsidian, onyx, opal, peridot, petrified wood, smithsonite, and turquoise. There is also a wide variety of gemstones found and produced in California, Idaho, Montana, and North Carolina.

The United States has two significant operations in known diamond-bearing areas. The first, the Kelsey Lake diamond mine, is the United States’ only commercial diamond mine and is close to the Colorado-Wyoming State line near Fort Collins, CO. Kelsey Lake did not report any production during 2002, and the company was upgrading the equipment in the processing plant. The mine is owned and operated by Great Western Diamond Co. (a subsidiary of McKenzie Bay International, Ltd. of Canada). The Kelsey Lake property includes nine known kimberlite pipes, of which three have been tested and have shown that diamonds are present. The remaining six pipes have yet to be fully explored and tested for their diamond potential.

Of diamonds recovered, 50% to 65% was clear gem quality, and almost one-third was one carat or larger in size. The identified resources are at least 17 million metric tons (Mt) grading an average of 4 carats per hundred metric tons (Taylor Hard Money Advisers, 2000§[1]).

The second operation is in Crater of Diamonds State Park near Murfreesboro in Pike County, AR, where a dig-for-fee operation for tourists and rockhounds is maintained by the State. Crater of Diamonds is the only diamond mine in the world that is open to the public. The diamonds occur in a lamproite breccia tuff associated with a volcanic pipe and in the soil developed from the lamproite breccia tuff. In 2002, 614 diamonds with an average weight of 0.12 carat were recovered at Crater of Diamonds State Park. Seven of the diamonds weighed more than 1 carat each. Since the diamond bearing pipe and the adjoining area became a State park in 1972, more than 22,000 diamonds have been recovered (J. Michael Howard, Geology Supervisor, Arkansas Geological Commission, written commun., 2003). Recent exploration demonstrated that there is about 78.5 Mt of diamond-bearing rock in this diamond deposit (Howard, 1999, p. 62). An Arkansas law, enacted early in 1999, prohibits commercial diamond mining in the park (Diamond Registry Bulletin, 1999).

Studies by the Wyoming Geological Survey have shown that Wyoming has the potential for a $1 billion diamond mining business. Wyoming has many of the same geologic conditions as Canada, and there is evidence of hundreds of kimberlite pipes in the State. Twenty diamondiferous kimberlite pipes and one diamondiferous mafic breccia pipe have been identified in southern Wyoming. Two of the largest kimberlite fields, State Line and Iron Mountain, and the largest lamproite field, Leucite Hills, in the United States are in Wyoming. There has been slight interest in the southern Wyoming and northern Colorado area by several diamond mining firms, but the only diamond mine developed in the area thus far is the Kelsey Lake mine. Individual diamond gems worth $89,000 and $300,000 have been found there (Associated Press, 2002§).

In addition to natural gemstones, synthetic gemstones and gemstone simulants are produced in the United States. Synthetic gemstones have the same chemical, optical, and physical properties as the natural materials that they appear to be. Simulants have an appearance similar to that of a natural gemstone material, but they have different chemical, optical, and physical properties. Synthetic gemstones produced in the United States include alexandrite, cubic zirconia, diamond, emerald, moissanite, ruby, sapphire, and turquoise. Simulants of coral, lapis lazuli, malachite, and turquoise also are manufactured in the United States. In addition, certain colors of synthetic sapphire and spinel, used to represent other gemstones, are classified as simulants.

Synthetic gemstone production in the United States was more than $18.1 million during 2002; simulant gemstone output was even greater and was estimated to be more than $100 million. Six firms in six States, representing virtually the entire U.S. synthetic gemstone industry, reported production to the USGS. The States with reported synthetic gemstone production were Arizona, California, Florida, Michigan, New York, and North Carolina.

One U.S. company, Gemesis Corp., produced consistent-quality synthetic gem diamond and reported a third year of production in 2002. The synthetic diamonds are produced using technology, equipment, and expertise developed by a team of scientists from Russia and the University of Florida. The weight of the synthetic diamond stones range from 1.5 to 2 carats, and the stones are yellow, brownish yellow, colorless, and green (Weldon, 1999§). During 2002, Gemesis moved into a new facility near Sarasota, FL, where it now has 27 diamond-growing machines running and eventually plans to have a total of 250 machines installed. Each of the machines is capable of growing 3-carat rough diamonds by generating temperatures and pressures that recreate the conditions in the Earth's mantle, where diamonds form (Davis, 2003). In the next year and a half, Gemesis machines could be producing as many as 30,000 to 40,000 stones each year, and revenues may hit $70 million to $80 million per year (Diamond Registry Bulletin, 2001). Gemesis diamonds will be available in retail jewelry stores in fall 2003. The prices of the Gemesis synthetic diamonds will be below those of natural diamond but still above the prices of simulated diamond (Weldon, 2003§).

A second U.S. company, Apollo Diamond, Inc., has developed and patented a method for growing gem-quality diamonds by chemical vapor deposition (CVD). The CVD technique transforms carbon into plasma, which then is precipitated onto a substrate as diamond. CVD has been used for more that a decade to cover large surfaces with microscopic diamond crystals, but until this process, no one had discovered the combination of temperature, gas composition, and pressure that results in the growth of a single diamond crystal. Robert Linares of Apollo Diamond received a patent for the process in June 2003. Now CVD diamonds can be grown for about $5 per carat. CVD diamonds precipitate as nearly 100% pure, almost flawless diamond and, therefore, may not be discernible from natural diamond. Apollo Diamond is planning to start selling their diamonds on the jewelry market by January 2004 (Davis, 2003).

In 2002, a North Carolina firm entered its fifth year of marketing moissanite, a gem-quality synthetic silicon carbide it produces. Moissanite is also an excellent diamond simulant, but it is being marketed for its own gem qualities.

Consumption

Although the United States accounts for little of the total global gemstone production, it is the world's leading gemstone market. U.S. gemstone markets accounted for more than an estimated 35% of world gemstone demand in 2002. The U.S. market for unset gem-quality diamond during the year was estimated to have exceeded $12.1 billion. Domestic markets for natural, unset nondiamond gemstones totaled about $788 million.

A poll conducted by a U.S. jewelry retailers association in the mid-1990s showed that about two-thirds of domestic consumers who were surveyed designated diamond as their favorite gemstone (ICA Gazette, 1996). In 2002, the top-ten-selling colored gemstones, in descending order, were blue sapphire, ruby, emerald, tanzanite, amethyst, rhodolite garnet, pearl, opal, peridot, and blue topaz. Only 27% of the jewelry retailers said their sales were down in 2002 compared with 37% in 2001.

[1]References that include a section mark (§) are found in the Internet References Cited section.

During 2002, 32% of the retail gemstone jewelry purchases were in the under $500 price range (Prost, 2003). During the 2002 holiday season, consumers were cautious, and the U.S. retail sales increase was a low 2.2% overall (by value). Mall-based jewelry stores posted only an 0.8% increase compared with sales of the 2001 holiday shopping season (Diamond Registry Bulletin, 2003d). In 2002, the value of the U.S. diamond jewelry market increased by 5% from that of 2001 to $27.4 billion. This means that the U.S. market accounted for more than one-half of the world's diamond jewelry sales in 2002. During 2002, diamond engagement rings accounted for 84% of all engagement rings purchased, an increase of 2.5% compared with 2001. The value of the U.S. diamond engagement ring market was $4.3 billion (Diamond Registry Bulletin, 2003c). In addition to jewelry, gemstones are used for collections, decorative art objects, and exhibits.

Prices

Gemstone prices are governed by many factors and qualitative characteristics, including beauty, clarity, defects, demand, durability, and rarity. Diamond pricing, in particular, is complex; values can vary significantly depending on time, place, and the subjective evaluations of buyers and sellers. There are more than 14,000 categories used to assess rough diamond and more than 100,000 different combinations of carat, clarity, color, and cut values used to assess polished diamond (Pearson, 1998).

Colored gemstone prices are generally influenced by market supply and demand considerations, and diamond prices are supported by producer controls on the quantity and quality of supply. Values and prices of gemstones produced and/or sold in the United States are listed in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported, exported, or reexported are listed in tables 6 through 10.

De Beers Group companies are a significant force affecting gem diamond prices worldwide because they mine about one-half of the diamonds produced each year. The companies also sort and valuate about two-thirds (by value) of the world's annual supply of rough diamonds through De Beers' subsidiary Diamond Trading Co. (DTC), which has marketing agreements with other producers.

Foreign Trade

During 2002, total U.S. gemstone trade with all countries and territories was about $17.3 billion, which was approximately 12% more (by value) than gemstone trade of the previous year. Diamonds accounted for about 96% of the 2002 gemstone trade total. In 2002, U.S. exports and reexports of diamond were shipped to 73 countries and territories, and imports of all gemstones were received from 114 countries and territories (tables 6-10). During 2002, U.S. trade in cut diamonds increased by about 15% compared with the previous year, and the United States remained the world's leading diamond importer. The United States is a significant international diamond transit center as well as the world's largest gem diamond market. The large volume of reexports shipped to other centers reveals the significance that the United States has in the world's diamond supply network (table 6).

Synthetic gemstone trade increased by more than 15% for the United States in 2002 compared with the previous year. Synthetic gemstone imports from Austria, China, Germany, Hong Kong, Switzerland, and Thailand made up almost 87% (by value) of the total domestic imports of synthetic gemstones during the year. Prices of certain synthetic gemstone imports, such as amethyst, were very competitive. The marketing of synthetic imports and enhanced gemstones as natural gemstones and the mixing of synthetic materials with natural stones in imported parcels continued to be problems for some domestic producers in 2002. There were also problems with some simulants being marketed as synthetic gemstones during the year.

World Review

The gemstone industry worldwide has two distinct sectors—diamond mining and marketing and the production and sale of colored gemstones. Most diamond supplies are controlled by a few major mining companies; prices are supported by managing the quality and quantity of the gemstones relative to demand, a function performed by De Beers through DTC. Unlike diamonds, colored gemstones are primarily produced at relatively small low-cost operations with few dominant producers; prices are influenced by consumer demand in addition to supply availability.

In 2002, world diamond production totaled about 132 million carats—76.5 million carats gem quality and 55.2 million carats industrial grade (table 11). Most production was concentrated in a few regions—Africa [Angola, Botswana, Congo (Kinshasa), Namibia, and South Africa], Asia (northeastern Siberia and Yakutia in Russia), Australia, North America (Northwest Territories in Canada), and South America (Brazil and Venezuela). In 2002, Australia led the world in total diamond output quantity (combined gemstone and industrial), and Botswana was the world's leading gemstone diamond producer in terms of output value and quantity.

De Beers reported that its sales of rough diamonds for 2002 were $5.15 billion, which was up by 15.7% from $4.45 billion in 2001. De Beers diamond stocks were reduced by nearly $1 billion during the year, and De Beers reported a net income of $434 million in 2002, down from $492 million the previous year (Diamond Registry Bulletin, 2003b).

The Antwerp High Council in Belgium reported that overall diamond trade increased by 14.8% to $26.3 billion during 2002. That was the combination of an increase of 18.9% in rough diamond trade and an increase of 10.7% in polished diamond trade. The United States was the strongest market for Antwerp polished diamond with exports to the United States increasing by 13% to $2.28 billion during 2002 (Diamond Registry Bulletin, 2003a).

Additional events in 2002 significant to diamond mining, production, and marketing worldwide include the following:

- The Ekati Diamond Mine, Canada's first operating commercial diamond mine, completed its fourth full year of production. In 2002, Ekati produced 4.98 million carats of diamonds (BHP Billiton Ltd., 2003). BHP Billiton has an 80% controlling ownership of the Ekati Mine in the Northwest Territories in Canada. Ekati has estimated reserves of 60.3 Mt of ore in kimberlite pipes that contain

54.3 million carats of diamonds, and the mine life is projected to be 25 years. Operating at full capacity, Ekati production is expected to range from 3.5 million to 4.5 million carats per year. Ekati diamonds are sold by BHP's Antwerp sales office. The Ekati is now producing from the Koala, Misery, and Panda kimberlite pipes (BHP Billiton Ltd., 2001). The Ekati already accounts for 4% of the world market by weight and 6% by value (Law-West, 2002). In 2002, BHP Billiton began using underground mining techniques to recover diamonds from deeper portions of the Koala and Panda kimberlite pipes, which were first open pit mined (Diamond Registry Bulletin, 2002). De Beers' hold on the world diamond market was further reduced at the end of 2002 when the agreement between Ekati and De Beers to sell 35% of Ekati production to De Beers expired and was not renewed. The agreement had helped Ekati get started in the world diamond market and ended on good terms (Jewelers' Circular Keystone, 2002).

- The Diavik Diamond Mine, also in the Northwest Territories, has estimated reserves of 25.6 Mt of ore in kimberlite pipes, containing 102 million carats of diamond, and the mine life is projected to be 20 years. Diavik received the required permits and regulatory approval in 2000 and began site infrastructure development and project construction. Diavik is an unincorporated joint venture between Diavik Diamond Mines Inc. (60%) and Aber Diamond Mines Ltd. (40%). The Diavik mine began diamond production in December 2002, and it should be built up to full production by February 2003—60 days ahead of the projected opening date (Professional Jeweler, 2002§). The mine is expected to produce about 102 million carats of diamond at a rate of 6 million carats per year worth about $63 per carat (Diavik Diamond Mines Inc., 2000, p. 10-12).
- A third Canadian commercial diamond project in the Northwest Territories is the Snap Lake diamond project. De Beers Canada Mining Inc. has projected that Snap Lake would begin production in 2006 or 2007 (Law-West, 2002). The Snap Lake diamond project has estimated reserves of 22.8 Mt of ore in a kimberlite dike that contains 38.8 million carats of diamond. The mine life is projected to be 20 years or more (Jack T. Haynes, Assistant Site Manager, De Beers Canada Mining Inc., oral commun., 2001).

In 2002, the worldwide diamond industry recovered somewhat from low demand in 2001 and moved toward the record levels of 2000. The world rough diamond supply increased by almost 10%, world demand for polished wholesale diamonds increased by 4%, and world diamond jewelry retail sales increased by 3% compared with the levels of 2001. This growth was constrained by economic uncertainties, weak stock markets, low consumer confidence, corporate "creative accounting" scandals, the hostilities in Afghanistan, and the long lead time to the expected arrival of U.S. and allied troops in Iraq. Worldwide diamond jewelry retail sales were valued at $56.9 billion, containing diamond valued $14.5 billion (polished wholesale prices) (Diamond Intelligence Briefs, 2003).

In 2002, an international rough diamond certification system called the Kimberley Process Certification Scheme (KPCS) was implemented to solve the problem of conflict diamonds—those rough diamonds used by rebel forces and their allies to help finance warfare aimed at subverting governments recognized as legitimate by the United Nations (U.N.). The KPCS was agreed upon by U.N. member nations, the diamond industry, and involved nongovernmental organizations. The KPCS includes the following key elements: the use of forgery-resistant certificates and tamper proof containers for shipments of rough diamonds; internal controls and procedures that provide credible assurance that conflict diamonds do not enter the legitimate diamond market; a certification process for all exports of rough diamonds; the gathering, organizing, and sharing of import and export data on rough diamonds with other participants of relevant production; credible monitoring and oversight of the international certification scheme for rough diamonds; effective enforcement of the provisions of the certification scheme through dissuasive and proportional penalties for violations; self regulation by the diamond industry that fulfills minimum requirements; and the sharing of information with all other participants on relevant rules, procedures, and legislation as well as examples of national certificates used to accompany shipments of rough diamonds (Weldon, 2001§). The KPCS will not be fully implemented until all participating countries have passed the necessary laws to carry it out.

- In the United States, the Clean Diamond Trade Act, which will implement effective measures to stop trade in conflict diamonds, was passed by the U.S. House of Representatives on November 28, 2001, and by the U.S. Senate on January 7, 2003. The President signed the Act into law on April 25, 2003. Enactment of the Clean Diamond Trade Act made the United States a full participant in the KPCS (U.S. House of Representatives, 2003§). U.S. participation is critical to the success of the KPCS in excluding conflict diamonds from the legitimate supply chain because the United States has the largest part of the world diamond market. The industry and trade associations have played an active role in achieving this progress in ending the problem of conflict diamonds (Professional Jeweler, 2003§).
- Near the end of 2001, De Beers quietly settled private civil class actions related to the industrial diamond case in Ohio against De Beers Industrial Diamonds Division (Pty) Ltd. and General Electric Co. The settlement established a $20 million cash fund plus interest and also provided for payment of an in-kind rebate of industrial diamonds that "class members" purchase from the plaintiffs during the period from January 1, 2002, to December 31, 2003. The settlement covered an alleged illegal price fixing that took place from November 1, 1987, through May 23, 1994 (Tacy Diamond Intelligence, 2002§).

In July, a Chicago, IL-based firm made the first prototype gem-quality diamond produced from cremated human remains. The firm began offering this service to the public in August 2002. By yearend 2002, a significant number of orders had been placed, and more than 30 diamonds had been produced. The diamonds are produced domestically and in Spain and Russia. During 2002, all diamonds produced were blue, but since yearend they are also producing yellow diamonds (Dean Van

Den Biesen, Vice President of Operations, LifeGem, Inc., oral commun., September 5, 2003).

Worldwide production of natural gemstones other than diamond was estimated to have exceeded $2 billion per year. Most nondiamond gemstone mines are small, low-cost, and widely dispersed operations in remote regions of developing nations. Foreign countries with major gemstone deposits other than diamond are Afghanistan (aquamarine, beryl, emerald, kunzite, lapis lazuli, ruby, and tourmaline), Australia (beryl, opal, and sapphire), Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline), Burma (beryl, jade, ruby, sapphire, and topaz), Colombia (beryl, emerald, and sapphire), Kenya (beryl, garnet, and sapphire), Madagascar (beryl, rose quartz, sapphire, and tourmaline), Mexico (agate, opal, and topaz), Sri Lanka (beryl, ruby, sapphire, and topaz), Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline), and Zambia (amethyst and beryl). In addition, pearls are cultured throughout the South Pacific and in other equatorial waters; Australia, China, French Polynesia, and Japan are key producers.

The U.S. colored gemstone market posted a recovery compared with the economic turbulence of 2001, showing considerable improvement in terms of value, but still not as good as the 2000 value. The industry is in a slight growth pattern, but the threatening hostilities with Iraq prevented an immediate economic recovery. The surge in retail spending through the holiday season reasserted the U.S. dominance as a gemstone market, while the European Union and Japan declined for the third year in a row. The rest of the Asian markets grew or remained the same as in the previous year. The popularity of colorful gemstones, colored synthetic gemstones, and “fancy” colored diamonds continued to increase. This was evidenced by increased sales in 2002 (Colored Stone, 2003).

In 2002, the American Gem Trade Association (a U.S. and Canadian trade association) announced that it was adding tanzanite to the traditional list of birthstones. Tanzanite is the first stone added to the traditional birthstone list in 90 years, and it joins turquoise and zircon as an additional birthstone for the month of December. Tanzanite was first introduced as a gemstone in 1969. It is by far the most popular of blue gemstones after sapphire. Tanzanite is characterized by combinations of royal blue and burgundy hues, which have an almost universal appeal. While some tanzanite displays a trace of blue when it is originally mined, most crystals emerge from the Earth with a muted gray green color. All tanzanite has been subjected to a heat process to produce the violet blue hues. The only known source of tanzanite is a 5-square-mile area in the hills of Merelani, 10 miles south of the Kilimanjaro International Airport, between Moshi and Arusha in Tanzania. With its growing popularity among consumers, adding it to the traditional list of birthstones will only increase the demand for tanzanite (American Gem Trade Association, 2002§).

U.S. shell production decreased again in 2002. Shell has been one of the largest segments of U.S. gemstone production for several years. The U.S. shell material from mussels is used as seed material for culturing pearls. This production decrease is the result of overharvesting in past years, the killing off of U.S. native mussel species by nuisance or invasive exotic species, and a decline in market demand. During the past 10 years, the United States has lost about three-quarters of the native mussel population, and one-half of the approximately 300 total U.S. native mussel species are now listed as endangered species. The zebra mussel is the invasive exotic species that has done most of the damage, and it has been introduced into U.S. rivers and waterways in discharged ballast water from transoceanic ships (Iowa Department of Natural Resources, 2001§; Scott Gritterf, Fisheries Biologist, Iowa Department of Natural Resources, oral commun., November 14, 2002). The market still has never completely recovered from the die-off of Japanese oysters. Japan had stockpiled seed materials, and now they are using manmade seed materials or seed materials from China and other sources. There has also been an increase in the popularity of darker and colored pearls that do not use U.S. seed material (Ted Kroll, Assistant Director of Fisheries, Kentucky Department of Fish and Wildlife, oral commun., November 15, 2002).

Outlook

There are indications that there will be continued growth in U.S. diamond and jewelry markets in 2003. Historically, diamonds have proven to hold their value despite wars or economic depressions (Schumann, 1998, p. 8).

Diamond exploration is continuing in Canada, and many new deposits have been found. There are several other commercial diamond projects and additional discoveries located in Alberta, British Columbia, the Northwest Territories, Nunavut, Ontario, and Quebec. When the Snap Lake mine begins production, Canada could account for 15% to 20% of the total world diamond production. If Canadian production continues to increase at about the same rate, Canada will probably eclipse South Africa’s diamond production within a decade.

Independent producers, such as Argyle Diamond Mines in Australia and Ekati and Diavik in Canada, will continue to bring a greater measure of competition to global markets. More competition presumably will bring more supplies and lower prices. Further consolidation of diamond producers and larger amounts of rough diamond being sold outside the DTC will continue as the diamond industry adjusts to De Beers giving up its control of the industry.

Numerous synthetics, simulants, and treated gemstones will enter the marketplace and necessitate more transparent trade industry standards to maintain customer confidence.

More diamond, gemstones, and jewelry will be sold through online marketplaces and other forms of e-commerce that emerge to serve the diamond and gemstone industry. This will take place as the gemstone industry and its customers become more comfortable with and learn the applications of new e-commerce tools.

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TABLE 1
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0-2.5	1.0-1.1	Single	1.54	Synthetic or pressed plastics, kaurigum	Fossil resin, color, low density, soft and trapped insects.
Apatite	Chloro-calcium phosphate	Colorless, pink, yellow, green, blue, violet	Small	Low	5.0	3.16-3.23	Double	1.63-1.65	Amblygonite, andalusite, brazilianite, precious beryl, titanite, topaz, tourmaline	Crystal habit, color, hardness, and appearance.
Azurite	Copper carbonate hydroxide	Azure, dark blue, pale blue	Small to medium	do.	3.5-4.0	3.7-3.9	do.	1.72-1.85	Dumortierite, hauynite, lapis lazuli, lazulite, sodalite	Color, softness, crystal habits and associated minerals.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	do.	High	6.0-6.5	3.64-3.68	do.	1.76-1.80	Sapphire, tanzanite, blue diamond, blue tourmaline, cordierite	Strong blue in ultraviolet light.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5-8.0	2.63-2.80	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	Red	Small	Very high	7.5-8.0	2.63-2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald	do.	Green	Medium	do.	7.5	2.63-2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5-8.0	2.63-2.80	do.	1.58	Genuine emerald	Lack of flaws, brilliant fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5-8.0	2.63-2.80	do.	1.58	Citrine, topaz, glass, doublets	Weak-colored.
Goshenite	do.	Colorless	do.	Low	7.5-8.0	2.63-2.80	do.	1.58	Quartz, glass, white sapphire, white topaz	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5-8.0	2.63-2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49-1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.60	do.	Banded, translucent.
Charoite	Hydrated sodium calcium hydroxi-fluoro-silicate	Lilac, violet, or white	Small to medium	do.	5.0-6.0	2.54-2.78	XX	1.55-1.56	Purple marble	Color, locality.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day light, red by artificial light	Small (CIS) Medium (Sri Lanka)	High	8.5	3.50-3.84	Double	1.75	Synthetic	Strong dichroism, color varies from red to green, hardness.
Cats-eye	do.	Greenish to brownish	Small to large	do.	8.5	3.50-3.84	do.	1.75	Synthetic, shell	Density, translucence, chatoyance.
Chrysolite	Beryllium aluminate	Yellow, green, and/or brown	Medium	Medium	8.5	3.50-3.84	Double	1.75	Tourmaline, peridot	Refractive index, silky.

See footnotes at end of table.

TABLE 1--Continued
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Chrysocolla	Hydrated copper silicate	Green, blue	Any	Low	2.0-4.0	2.0-2.4	XX	1.46-1.57	Azurite, dyed chalcedony, malachite, turquoise, variscite	Lack of crystals, color, fracture, low density and softness.
Coral	Calcium carbonate	Orange, red, white, black, purple, or green	Branching, medium	do.	3.5-4.0	2.6-2.7	Double	1.49-1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95-4.10	do.	1.78	Synthetics, including spinel, garnet	Inclusions, fluorescence.
Sapphire, blue	do.	Blue	Medium	High	9.0	3.95-4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, colorless, orange, green, or violet	Medium to large	Medium	9.0	3.95-4.10	do.	1.78	Synthetics, glass and doublets, morganite	Inclusions, double refraction, refractive index.
Sapphire and ruby, stars	do.	Red, pink, violet, blue, or gray	do.	High to low	9.0	3.95-4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.
Sapphire or ruby, synthetic	do.	Yellow, pink, or blue	Up to 20 carats	Low	9.0	3.95-4.10	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Cubic zirconia	Zirconium and yttrium oxides	Colorless, pink, blue, lavender, yellow	Small	do.	8.25-8.5	5.8	Single	2.17	Diamond, zircon, titania, moissanite	Hardness, density, refractive index, lack of flaws and inclusions.
Diamond	Carbon	White, blue-white, yellow, brown, green, red, pink, blue	Any	Very high	10.0	3.516-3.525	do.	2.42	Zircon, titania, cubic zirconia, moissanite	High index, dispersion, hardness, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green-blue	Large	Low	6.0-6.5	2.56	XX	1.52	Jade, turquoise	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play (schiller)	do.	do.	6.0-6.5	2.56	XX	1.56	do.	Do.
Moonstone	do.	Colorless, white, gray, or yellow with white, blue, or bronze schiller	do.	do.	6.0-6.5	2.77	XX	1.52-1.54	Glass, chalcedony, opal	Pale sheen, opalescent.
Sunstone	do.	Orange, red brown, colorless with gold or red glittery schiller	Small to medium	do.	6.0-6.5	2.77	XX	1.53-1.55	Aventurine, glass	Red glittery schiller.
Garnet	Complex silicate	Brown, black, yellow, green, red, or orange	do.	Low to high	6.5-7.5	3.15-4.30	Single strained	1.79-1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Hematite	Iron oxide	Black, black-gray, brown-red	Medium to large	Low	5.5-6.5	5.12-5.28	XX	2.94-3.22	Davidite, cassiterite, magnetite, neptunite, pyrolusite, wolframite	Crystal habit, streak and hardness.
Jade:										
Jadeite	Complex silicate	Green, yellow, black, white, or mauve	Large	Low to very high	6.5-7.0	3.3-3.5	Crypto-crystalline	1.65-1.68	Nephrite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0-6.5	2.96-3.10	do.	1.61-1.63	Jadeite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Do.

See footnotes at end of table.

TABLE 1--Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Jet (gagate)	Lignite	Deep black, dark brown	do.	Low	2.5-4.0	1.19-1.35	XX	1.64-1.68	Anthracite, asphalt, cannel coal, onyx, schorl, glass, rubber	Luster, color.
Lapis lazuli	Sodium calcium aluminum silicate	Dark azure-blue to bright indigo blue or even a pale sky blue	do.	do.	5.0-6.0	2.50-3.0	XX	1.50	Azurite, dumortierite, dyed howlite, lazulite, sodalite, glass	Color, crystal habit, associated minerals, luster, and localities.
Malachite	Hydrated copper carbonate	Light to black-green banded	do.	do.	3.5-4.0	3.25-4.10	XX	1.66-1.91	Brochantite, chrysoprase, opaque green gemstones	Color banding, softness, associated minerals.
Moissanite	Silicon carbide	Colorless and pale shades of green, blue, or yellow	Small	Low to medium	9.25	3.21	Double	2.65-2.69	Diamond, zircon, titania, cubic zirconia	Hardness, dispersion, refractive index, lack of flaws and inclusions.
Obsidian	Amorphous, variable (usually felsic)	Black, gray, brown, dark green, white, transparent	Large	Low	5.0-5.5	2.35-2.60	XX	1.45-1.55	Aegirine-augite, gagate, gadolinite, hematite, pyrolusite, wolframite	Color, conchoidal fracture, flow bubbles, softness, and lack of crystal faces.
Opal	Hydrated silica	Reddish orange, colors flash in white gray, black, red, or yellow	do.	Low to high	5.5-6.5	1.9-2.3	Single	1.45	Glass, synthetics, triplets, chalcedony	Color play (opalescence).
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5-7.0	3.27-3.37	Double (strong)	1.65-1.69	Tourmaline, chrysoberyl	Strong double refraction, low dichroism.
Quartz:										
Agate	Silicon dioxide	Any	Large	Low	7.0	2.58-2.64	XX	XX	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65-2.66	Double	1.55	Glass, plastic, fluorite	Macrocrystalline, refractive index, color, transparent, hardness.
Aventurine	do.	Green, red-brown, gold-brown, with metallic metallic iridescent reflection	do.	Low	7.0	2.64-2.69	do.	1.54-1.55	Iridescent analcime, aventurine feldspar, emerald, aventurine glass	Macrocrystalline, color, metallic iridescent flake reflections, hardness.
Cairngorm	do.	Smoky orange or yellow	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Macrocrystalline, refractive index, color, transparent, hardness.
Carnelian	do.	Flesh red to brown red	do.	do.	6.5-7.0	2.58-2.64	do.	1.53-1.54	Jasper	Cryptocrystalline, color, hardness.
Chalcedony	do.	Bluish, white, gray	do.	do.	6.5-7.0	2.58-2.64	do.	1.53-1.54	Tanzanite	Do.
Chrysoprase	do.	Green, apple-green	do.	do.	6.5-7.0	2.58-2.64	do.	1.53-1.54	Chrome chalcedony, jade, prase opal, prehnite, smithsonite, variscite, artifically colored green chalcedony	Do.
Citrine	Silica	Yellow	Large	Low	7.0	2.65-2.66	Double	1.55	do.	Macrocrystalline, refractive index, color, transparent, hardness.
Crystal:										
Rock crystal	do.	Colorless	do.	do.	7.0	2.65-2.66	do.	1.55	Topaz, colorless sapphire	Do.
Jasper	do.	Any, striped, spotted, or sometimes uniform	do.	do.	7.0	2.58-2.66	XX	XX	do.	Cryptocrystalline, opaque, vitreous luster, hardness.

See footnotes at end of table.

TABLE 1--Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Crystal--Continued:										
Onyx	Silica	Many colors	Large	Low	7.0	2.58-2.64	XX	XX	Topaz, colorless sapphire	Cryptocrystalline, uniformly banded, hardness.
Petrified wood	do.	Brown, gray, red, yellow	do.	do.	6.5-7.0	2.58-2.91	Double	1.54	Agate, jasper	Color, hardness, wood grain.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Macrocrystalline, refractive index, color, transparent, hardness.
Tiger's eye	do.	Golden yellow, brown, red, blue-black	do.	do.	6.5-7.0	2.58-2.64	XX	1.53-1.54	XX	Macrocrystalline, color, hardness, hatoyancy.
Rhodochrosite	Manganese carbonate	Rose-red to yellowish, stripped	do.	do.	4.0	3.45-3.7	Double	1.6-1.82	Fire opal, rhodonite, tugtupite, tourmaline	Color, crystal habit, reaction to acid, and perfect rhombohedral cleavage.
Rhodonite	Manganese iron calcium silicate	Dark red, flesh red, with dendritic inclusions of black manganese oxide	do.	do.	5.5-6.5	3.40-3.74	do.	1.72-1.75	Rhodochrosite, thulite, hessonite, spessartine, pyroxmangite, spinel, tourmaline	Color, black inclusions, lack of reaction to acid and hardness.
Shell:										
Mother-of-pearl	Calcium carbonate	White, cream, green, blue-green, with iridescent color play	Small	Low	3.5	2.6-2.85	XX	XX	Glass and plastic imitation	Luster, iridescent play of color.
Pearl	do.	White, cream to black, sometimes with hint of pink, green, purple	do.	Low to high	2.5-4.5	2.6-2.85	XX	XX	Cultured and glass or plastic imitation	Luster, iridescence, structure, x-ray.
Spinel	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5-3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5-3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5-7.0	3.13-3.20	do.	1.66	Synthetic spinel	Refractive index, color, pleochroism.
Kunzite	do.	Pink to lilac	do.	do.	6.5-7.0	3.13-3.20	do.	1.66	Amethyst, morganite	Refractive index, color, pleochroism.
Tanzanite	Complex silicate	Blue to lavender	Small	High	6.0-7.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism, color.
Topaz	do.	White, blue, green, pink, yellow, gold	Medium	Low to medium	8.0	3.4-3.6	do.	1.62	Beryl, quartz	Color, density, hardness, refractive index, perfect in basal cleavage.
Tourmaline	do.	Any, including mixed	do.	do.	7.0-7.5	2.98-3.20	do.	1.63	Peridot, beryl, garnet corundum, glass	Double refraction, color, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green with black, brown-red inclusions	Large	Low	6.0	2.60-2.83	Double	1.63	Glass, plastics, variscite, dumortierite, dyed howlite, chrysocolla	Difficult if matrix not present, matrix usually limonitic.
Unakite	Granitic rock, feldspar, epidote, quartz	Olive green, pink, and blue-gray	do.	do.	6.0-7.0	2.60-3.20	XX	XX	XX	Olive green, pink, and gray-blue colors.
Zircon	Zirconium silicate	White, blue, brown, yellow, or green	Small to medium	Low to medium	6.0-7.5	4.0-4.8	Double (strong)	1.79-1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

XX Not applicable.
[1]Small--up to 5 carats; medium--5 to 50 carats; large--more than 50 carats.

TABLE 2
SYNTHETIC GEMSTONE PRODUCTION METHODS

Gemstone	Production method	Company/producer	Date of first production
Alexandrite	Flux	Creative Crystals	1970s.
Do.	Melt pulling	J.O. Crystal	1990s.
Do.	do.	Kyocera	1980s.
Do.	Zone melt	Seiko	1980s.
Cubic zirconia	Skull melt	Various producers	1970s.
Emerald	Flux	Chatham	1930s.
Do.	do.	Gilson	1960s.
Do.	do.	Kyocera	1970s.
Do.	do.	Seiko	1980s.
Do.	do.	Lennix	1980s.
Do.	do.	Russia	1980s.
Do.	Hydrothermal	Lechleitner	1960s.
Do.	do.	Regency	1980s.
Do.	do.	Biron	1980s.
Do.	do.	Russia	1980s.
Ruby	Flux	Chatham	1950s.
Do.	do.	Kashan	1960s.
Do.	do.	J.O. Crystal	1980s.
Do.	do.	Douras	1990s
Do.	Zone melt	Seiko	1980s.
Do.	Melt pulling	Kyocera	1970s.
Do.	Verneuil	Various producers	1900s.
Sapphire	Flux	Chatham	1970s.
Do.	Zone melt	Seiko	1980s.
Do.	Melt pulling	Kyocera	1980s.
Do.	Verneuil	Various producers	1900s.
Star ruby	do.	Linde	1940s.
Do.	Melt pulling	Kyocera	1980s.
Do.	do.	Nakazumi	1980s.
Star sapphire	Verneuil	Linde	1940s.

TABLE 3
VALUE OF U.S. GEMSTONE PRODUCTION, BY TYPE[1]

(Thousand dollars)

Gem materials	2001	2002
Beryl	(2)	9
Coral, all types	83	108
Diamond	(3)	(3)
Garnet	46 r	46
Gem feldspar	(2)	379 e
Geode/nodules	375	(2)
Opal	44	(2)
Quartz:		
Macrocrystalline[4]	307	246
Cryptocrystalline[5]	381	84
Sapphire/ruby	152	212
Shell	2,860	1,440
Topaz	(2)	(2)
Tourmaline	334	105
Turquoise	(2)	540
Other	8,350	8,420
Total	14,900	12,600

[e]Estimated. [r]Revised.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Included in "Total."

[3]Included with "Other."

[4]Macrocrystalline quartz (crystals recognizable with the naked eye) includes amethyst, amethyst quartz, aventurine, blue quartz, citrine, hawk's eye, pasiolite, prase, quartz cat's eye, rock crystal, rose quartz, smoky quartz, and tiger's eye.

[5]Cryptocrystalline (microscopically small crystals) includes agate, carnelian, chalcedony, chrysoprase, fossilized wood, heliotrope, jasper, moss agate, onyx, and sard.

TABLE 4

PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY IN 2002[1]

Carat weight	Description, color[3]	Clarity[2] (GIA terms)	Representative prices		
			January[4]	June[5]	December[6]
0.25	G	VS1	$1,200	$1,200	$1,200
.25	G	VS2	1,150	1,150	1,150
.25	G	SI1	975	975	975
.25	H	VS1	1,100	1,100	1,100
.25	H	VS2	1,000	1,000	1,000
.25	H	SI1	925	925	925
.50	G	VS1	3,200	3,200	3,200
.50	G	VS2	2,800	2,800	2,800
.50	G	SI1	2,400	2,400	2,400
.50	H	VS1	2,800	2,800	2,800
.50	H	VS2	2,400	2,400	2,400
.50	H	SI1	2,200	2,200	2,200
.75	G	VS1	3,800	3,800	3,600
.75	G	VS2	3,600	3,600	3,500
.75	G	SI1	3,300	3,300	3,200
.75	H	VS1	3,500	3,500	3,300
.75	H	VS2	3,450	3,450	3,200
.75	H	SI1	3,000	3,000	2,900
1.00	G	VS1	5,800	5,800	5,800
1.00	G	VS2	5,500	5,500	5,500
1.00	G	SI1	4,800	4,800	4,800
1.00	H	VS1	5,200	5,200	5,200
1.00	H	VS2	4,900	4,900	4,900
1.00	H	SI1	4,700	4,700	4,700

[1]Data are rounded to no more than three significant digits.

[2]Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; G, H, I—traces of color.

[3]Clarity: IF—no blemishes; VVS1—very, very slightly included; VS1—very slightly included; VS2—very slightly included, but not visible; SII—slightly included.

[4]Source: Jewelers' Circular Keystone, v. 173, no. 2, February 2002, p. 49.

[5]Source: Jewelers' Circular Keystone, v. 173, no. 7, July 2002, p. 52.

[6]Source: Jewelers' Circular Keystone, v. 174, no. 1, January 2003, p. 40.

TABLE 5

PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES IN 2002

Gemstone	Price range per carat	
	January[1]	December[2]
Amethyst	$7-$14	$7-$14
Blue sapphire	800-1,300	750-1,200
Blue topaz	3-5	3-5
Emerald	1,300-2,000	1,300-2,000
Green tourmaline	70-125	70-150
Pearl:[3]		
Cultured saltwater	5	5
Natural	210	210
Pink tourmaline	60-125	60-125
Rhodolite garnet	18-30	18-30
Ruby	1,200-1,550	1,100-1,450
Tanzanite	170-270	200-300

[1]Source: The Guide, spring/summer 2002, p. 14, p. 30, p. 43, p. 59, p. 71, p. 85, p. 95, p. 97, p. 103, p. 125, and p. 137. These figures are approximate current wholesale purchase prices paid by retail jewelers on a per stone basis for fine-quality stones.

[2]Source: The Guide, fall/winter 2002-2003, p. 14, p. 30, p. 45, p. 61, p. 72, p. 86, p. 96, p. 98, p. 104, p. 123, and p. 135. These figures are approximate current wholesale purchase prices paid by retail jewelers on a per stone basis for fine-quality stones.

[3]Prices are per 4.6 mm pearl.

TABLE 6
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY[1]

Country	2001 Quantity (carats)	2001 Value[2] (millions)	2002 Quantity (carats)	2002 Value[2] (millions)
Exports:				
Belgium	573,000	$454	343,000	$278
Canada	98,800	29	105,000	41
France	35,400	135	8,760	37
Germany	23,400	4	3,360	3
Guatemala	135,000	13	168,000	17
Hong Kong	336,000	125	251,000	89
India	294,000	35	83,100	12
Israel	575,000	512	246,000	477
Japan	35,400	27	13,800	31
Mexico	91,500	20	199,000	43
Netherlands	36,600	7	460	8
Switzerland	102,000	163	9,570	48
Thailand	85,500	15	28,200	5
United Kingdom	42,300	68	19,000	19
Other	133,000	96	76,500	57
Total	2,600,000	1,700	1,550,000	1,160
Reexports:				
Belgium	1,340,000	565	2,650,000	801
Canada	117,000	47	109,000	59
Dominican Republic	52,600	7	102,000	9
Hong Kong	1,390,000	347	2,470,000	381
India	723,000	92	1,230,000	157
Israel	1,760,000	899	4,290,000	1,250
Japan	91,100	32	181,000	35
Malaysia	16,700	4	64,200	6
Mexico	29,100	4	12,900	3
Singapore	76,400	14	158,000	20
Switzerland	277,000	130	382,000	191
Thailand	185,000	25	368,000	55
United Arab Emirates	194,000	27	253,000	71
United Kingdom	103,000	102	364,000	134
Other	68,100	49	117,000	59
Total	6,420,000	2,340	12,700,000	3,230
Grand total	9,010,000	4,050	14,300,000	4,400

[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.

Source: U.S. Census Bureau.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY[1]

Kind, range, and country of origin	2001 Quantity (carat)	2001 Value[2] (millions)	2002 Quantity (carat)	2002 Value[2] (millions)
Rough or uncut, natural:[3]				
Belgium	73,800	$75	17,800	$12
Botswana	4,880	12	6,350	18
Brazil	16,800	8	20,000	15
Canada	8,650	9	9,900	2
Congo (Brazzaville)	4,750	10	9,630	14
Congo (Kinshasa)	15,200	10	27,800	24
Ghana	20,400	3	3,180	3
Guinea	7,060	14	6,850	19
Guyana	34,500	4	54,900	6
Hong Kong	3,780	4	353	(4)
Israel	9,120	10	5,590	15
Russia	24,400	11	26,700	6
South Africa	297,000	290	436,000	353
United Kingdom	367,000	84	344,000	69
Venezuela	6,110	3	15,100	5
Other	6,880	5	29,600	7
Total	900,000	550	1,010,000	567
Cut but unset, not more than 0.5 carat:				
Australia	3,440	(4)	2,650	1
Belgium	731,000	216	770,000	227
Brazil	12,600	2	7,660	2
Canada	3,320	1	4,960	1
China	33,800	7	70,400	6
Dominican Republic	6,970	1	12,900	1
Hong Kong	316,000	59	403,000	64
India	9,050,000	1,510	11,500,000	1,890
Israel	992,000	535	997,000	454
Japan	7,980	3	2,500	1
Mexico	140,000	12	249,000	12
Singapore	9,240	2	4,110	1
Sri Lanka	10,500	2	7,110	2
Switzerland	10,900	4	6,600	2
Thailand	77,700	14	99,600	11
United Arab Emirates	86,500	21	82,300	18
United Kingdom	7,490	7	12,000	4
Other	22,000	9	23,500	7
Total	11,500,000	2,410	14,300,000	2,710
Cut but unset, more than 0.5 carat:				
Belgium	1,100,000	1,840	1,280,000	2,060
Canada	3,910	14	7,520	27
France	7,150	31	2,250	17
Hong Kong	192,000	145	89,800	153
India	673,000	406	1,120,000	742
Israel	2,550,000	4,560	3,040,000	5,300
Japan	5,110	13	2,960	7
Mauritius	3,770	7	3,230	7
Russia	62,900	112	45,200	78
South Africa	24,100	161	30,600	127
Switzerland	13,700	118	13,500	101
Thailand	9,100	9	5,140	5
United Arab Emirates	19,700	17	7,520	8
United Kingdom	15,700	118	21,000	100
Other	23,300	72	27,600	67
Total	4,710,000	7,630	5,690,000	8,800

[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Includes some natural advanced diamond.
[4]Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

Kind and country	2001 Quantity (carats)	2001 Value[2] (millions)	2002 Quantity (carats)	2002 Value[2] (millions)
Emerald:				
Australia	161,000	(3)	10,200	(3)
Belgium	11,700	$2	26,800	$1
Brazil	2,050,000	6	4,940,000	6
China	2,120	(3)	18,100	(3)
Colombia	1,070,000	58	683,000	69
Germany	29,700	1	15,200	1
Hong Kong	354,000	6	102,000	4
India	2,040,000	20	2,100,000	20
Israel	127,000	26	97,900	20
Japan	16,900	1	1,090	(3)
Sri Lanka	41,000	2	95	(3)
Switzerland	36,300	10	75,200	9
Taiwan	83	(3)	33	(3)
Thailand	287,000	5	538,000	7
United Kingdom	5,770	1	44,500	4
Zambia	106,000	1	408	(3)
Other	32,000	3	18,000	2
Total	6,370,000	141	8,670,000	143
Ruby:				
Belgium	500	1	15,000	2
Brazil	134	(3)	301	(3)
Burma	9,740	3	11,000	3
China	8,940	(3)	45,600	(3)
Colombia	328	(3)	--	--
Germany	24,800	(3)	18,200	1
Hong Kong	123,000	4	140,000	4
India	762,000	2	1,110,000	5
Israel	26,500	1	32,700	2
Japan	28,400	(3)	2,300	(3)
Pakistan	1,400	(3)	--	--
Sri Lanka	4,260	1	3,210	(3)
Switzerland	26,400	10	13,800	15
Thailand	1,940,000	43	2,220,000	50
United Kingdom	21,800	2	20,800	4
Other	25,700	2	24,300	1
Total	3,000,000	69	3,660,000	88
Sapphire:				
Australia	3,270	(3)	82,700	1
Belgium	1,720	1	8,440	1
Brazil	642	(3)	1,250	(3)
Burma	395	1	669	4
Canada	250	(3)	664	(3)
China	15,100	(3)	28,800	(3)
Colombia	3,680	(3)	--	--
France	1,670	1	1,710	1
Germany	42,500	1	143,000	2
Hong Kong	281,000	8	251,000	7
India	873,000	5	828,000	4
Israel	40,700	3	26,700	2
Sri Lanka	294,000	20	274,000	25
Switzerland	36,900	12	31,600	8
Thailand	4,470,000	66	5,040,000	77
United Kingdom	17,500	3	32,700	4
Other	65,900	2	28,700	3
Total	6,150,000	122	6,780,000	139

See footnotes at end of table.

TABLE 8--Continued

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

	2001		2002	
Kind and country	Quantity (carats)	Value[2] (millions)	Quantity (carats)	Value[2] (millions)
Other:				
Rough, uncut:				
Australia	NA	$4	NA	$3
Brazil	NA	13	NA	10
China	NA	1	NA	3
Colombia	NA	(3)	NA	(3)
Fiji	NA	2	NA	2
Hong Kong	NA	1	NA	1
India	NA	2	NA	1
Indonesia	NA	2	NA	2
Kenya	NA	(3)	NA	(3)
Nigeria	NA	(3)	NA	(3)
Pakistan	NA	1	NA	3
Philippines	NA	1	NA	1
Russia	NA	(3)	NA	(3)
South Africa	NA	1	NA	1
Switzerland	NA	(3)	NA	(3)
Taiwan	NA	(3)	NA	(3)
Tanzania	NA	1	NA	1
Thailand	NA	1	NA	2
United Kingdom	NA	1	NA	1
Zambia	NA	(3)	NA	1
Other	NA	7	NA	8
Total	NA	38	NA	41
Cut, set and unset:				
Australia	NA	16	NA	16
Austria	NA	1	NA	2
Brazil	NA	7	NA	8
Canada	NA	1	NA	1
China	NA	12	NA	26
Columbia	NA	1	NA	1
French Polynesia	NA	5	NA	7
Germany	NA	15	NA	18
Hong Kong	NA	44	NA	32
India	NA	82	NA	75
Indonesia	NA	1	NA	(3)
Israel	NA	5	NA	5
Japan	NA	20	NA	11
Mexico	NA	2	NA	1
South Africa	NA	1	NA	1
Sri Lanka	NA	6	NA	6
Switzerland	NA	2	NA	2
Taiwan	NA	1	NA	2
Tanzania	NA	10	NA	7
Thailand	NA	27	NA	31
United Kingdom	NA	8	NA	8
Other	NA	3	NA	6
Total	NA	268	NA	265

NA Not available. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 9
VALUE OF U.S. IMPORTS OF SYNTHETIC AND IMITATION
GEMSTONES, BY COUNTRY[1]

(Thousand dollars)[2]

Country	2001	2002
Synthetic, cut but unset:		
Australia	224	27
Austria	2,980	2,730
Belgium	80	72
Brazil	62	143
China	13,700	10,300
France	974	831
Germany	10,000	9,630
Hong Kong	2,410	1,950
India	819	822
Italy	43	50
Japan	53	28
Korea, Republic of	1,360	727
Netherlands	74	65
Singapore	157	79
Spain	31	14
Sri Lanka	1,250	844
Switzerland	7,530	6,360
Taiwan	464	312
Thailand	1,970	1,670
Other	165	913
Total	44,300	37,600
Imitation:[3]		
Austria	64,800	39,900
China	1,330	2,260
Czech Republic	13,700	8,850
Germany	1,140	1,300
Hong Kong	255	1,560
India	355	1,280
Italy	207	139
Japan	400	247
Korea, Republic of	1,120	467
Spain	147	72
Taiwan	245	164
Other	497	434
Total	84,300	56,700

[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Includes pearls.

Source: U.S. Census Bureau.

TABLE 10
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES[1]

(Thousand carats and thousand dollars)

Stones	2001 Quantity	2001 Value[2]	2002 Quantity	2002 Value[2]
Diamonds:				
Rough or uncut	900	550,000	1,010	567,000
Cut but unset	16,200	10,000,000	19,900	11,500,000
Emeralds, cut but unset	6,370	141,000	8,670	143,000
Coral and similar materials, unworked	NA	10,900	NA	10,400
Rubies and sapphires, cut but unset	9,150	191,000	10,400	226,000
Pearls:				
Natural	NA	8,520	NA	1,490
Cultured	NA	47,200	NA	35,000
Imitation	NA	1,290	NA	968
Other precious and semiprecious stones:				
Rough, uncut	1,020,000	22,200	812,000	24,200
Cut, set and unset	NA	213,000	NA	229,000
Other	NA	5,070	NA	6,580
Synthetic:				
Cut but unset	345,000	44,300	251,000	37,600
Other	NA	5,760	NA	5,610
Imitation gemstone[3]	NA	83,000	NA	55,700
Total	XX	11,400,000	XX	12,900,000

NA Not available. XX Not applicable.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Does not include pearls.

Source: U.S. Census Bureau.

TABLE 11

NATURAL DIAMOND: ESTIMATED WORLD PRODUCTION, BY TYPE AND COUNTRY[1, 2, 3]

(Thousand carats)

Type and country[4]	1998	1999	2000	2001	2002
Gemstones:					
Angola	2,400	3,360	3,914 [5]	4,653 [5]	5,400
Australia	18,400	13,400 [r]	12,000 [r]	10,700	15,100
Botswana	14,800 [r]	17,200 [r]	18,500 [r]	19,800 [r]	21,300
Brazil	100 [5]	900 [5]	1,000 [5]	1,000 [5]	700
Canada	203 [5]	2,429 [5]	2,435 [r, 5]	3,685 [r, 5]	4,984 [5]
Central African Republic	330	311	346	360	375
China	230	230	230	235	235
Congo (Kinshasa)	5,080	4,120	3,500	9,100	9,100
Cote d' Ivoire	210	270	210	210	160
Ghana	658 [r]	546 [r]	792 [r]	936 [r]	770
Guinea	294	287 [r]	278	270	270
Guyana	50 [r, 5]	45 [r, 5]	82 [r, 5]	179 [r, 5]	100
Liberia	150	120	100	100	120
Namibia	1,350 [r]	1,630 [r]	1,450 [r]	1,487 [r, 5]	1,350
Russia	11,500	11,500	11,600	11,600	11,500
Sierra Leone	200	450	450	450	450
South Africa	4,280 [r]	4,010 [r]	4,320 [r]	4,470	4,350
Tanzania	83	200	301	216 [r]	182
Venezuela	80	59	29 [r]	14 [r]	15
Zimbabwe	10	15	8 [r]	-- [r]	--
Other	19 [r]	20 [r]	24 [r]	25 [r]	25
Total	60,400	61,100 [r]	61,600 [r]	69,500 [r]	76,500
Industrial:					
Angola	364	373	435	517	600
Australia	22,500	16,381 [5]	14,700	13,100	18,500
Botswana	5,000	5,730 [r]	6,160 [r]	6,600 [r]	7,100
Central African Republic	200	120	115	120	125
China	900	920	920	950	955
Congo (Kinshasa)	21,000	16,000	14,200	9,100	9,100
Cote d' Ivoire	100	128	110	110	90
Ghana	165 [r]	136 [r]	198 [r]	234 [r]	193
Guinea	98	96 [r]	91	100 [r]	100
Liberia	150	80	70	70	80
Namibia	71 [r]	-- [r]	106 [r]	--	--
Russia	11,600	11,500	11,600	11,600	11,500
Sierra Leone	50	150	150	150	150
South Africa	6,420 [r]	6,010 [r]	6,470 [r]	6,700	6,530
Tanzania	15	35	53 [r]	38 [r]	33
Venezuela	17	36	80 [r]	38 [r]	40
Zimbabwe	19	30	15 [r]	-- [r]	--
Other	44 [r]	52 [r]	64 [r]	66 [r]	68
Total	68,700	57,800 [r]	55,500 [r]	49,500 [r]	55,200
Grand total	129,000	119,000 [r]	117,000 [r]	119,000 [r]	132,000

[r]Revised. -- Zero.

[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through May 27, 2003.

[3]In addition to the countries listed, natural diamond is produced in Nigeria, but information is inadequate to estimate output.

[4]Includes near-gem and cheap-gem qualities.

[5]Reported figure.

Gemstones

By Donald W. Olson

Domestic survey data and tables were prepared by Nicholas A. Muniz and Christine K. Pisut, statistical assistants, and the world production table was prepared by Glenn J. Wallace, international data coordinator.

In this report, the terms “gem” and “gemstone” mean any mineral or organic material (such as amber, pearl, and petrified wood) used for personal adornment, display, or object of art because it possesses beauty, durability, and rarity. Of more than 4,000 mineral species, only about 100 possess all these attributes and are considered to be gemstones. Silicates other than quartz compose the largest group of gemstones; oxides and quartz compose the second largest (table 1). A further subcategory of gemstones is colored gemstone, which in this report designates all nondiamond gemstones, including amber, coral, and shell. In addition, laboratory-created gemstones, cultured pearls, and gemstone simulants are discussed but are treated separately from natural gemstones (table 2). Trade data in this report are from the U.S. Census Bureau. Quantities are reported in carats unless otherwise noted. All percentages in the report were computed based on the unrounded data. Current information on industrial-grade diamond and industrial-grade garnet can be found in the U.S. Geological Survey (USGS) Minerals Yearbook chapters on industrial diamond and industrial garnet.

Gemstones have fascinated humans since prehistoric times. They have been valued as treasured objects throughout history by all societies in all parts of the world. Amber, amethyst, coral, diamond, emerald, garnet, jade, jasper, lapis lazuli, pearl, rock crystal, ruby, serpentine, and turquoise are some of the first stones known to have been used for making jewelry. These stones served as symbols of wealth and power. Today, gems are worn more for pleasure or in appreciation of their beauty than to demonstrate wealth. In addition to jewelry, gemstones are used for collections, decorative art objects, and exhibits.

Production

Commercial mining of gemstones has never been extensive in the United States. More than 60 varieties of gemstones have been produced commercially from domestic mines, but most of the deposits have been relatively small compared with other mining operations. In the United States, much of the current gemstone mining is conducted by collectors, gem clubs, and hobbyists rather than by businesses.

The commercial gemstone industry in the United States consists of individuals and companies that mine gemstones or harvest shell and pearl, firms that manufacture laboratory-created gemstones, and individuals and companies that cut natural and laboratory-created gemstones. The domestic gemstone industry is focused on the production of colored gemstones and on the cutting of large diamonds. Industry employment is estimated to range from 1,000 to 1,500 workers (U.S. International Trade Commission, 1997, p. 1).

Most natural gemstone producers in the United States are small businesses that are widely dispersed and operate independently. The small producers probably have an average of less than three employees, including those who only work part time. The number of gemstone mines operating from year to year fluctuates because the uncertainty associated with the discovery and marketing of gem-quality minerals makes it difficult to obtain financing for developing and sustaining economically viable deposits (U.S. International Trade Commission, 1997, p. 23).

The total value of natural gemstones produced in the United States during 2003 was estimated to be at least $12.5 million (table 3). The production value decreased slightly from that of the preceding year.

The estimate of 2003 U.S. gemstone production was based on a survey of more than 230 domestic gemstone producers conducted by the USGS. The survey provided a foundation for projecting the scope and level of domestic gemstone production during the year. However, the USGS survey did not represent all gemstone activity in the United States, which includes thousands of professional and amateur collectors. Consequently, the USGS supplemented its survey with estimates of domestic gemstone production from related published data, contacts with gemstone dealers and collectors, and information garnered at gem and mineral shows.

Natural gemstone materials indigenous to the United States are collected, produced, and/or marketed in every State. During 2003, all 50 States produced at least $1,000 worth of gemstone materials. Seven States accounted for 77% of the total value, as reported by survey respondents. These States, in order of declining value of production, were Tennessee, Arizona, Oregon, California, Nevada, Montana, and Idaho. Some States were known for the production of a single gemstone material—Tennessee for freshwater pearls, for example. Other States produced a variety of gemstones, for example Arizona, whose gemstone deposits included agate, amethyst, azurite, chrysocolla, garnet, jade, jasper, malachite, obsidian, onyx, opal, peridot, petrified wood, smithsonite, and turquoise. There is also a wide variety of gemstones found and produced in California, Idaho, Montana, and North Carolina.

The United States has two significant operations in known diamond-bearing areas. The first, the Kelsey Lake diamond mine, is the United States’ only commercial diamond mine and is close to the Colorado-Wyoming State line near Fort Collins, CO. Kelsey Lake did not report any production during 2003. The mine is owned and operated by Great Western Diamond Co. (a subsidiary of McKenzie Bay International, Ltd. of Canada). The Kelsey Lake property includes nine known kimberlite pipes, of which three have been tested and have shown that diamonds are present. The remaining six pipes have yet to be fully explored and tested for their diamond potential. Of the diamonds recovered, 50% to 65% was clear gem quality, and almost one-third was one carat or larger in size. The identified resources are at least 17 million metric tons (Mt) grading an average of 4 carats per 100 metric tons (Taylor Hard Money Advisers, 2000§[1]). Diamond was produced at Kelsey Lake through the month of April 2002. As of early 2003, the mine was in care-and-maintenance mode.

The second U.S. diamond operation is in Crater of Diamonds State Park near Murfreesboro in Pike County, AR, where a dig-for-fee operation for tourists and rockhounds is maintained by the State of Arkansas. Crater of Diamonds is the only diamond mine in the world that is open to the public. The diamonds occur in a lamproite breccia tuff associated with a volcanic pipe and in the soil developed from the lamproite breccia tuff. In 2003, 641 diamonds with an average weight of 0.2 carats were recovered at Crater of Diamonds State Park. Since the diamond-bearing pipe and the adjoining area became a State park in 1972, more than 22,000 diamonds have been recovered (J.M. Howard, geology supervisor, Arkansas Geological Commission, written commun., 2003). Exploration has demonstrated that there is about 78.5 Mt of diamond-bearing rock in this diamond deposit (Howard, 1999, p. 62). An Arkansas law, enacted early in 1999, prohibits commercial diamond mining in the park (Diamond Registry Bulletin, 1999).

Studies by the Wyoming Geological Survey have shown that Wyoming has the potential for a $1 billion diamond mining business. Wyoming has many of the same geologic conditions as Canada, and there is evidence of hundreds of kimberlite pipes in the State. Twenty diamondiferous kimberlite pipes and one diamondiferous mafic breccia pipe have been identified in southern Wyoming. Two of the largest kimberlite fields, State Line and Iron Mountain, and the largest lamproite field in the United States, Leucite Hills, are in Wyoming. There has been slight interest in the southern Wyoming and northern Colorado area by several diamond mining firms, but the only diamond mine developed in the area thus far is the Kelsey Lake Mine. Individual diamond gems worth $89,000 and $300,000 have been found there (Associated Press, 2002§).

In addition to natural gemstones, laboratory-created gemstones and gemstone simulants are produced in the United States. Laboratory-created or synthetic gemstones have the same chemical, optical, and physical properties as the natural materials that they appear to be. Simulants have an appearance similar to that of a natural gemstone material, but they have different chemical, optical, and physical properties. Laboratory-created gemstones produced in the United States include alexandrite, cubic zirconia, diamond, emerald, moissanite, ruby, sapphire, and turquoise. Simulants of coral, lapis lazuli, malachite, and turquoise also are manufactured in the United States. In addition, certain colors of laboratory-created sapphire and spinel, used to represent other gemstones, are classified as simulants.

Laboratory-created gemstone production in the United States was valued at more than $33.4 million during 2003; simulant gemstone output was even greater and was estimated to be valued at more than $100 million. Five firms in five States, representing virtually the entire U.S. laboratory-created gemstone industry, reported production to the USGS. The States with reported laboratory-created gemstone production, in descending production value order, were North Carolina, New York, Florida, Michigan, and Arizona.

One U.S. company, Gemesis Corp., produced consistent quality laboratory-created gem diamond and reported a fourth year of production in 2003. The laboratory-created diamonds are produced using equipment, expertise, and technology developed by a team of scientists from Russia and the University of Florida. The weight of the laboratory-created diamond stones range from 1.5 to 2 carats, and most of the stones are yellow, brownish yellow, colorless, and green (Weldon, 1999§). In 2002, Gemesis moved into a new facility near Sarasota, FL, where it started with 27 diamond-growing machines, each machine capable of growing 3-carat rough diamonds by generating temperatures and pressures that recreate the conditions in the Earth's mantle, where natural diamonds form. Gemesis eventually plans to have 250 diamond-growing machines installed (Davis, 2003). In the near future, Gemesis could be producing as much as 30,000 to 40,000 stones each year, and annual revenues may hit $70 million to $80 million (Diamond Registry Bulletin, 2001). Gemesis diamonds became available for retail purchase in jewelry stores and on the Internet in the fall of 2003. The prices of the Gemesis laboratory-created diamonds will be below those of natural diamond but still above the prices of simulated diamond (Weldon, 2003§).

A second U.S. company, Apollo Diamond, Inc., has developed and patented a method for growing gem-quality diamond by chemical vapor deposition (CVD). The CVD technique transforms carbon into plasma, which then is precipitated onto a substrate as diamond. CVD has been used for more that a decade to cover large surfaces with microscopic diamond crystals, but until this process, no one had discovered the combination of temperature, gas composition, and pressure that resulted in the growth of a single diamond crystal. Robert Linares of Apollo Diamond received a patent for the process in June 2003. Now CVD diamond can be grown for about $5 per carat. CVD diamond precipitates as nearly 100% pure, almost flawless diamond, and therefore may not be discernible from natural diamond. Apollo Diamond is planning to start selling their diamonds in the jewelry market during 2004 (Davis, 2003).

In 2003, a North Carolina firm entered its sixth year of marketing moissanite, a gem-quality laboratory-created silicon carbide it produces. Moissanite is also an excellent diamond simulant, but it is being marketed for its own gem qualities.

Consumption

Although the United States accounts for little of the total global gemstone production, it is the world's leading gemstone market. U.S. gemstone markets accounted for more than an estimated 35% of world gemstone demand in 2003. The U.S. market for unset gem-quality diamond during the year was estimated to have exceeded $12.9 billion. Domestic markets for natural, unset nondiamond gemstones totaled nearly $816 million.

In the United States about two-thirds of domestic consumers designate diamond as their favorite gemstone when surveyed. In 2003, the top 10 selling colored gemstones, in descending order,

[1]References that include a section mark (§) are found in the Internet References Cited section.

were blue sapphire, ruby, tanzanite, emerald, amethyst, blue topaz, tsavorite garnet, aquamarine, opal, and green tourmaline. Only 25% of the jewelry retailers said their sales were down in 2003 compared with 27% in 2002. During 2003, almost 50% of the retail gemstone jewelry purchases were in the under $500 price range. Sixty-six percent of U.S. jewelry retailers said their customers show a lack of concern about political issues, such as human-rights violations or possible criminal connections with gemstone mining. Eighty-two percent of the retailers said that news reports on such issues did not have an impact on their jewelry sales (Prost, 2003; Wade, 2004). During the 2003 holiday season, overall U.S. retail sales increased by 5.2% compared with the previous year (by value). Jewelers and luxury retailers generally posted higher increases than the overall sales increases compared with sales of the 2002 holiday shopping season (Diamond Registry Bulletin, 2004a). In 2003, the value of the U.S. diamond jewelry market increased by 6% from that of 2002 to $29.1 billion (Diamond Registry Bulletin, 2004g). The U.S. market accounted for about 56% of the global diamond jewelry retail market in 2003 (Rosen, 2004§).

Prices

Gemstone prices are governed by many factors and qualitative characteristics, including beauty, clarity, defects, demand, durability, and rarity. Diamond pricing, in particular, is complex; values can vary significantly depending on time, place, and the subjective evaluations of buyers and sellers. There are more than 14,000 categories used to assess rough diamond and more than 100,000 different combinations of carat, clarity, color, and cut values used to assess polished diamond (Pearson, 1998).

Colored gemstone prices are generally influenced by market supply and demand considerations, and diamond prices are supported by producer controls on the quantity and quality of supply. Values and prices of gemstones produced and/or sold in the United States are listed in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported, exported, or reexported are listed in tables 6 through 10.

De Beers Group companies are a significant force affecting gem diamond prices worldwide because they mine more than 40% of the diamonds produced each year (De Beers Group, 2004§). De Beers companies also sort and valuate about two-thirds (by value) of the world's annual supply of rough diamonds through De Beers' subsidiary Diamond Trading Co. (DTC), which has marketing agreements with other producers (De Beers Group, 2003§).

Foreign Trade

During 2003, total U.S. gemstone trade with all countries and territories was valued at about $18.7 billion, which was approximately 8% more than gemstone trade of the previous year. Diamond accounted for about 96% of the 2003 gemstone trade total. In 2003, U.S. exports and reexports of diamond were shipped to 74 countries and territories, and imports of all gemstones were received from 114 countries and territories (tables 6-10). During 2003, U.S. trade in cut diamonds increased by about 6% compared with the previous year, and the United States remained the world's leading diamond importer. The United States is a significant international diamond transit center as well as the world's leading gem diamond market. The large volume of reexports shipped to other centers reveals the significance that the United States has in the world's diamond supply network (table 6).

In 2003, trade in laboratory-created gemstone decreased by more than 3% for the United States, compared with the previous year. Laboratory-created gemstone imports from China, Germany, Hong Kong, Sri Lanka, Switzerland, and Thailand made up almost 90% (by value) of the total domestic imports of laboratory-created gemstones during the year. Prices of certain laboratory-created gemstone imports, such as amethyst, were very competitive. The marketing of imported laboratory-created gemstones and enhanced gemstones as natural gemstones and the mixing of laboratory-created materials with natural stones in imported parcels continued to be problems for some domestic producers in 2003. There also were problems with some simulants being marketed as laboratory-created gemstones during the year.

World Industry Structure

The gemstone industry worldwide has two distinct sectors—diamond mining and marketing and the production and sale of colored gemstones. Most diamond supplies are controlled by a few major mining companies; prices are supported by managing the quality and quantity of the gemstones relative to demand, a function performed by De Beers through DTC. Unlike diamonds, colored gemstones are primarily produced at relatively small, low-cost operations with few dominant producers; prices are influenced by consumer demand and supply availability.

In 2003, world diamond production totaled about 150 million carats—80.9 million carats gem quality and 69.5 million carats industrial grade (table 11). Most production was concentrated in a few regions—Africa [Angola, Botswana, Congo (Kinshasa), Namibia, and South Africa], Asia (northeastern Siberia and Yakutia in Russia), Australia, North America (Northwest Territories in Canada), and South America (Brazil and Venezuela). In 2002, Australia led the world in total diamond output quantity (combined gemstone and industrial), and Botswana was the world's leading gemstone diamond producer in terms of output value and quantity.

De Beers reported that its sales of rough diamonds for 2003 were $5.5 billion, which was up by 7% from $5.15 billion in 2002 (Diamond Registry Bulletin, 2004e).

The Antwerp [Belgium] High Council's Hoge Raad voor Diamant Diamond Office reported that polished diamond exports increased by 11.9% to $7.19 billion during 2003, compared to $6.42 billion in 2002. Israel's polished diamond exports increased by 5.9% to $5.53 billion during 2003, and its exports of rough diamond increased by 37.8% to $2.29 billion. The United States was the leading diamond trading partner for both Belgium and Israel (Diamond Registry Bulletin, 2004b).

Additional events in 2003 significant to diamond mining, production, and marketing worldwide include the following:

The Ekati Diamond Mine, Canada's first operating commercial diamond mine, completed its fifth full year of production. In 2003, Ekati produced 5.57 million carats of diamond from 4.46 Mt of ore (BHP Billiton Ltd., 2004b). BHP Billiton Ltd. has an 80% controlling ownership of the Ekati, which is located in the Northwest Territories in Canada. Ekati has estimated reserves of 60.3 Mt of ore in kimberlite pipes that contain 54.3 million carats of diamond, and Ekati projects the mine life to be 25 years. Ekati diamonds are sold by BHP's Antwerp sales office. The Ekati Mine is now producing from the Koala, Panda, and Misery kimberlite pipes. In November 2002, BHP began using underground mining techniques to recover diamonds from deeper portions of the Koala kimberlite pipe, which was first open pit mined (Diamond Registry Bulletin, 2002). Plans have now been approved for underground mining of deeper portions of the adjacent Panda kimberlite pipe, and initial production is expected in early 2005 (BHP Billiton Ltd., 2004a).

The Diavik Diamond Mine, also in the Northwest Territories, has estimated its reserves to be 25.6 Mt of ore in kimberlite pipes, containing 107 million carats of diamond, and Diavik projects the mine life to be 16 to 22 years. Diavik is an unincorporated joint venture between Diavik Diamond Mines Inc. (60%) and Aber Diamond Mines Ltd. (40%). The Diavik Mine began diamond production in December 2002, and it achieved full production by February 2003—60 days ahead of the projected opening date (Professional Jeweler, 2002§). In 2003, Diavik produced 3.8 million carats of diamond from 1.3 Mt of ore. The mine is expected to produce about 107 million carats of diamond at a rate of 8 million carats per year worth about $63 per carat (Diavik Diamond Mines Inc., 2000, p. 10-12; 2004).

A third Canadian commercial diamond project in the Northwest Territories is the Snap Lake diamond project. De Beers Canada Mining Inc. has projected that Snap Lake would begin production in 2006 or 2007 (Law-West, 2002). The Snap Lake diamond project estimates its reserves to be 22.8 Mt of ore in a kimberlite dike that contain about 38.8 million carats of diamond. The mine life is projected to be 20 years or more (Jack T. Haynes, assistant site manager, De Beers Canada Mining Inc., oral commun., 2001).

In 2002, an international rough diamond certification system called the Kimberley Process Certification Scheme (KPCS) was implemented to solve the problem of conflict diamonds—rough diamonds used by rebel forces and their allies to help finance warfare aimed at subverting governments recognized as legitimate by the United Nations (U.N.). The KPCS was agreed upon by U.N. member nations, the diamond industry, and involved nongovernmental organizations. The KPCS includes the following key elements: the use of forgery-resistant certificates and tamper-proof containers for shipments of rough diamonds; internal controls and procedures that provide credible assurance that conflict diamonds do not enter the legitimate diamond market; a certification process for all exports of rough diamonds; the gathering, organizing, and sharing of import and export data on rough diamonds with other participants of relevant production; credible monitoring and oversight of the international certification scheme for rough diamonds; effective enforcement of the provisions of the certification scheme through dissuasive and proportional penalties for violations; self-regulation by the diamond industry that fulfills minimum requirements; and the sharing of information with all other participants on relevant rules, procedures, and legislation as well as examples of national certificates used to accompany shipments of rough diamonds (Weldon, 2001§). The KPCS will not be fully implemented until all participating countries have passed the necessary laws to carry it out.

In the United States, the Clean Diamond Trade Act, which will implement effective measures to stop trade in conflict diamonds, was passed by the U.S. House of Representatives on November 28, 2001, and by the U.S. Senate on January 7, 2003. The President signed the Act into law on April 25, 2003. Enactment of the Clean Diamond Trade Act made the United States a full participant in the KPCS (U.S. House of Representatives, 2003§). U.S. participation is critical to the success of the KPCS in excluding conflict diamonds from the legitimate supply chain because the United States has the largest part of the world diamond market. The industry and trade associations have played an active role in achieving this progress in ending the problem of conflict diamonds (Professional Jeweler, 2003§).

Near the end of 2003, De Beers and the U.S. Department of Justice began work toward settlement of its long-running dispute over alleged illegal price fixing. On July 13, 2004, De Beers Centenery AG pled guilty in Federal court in Ohio to conspiring to fix the price of industrial diamond in the United States and elsewhere, resolving a 1994 case. De Beers was sentenced to pay a $10 million fine. With this settlement, De Beers is now free to enter the U.S. market (Diamond Registry Bulletin, 2004f, h).

Worldwide production of natural gemstones other than diamond was estimated to have exceeded $2 billion in 2003. Most nondiamond gemstone mines are small, low-cost, and widely dispersed operations in remote regions of developing nations. Foreign countries with major gemstone deposits other than diamond are Afghanistan (aquamarine, beryl, emerald, kunzite, lapis lazuli, ruby, and tourmaline), Australia (beryl, opal, and sapphire), Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline), Burma (beryl, jade, ruby, sapphire, and topaz), Colombia (beryl, emerald, and sapphire), Kenya (beryl, garnet, and sapphire), Madagascar (beryl, rose quartz, sapphire, and tourmaline), Mexico (agate, opal, and topaz), Sri Lanka (beryl, ruby, sapphire, and topaz), Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline), and Zambia (amethyst and beryl). In addition, pearls are cultured throughout the South Pacific and in other equatorial waters; Australia, China, French Polynesia, and Japan are key producers.

The U.S. colored gemstone market posted an overall increased sales during 2003 compared with the previous years sales. There were 3 months in which colored stone trade contracted—March, April, and November. Colored stone sales in April were at their lowest level since November 2001, as the general slowdown in business finally was reflected in the wholesale end of colored stone trade (Colored Stone, 2003, 2004a, b).

The popularity of colored gemstones, colored laboratory-created gemstones, and "fancy" colored diamonds continued to increase in 2003. This was indicated by a recent survey by the Jewelry Consumer Opinion Council (Diamond Registry Bulletin, 2004d). Colored stone popularity also was evidenced by their general increased sales in 2003 (Colored Stone, 2003, 2004a, b).

Tanzanite continued to increased in popularity, moving up to third best selling stone in 2003 from fourth best selling colored stone in 2002. This increase is in part owing to the American Gem Trade Association (a United States and Canadian trade association) adding tanzanite to the traditional list of birthstones for December in 2002. It is by far the most popular of blue and violet-blue gemstones after sapphire. Tanzanite is characterized by combinations of royal blue and burgundy hues, which have an almost universal appeal. While some tanzanite displays a trace of blue when it is originally mined, most crystals emerge from the Earth with a muted gray-green color. All tanzanite has been subjected to a heat process to produce the violet-blue hues. The only known source of tanzanite is a 5-square-mile area in the hills of Merelani, 10 miles south of the Kilimanjaro International Airport, between Moshi and Arusha in Tanzania. Its rarity appears to also add to tanzanite's growing popularity among consumers.

Though U.S. shell production increased by 72% in 2003 compared with 2002, shell is not expected to ever be the large segment of U.S. gemstone production it was for several years in the past. The U.S. shell material from mussels is used as seed material for culturing pearls. The lower shell production is owing to overharvesting in past years, the killing off of U.S. native mussel species by invasive exotic species, and a decline in market demand. During the past 10 years, the United States has lost about three-quarters of the native mussel population, and one-half of the approximately 300 total U.S. native mussel species are now listed as endangered species. The zebra mussel is the invasive exotic species that has done most of the damage, and it has been introduced into U.S. rivers and waterways in discharged ballast water from transoceanic ships (Iowa Department of Natural Resources, 2001§; Scott Gritterf, fisheries biologist, Iowa Department of Natural Resources, oral commun., November 14, 2002). The market still has not completely recovered from the die-off of Japanese oysters. Seed material had been stockpiled in Japan, and now producers in Japan are using manmade seed materials or seed materials from China and other sources in addition to the stockpiled material. There also has been an increase in the popularity of darker and colored pearls that do not use U.S. seed material (Ted Kroll, assistant director of fisheries, Kentucky Department of Fish and Wildlife, oral commun., November 15, 2002).

Outlook

There are indications that there will be continued growth in U.S. diamond and jewelry markets in 2004. Historically, diamonds have proven to hold their value despite wars or economic depressions (Schumann, 1998, p. 8).

Diamond exploration is continuing in Canada, and many new deposits have been found. There are several other commercial diamond projects and additional discoveries located in Alberta, British Columbia, Northwest Territories, Nunavut, Ontario, and Quebec. Canada produced about 15% of the world's diamond in 2003, and in price per carat of diamond produced, Canada outranked many of the world's traditionally major diamond-mining countries (Diamond Registry Bulletin, 2004c). If Canadian production continues to increase at about the same rate, Canada will probably eclipse South Africa's diamond production within a decade.

Independent producers, such as Argyle Diamond Mines in Australia and Ekati and Diavik in Canada, will continue to bring a greater measure of competition to global markets. More competition presumably will bring more supplies and lower prices. Further consolidation of diamond producers and larger amounts of rough diamond being sold outside DTC will continue as the diamond industry adjusts to De Beers' reduced influence on the industry.

More laboratory-created gemstones, simulants, and treated gemstones will enter the marketplace and necessitate more transparent trade industry standards to maintain customer confidence.

Internet sales of diamonds, gemstones, and jewelry will continue to grow and increase in popularity, as will other forms of e-commerce that emerge to serve the diamond and gemstone industry. This will take place as the gemstone industry and its customers become more comfortable with and learn the applications of new e-commerce tools (Diamond Registry Bulletin, 2004i, j).

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TABLE 1
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0-2.5	1.0-1.1	Single	1.54	Synthetic or pressed plastics, kaurigum	Fossil resin, color, low density, soft and trapped insects.
Apatite	Chloro-calcium phosphate	Colorless, pink, yellow, green, blue, violet	Small	Low	5.0	3.16-3.23	Double	1.63-1.65	Amblygonite, andalusite, brazilianite, precious beryl, titanite, topaz, tourmaline	Crystal habit, color, hardness, and appearance.
Azurite	Copper carbonate hydroxide	Azure, dark blue, pale blue	Small to medium	do.	3.5-4.0	3.7-3.9	do.	1.72-1.85	Dumortierite, hauynite, lapis lazuli, lazulite, sodalite	Color, softness, crystal habits and associated minerals.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	do.	High	6.0-6.5	3.64-3.68	do.	1.76-1.80	Sapphire, tanzanite, blue diamond, blue tourmaline, cordierite	Strong blue in ultraviolet light.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5-8.0	2.63-2.80	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	Red	Small	Very high	7.5-8.0	2.63-2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald	do.	Green	Medium	do.	7.5	2.63-2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5-8.0	2.63-2.80	do.	1.58	Genuine emerald	Lack of flaws, brilliant fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5-8.0	2.63-2.80	do.	1.58	Citrine, topaz, glass, doublets	Weak-colored.
Goshenite	do.	Colorless	do.	Low	7.5-8.0	2.63-2.80	do.	1.58	Quartz, glass, white sapphire, white topaz	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5-8.0	2.63-2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49-1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.60	do.	Banded, translucent.
Charoite	Hydrated sodium calcium hydroxi-fluoro-silicate	Lilac, violet, or white	Small to medium	do.	5.0-6.0	2.54-2.78	XX	1.55-1.56	Purple marble	Color, locality.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day light, red by artificial light	Small (CIS[3]); medium (Sri Lanka)	High	8.5	3.50-3.84	Double	1.75	Synthetic	Strong dichroism, color varies from red to green, hardness.
Cats-eye	do.	Greenish to brownish	Small to large	do.	8.5	3.50-3.84	do.	1.75	Synthetic, shell	Density, translucence, chatoyance.
Chrysolite	Beryllium aluminate	Yellow, green, and/or brown	Medium	Medium	8.5	3.50-3.84	Double	1.75	Tourmaline, peridot	Refractive index, silky.

See footnotes at end of table.

TABLE 1--Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Chrysocolla	Hydrated copper silicate	Green, blue	Any	Low	2.0-4.0	2.0-2.4	XX	1.46-1.57	Azurite, dyed chalcedony, malachite, turquoise, variscite	Lack of crystals, color, fracture, low density and softness.
Coral	Calcium carbonate	Orange, red, white, black, purple, or green	Branching, medium	do.	3.5-4.0	2.6-2.7	Double	1.49-1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95-4.10	do.	1.78	Synthetics, including spinel, garnet	Inclusions, fluorescence.
Sapphire, blue	do.	Blue	Medium	High	9.0	3.95-4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, colorless, orange, green, or violet	Medium to large	Medium	9.0	3.95-4.10	do.	1.78	Synthetics, glass and doublets, morganite	Inclusions, double refraction, refractive index.
Sapphire and ruby, stars	do.	Red, pink, violet, blue, or gray	do.	High to low	9.0	3.95-4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.
Sapphire or ruby, synthetic	do.	Yellow, pink, or blue	Up to 20 carats	Low	9.0	3.95-4.10	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Cubic zirconia	Zirconium and yttrium oxides	Colorless, pink, blue, lavender, yellow	Small	do.	8.25-8.5	5.8	Single	2.17	Diamond, zircon, titania, moissanite	Hardness, density, refractive index, lack of flaws and inclusions.
Diamond	Carbon	White, blue-white, yellow, brown, green, red, pink, blue	Any	Very high	10.0	3.516-3.525	do.	2.42	Zircon, titania, cubic zirconia, moissanite	High index, dispersion, hardness, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green-blue	Large	Low	6.0-6.5	2.56	XX	1.52	Jade, turquoise	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play (schiller)	do.	do.	6.0-6.5	2.56	XX	1.56	do.	Do.
Moonstone	do.	Colorless, white, gray, or yellow with white, blue, or bronze schiller	do.	do.	6.0-6.5	2.77	XX	1.52-1.54	Glass, chalcedony, opal	Pale sheen, opalescent.
Sunstone	do.	Orange, red brown, colorless with gold or red glittery schiller	Small to medium	do.	6.0-6.5	2.77	XX	1.53-1.55	Aventurine, glass	Red glittery schiller.
Garnet	Complex silicate	Brown, black, yellow, green, red, or orange	do.	Low to high	6.5-7.5	3.15-4.30	Single strained	1.79-1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Hematite	Iron oxide	Black, black-gray, brown-red	Medium to large	Low	5.5-6.5	5.12-5.28	XX	2.94-3.22	Davidite, cassiterite, magnetite, neptunite, pyrolusite, wolframite	Crystal habit, streak and hardness.
Jade:										
Jadeite	Complex silicate	Green, yellow, black, white, or mauve	Large	Low to very high	6.5-7.0	3.3-3.5	Crypto-crystalline	1.65-1.68	Nephrite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.

See footnotes at end of table.

TABLE 1--Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Jade--Continued:										
Nephrite	Complex hydrous silicate	Green, yellow, black, white, or mauve	Large	Low to very high	6.0-6.5	2.96-3.10	Crypto-crystalline	1.61-1.63	Jadeite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.
Jet (gagate)	Lignite	Deep black, dark brown	do.	Low	2.5-4.0	1.19-1.35	XX	1.64-1.68	Anthracite, asphalt, cannel coal, onyx, schorl, glass, rubber	Luster, color.
Lapis lazuli	Sodium calcium aluminum silicate	Dark azure-blue to bright indigo blue or even a pale sky blue.	do.	do.	5.0-6.0	2.50-3.0	XX	1.50	Azurite, dumortierite, dyed howlite, lazulite, sodalite, glass	Color, crystal habit, associated minerals, luster, and localities.
Malachite	Hydrated copper carbonate	Light to black-green banded	do.	do.	3.5-4.0	3.25-4.10	XX	1.66-1.91	Brochantite, chrysoprase, opaque green gemstones	Color banding, softness, associated minerals.
Moissanite	Silicon carbide	Colorless and pale shades of green, blue, yellow	Small	Low to medium	9.25	3.21	Double	2.65-2.69	Diamond, zircon, titania, cubic zirconia	Hardness, dispersion, refractive index, lack of flaws and inclusions.
Obsidian	Amorphous, variable (usually felsic)	Black, gray, brown, dark green, white, transparent	Large	Low	5.0-5.5	2.35-2.60	XX	1.45-1.55	Aegirine-augite, gadolinite gagate, hematite, pyrolusite, wolframite	Color, conchoidal fracture, flow bubbles, softness, and lack of crystal faces.
Opal	Hydrated silica	Reddish orange, colors flash in white gray, black, red, or yellow	do.	Low to high	5.5-6.5	1.9-2.3	Single	1.45	Glass, synthetics, triplets, chalcedony	Color play (opalescence).
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5-7.0	3.27-3.37	Double (strong)	1.65-1.69	Tourmaline, chrysoberyl	Strong double refraction, low dichroism.
Quartz:										
Agate	Silicon dioxide	Any	Large	Low	7.0	2.58-2.64	XX	XX	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65-2.66	Double	1.55	Glass, plastic, fluorite	Macrocrystalline, refractive index, color, transparent, hardness.
Aventurine	do.	Green, red-brown, gold-brown, with metallic iridescent reflection	do.	Low	7.0	2.64-2.69	do.	1.54-1.55	Iridescent analcime, aventurine feldspar, emerald, aventurine glass	Macrocrystalline, color, metallic iridescent flake reflections, hardness.
Cairngorm	do.	Smoky orange or yellow	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Macrocrystalline, refractive index, color, transparent, hardness.
Carnelian	do.	Flesh red to brown red	do.	do.	6.5-7.0	2.58-2.64	do.	1.53-1.54	Jasper	Cryptocrystalline, color, hardness.
Chalcedony	do.	Bluish, white, gray	do.	do.	6.5-7.0	2.58-2.64	do.	1.53-1.54	Tanzanite	Do.
Chrysoprase	do.	Green, apple-green	do.	do.	6.5-7.0	2.58-2.64	do.	1.53-1.54	Chrome chalcedony, jade, prase opal, prehnite, smithsonite, variscite, artifically colored green chalcedony	Do.
Citrine	Silica	Yellow	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Macrocrystalline, refractive index, color, transparent, hardness.
Crystal:										
Rock	do.	Colorless	do.	do.	7.0	2.65-2.66	do.	1.55	Topaz, colorless sapphire	Do.

See footnotes at end of table.

TABLE 1--Continued
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Crystal--Continued:										
Jasper	Silica	Any, striped, spotted, or sometimes uniform	Large	Low	7.0	2.58-2.66	XX	XX	Topaz, colorless sapphire	Cryptocrystalline, opaque, vitreous luster, hardness.
Onyx	do.	Many colors	do.	do.	7.0	2.58-2.64	XX	XX	do.	Cryptocrystalline, uniformly banded, hardness.
Petrified wood	do.	Brown, gray, red, yellow	do.	do.	6.5-7.0	2.58-2.91	Double	1.54	Agate, jasper	Color, hardness, wood grain.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Macrocrystalline, refractive index, color, transparent, hardness.
Tiger's eye	do.	Golden yellow, brown, red, blue-black	do.	do.	6.5-7.0	2.58-2.64	XX	1.53-1.54	XX	Macrocrystalline, color, hardness, hatoyancy.
Rhodochrosite	Manganese carbonate	Rose-red to yellowish, stripped	do.	do.	4.0	3.45-3.7	Double	1.6-1.82	Fire opal, rhodonite, tugtupite, tourmaline	Color, crystal habit, reaction to acid, and perfect rhombohedral cleavage.
Rhodonite	Manganese iron calcium silicate	Dark red, flesh red, with dendritic inclusions of black manganese oxide	do.	do.	5.5-6.5	3.40-3.74	do.	1.72-1.75	Rhodochrosite, thulite, hessonite, pyroxmangite, spessartine, spinel, tourmaline	Color, black inclusions, lack of reaction to acid and hardness.
Shell:										
Mother-of-pearl	Calcium carbonate	White, cream, green, blue-green, with iridescent play of color	Small	Low	3.5	2.6-2.85	XX	XX	Glass and plastic imitation	Luster, iridescent play of color.
Pearl	do.	White, cream to black, sometimes with hint of pink, green, purple	do.	Low to high	2.5-4.5	2.6-2.85	XX	XX	Cultured and glass or plastic imitation	Luster, iridescence, structure, x-ray.
Spinel	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5-3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5-3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5-7.0	3.13-3.20	do.	1.66	Synthetic spinel	Refractive index, color, pleochroism.
Kunzite	do.	Pink to lilac	do.	do.	6.5-7.0	3.13-3.20	do.	1.66	Amethyst, morganite	Do.
Tanzanite	Complex silicate	Blue to lavender	Small	High	6.0-7.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism, color.
Topaz	do.	White, blue, green, pink, yellow, gold	Medium	Low to medium	8.0	3.4-3.6	do.	1.62	Beryl, quartz	Color, density, hardness, refractive index, perfect in basal cleavage.
Tourmaline	do.	Any, including mixed	do.	do.	7.0-7.5	2.98-3.20	do.	1.63	Peridot, beryl, garnet corundum, glass	Double refraction, color, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green with black, brown-red inclusions	Large	Low	6.0	2.60-2.83	do.	1.63	Glass, plastics, variscite, dumortierite, chrysocolla dyed howlite	Difficult if matrix not present, matrix usually limonitic.
Unakite	Granitic rock, feldspar, epidote, quartz	Olive green, pink, and blue-gray	do.	do.	6.0-7.0	2.60-3.20	XX	XX	XX	Olive green, pink, and gray-blue colors.

See footnotes at end of table.

TABLE 1--Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Zircon	Zirconium silicate	White, blue, brown, yellow, or green	Small to medium	Low to medium	6.0-7.5	4.0-4.8	Double (strong)	1.79-1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

XX Not applicable.
[1]Small: up to 5 carats; medium: 5 to 50 carats; large: more than 50 carats.
[2]Low: up to $25 per carat; medium: up to $200 per carat; high: more than $200 per carat.
[3]Commonwealth of Independent States.

TABLE 2
LABORATORY-CREATED GEMSTONE PRODUCTION METHODS

Gemstone	Production method	Company/producer	Date of first production
Alexandrite	Flux	Creative Crystals	1970s.
Do.	Melt pulling	J.O. Crystal	1990s.
Do.	do.	Kyocera	1980s.
Do.	Zone melt	Seiko	1980s.
Cubic zirconia	Skull melt	Various producers	1970s.
Emerald	Flux	Chatham	1930s.
Do.	do.	Gilson	1960s.
Do.	do.	Kyocera	1970s.
Do.	do.	Seiko	1980s.
Do.	do.	Lennix	1980s.
Do.	do.	Russia	1980s.
Do.	Hydrothermal	Lechleitner	1960s.
Do.	do.	Regency	1980s.
Do.	do.	Biron	1980s.
Do.	do.	Russia	1980s.
Ruby	Flux	Chatham	1950s.
Do.	do.	Kashan	1960s.
Do.	do.	J.O. Crystal	1980s.
Do.	do.	Douras	1990s.
Do.	Zone melt	Seiko	1980s.
Do.	Melt pulling	Kyocera	1970s.
Do.	Verneuil	Various producers	1900s.
Sapphire	Flux	Chatham	1970s.
Do.	Zone melt	Seiko	1980s.
Do.	Melt pulling	Kyocera	1980s.
Do.	Verneuil	Various producers	1900s.
Star ruby	do.	Linde	1940s.
Do.	Melt pulling	Kyocera	1980s.
Do.	do.	Nakazumi	1980s.
Star sapphire	Verneuil	Linde	1940s.

TABLE 3
VALUE OF U.S. GEMSTONE PRODUCTION, BY TYPE[1]

(Thousand dollars)

Gem materials	2002	2003
Beryl	9	18
Coral, all types	108	118
Diamond	(2)	(2)
Garnet	46	56
Gem feldspar	379 e	659
Geode/nodules	(3)	(3)
Opal	(3)	(3)
Quartz:		
Macrocrystalline[4]	246	228
Cryptocrystalline[5]	84	391
Sapphire/ruby	212	474
Shell	1,440	2,490
Topaz	(3)	(3)
Tourmaline	105	48
Turquoise	540	827
Other	8,420	3,450
Total	12,600	12,500

See footnotes at end of table.

TABLE 3--Continued
VALUE OF U.S. GEMSTONE PRODUCTION, BY TYPE[1]

[e]Estimated.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Included with "Other."
[3]Included in "Total."
[4]Macrocrystalline quartz (crystals recognizable with the naked eye) includes amethyst, amethyst quartz, aventurine, blue quartz, citrine, hawk's eye, pasiolite, prase, quartz cat's eye, rock crystal, rose quartz, smoky quartz, and tiger's eye.
[5]Cryptocrystalline (microscopically small crystals) includes agate, carnelian, chalcedony, chrysoprase, fossilized wood, heliotrope, jasper, moss agate, onyx, and sard.

TABLE 4
PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY IN 2003[1]

Carat weight	Description, color[3]	Clarity[2] (GIA terms)	Representative prices January[4]	June[5]	December[6]
0.25	G	VS1	$1,200	$1,200	$1,200
do.	G	VS2	1,150	1,150	1,150
do.	G	SI1	975	975	975
do.	H	VS1	1,100	1,100	1,100
do.	H	VS2	1,000	1,000	1,000
do.	H	SI1	925	925	925
0.50	G	VS1	3,200	3,200	3,200
do.	G	VS2	2,800	2,800	2,800
do.	G	SI1	2,400	2,400	2,400
do.	H	VS1	2,800	2,800	2,800
do.	H	VS2	2,400	2,400	2,400
do.	H	SI1	2,200	2,200	2,200
0.75	G	VS1	3,600	3,600	3,600
do.	G	VS2	3,500	3,500	3,500
do.	G	SI1	3,200	3,200	3,200
do.	H	VS1	3,300	3,300	3,300
do.	H	VS2	3,200	3,200	3,200
do.	H	SI1	2,900	2,900	2,900
1.00	G	VS1	5,800	5,800	5,800
do.	G	VS2	5,500	5,500	5,500
do.	G	SI1	4,800	4,800	4,800
do.	H	VS1	5,200	5,200	5,200
do.	H	VS2	4,900	4,900	4,900
do.	H	SI1	4,700	4,700	4,700

[1]Data are rounded to no more than three significant digits.
[2]Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; G, H, I—traces of color.
[3]Clarity: IF—no blemishes; VVS1—very, very slightly included; VS1—very slightly included; VS2—very slightly included, but not visible; SI1—slightly included.
[4]Source: Jewelers' Circular Keystone, v. 174, no. 2, February 2003, p. 44.
[5]Source: Jewelers' Circular Keystone, v. 174, no. 7, July 2003, p. 52.
[6]Source: Jewelers' Circular Keystone, v. 175, no. 1, January 2004, p. 28.

TABLE 5
PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES IN 2003

Gemstone	Price range per carat January[1]	December[2]
Amethyst	$7-14	$7-14
Blue sapphire	650-1,000	650-1,000
Blue topaz	3-5	3-5
Emerald	1,500-2,000	1,400-2,000
Green tourmaline	70-150	45-60
Pearl:[3]		
Cultured saltwater	5	5
Natural	210	210

See footnotes at end of table.

TABLE 5--Continued
PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES IN 2003

Gemstone	Price range per carat January[1]	Price range per carat December[2]
Pink tourmaline	60-125	60-125
Rhodolite garnet	18-30	18-30
Ruby	1,000-1,400	900-1,250
Tanzanite	175-275	175-275

[1]Source: The Guide, spring/summer 2003, p. 14, 30, 45, 61, 72, 86, 96, 98, 104, 123, and 135. These figures are approximate current wholesale purchase prices paid by retail jewelers on a per stone basis for fine-quality stones.
[2]Source: The Guide, fall/winter 2002-2003, p. 14, 30, 45, 61, 72, 86, 96, 98, 104, 123, and 135. These figures are approximate current wholesale purchase prices paid by retail jewelers on a per stone basis for fine-quality stones.
[3]Prices are per 4.6 mm pearl.

TABLE 6
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY[1]

Country	2002 Quantity (carats)	2002 Value[2] (millions)	2003 Quantity (carats)	2003 Value[2] (millions)
Exports:				
Belgium	343,000	$278	14,200	$11
Canada	105,000	41	78,200	47
France	8,760	37	3,150	7
Germany	3,360	3	4,790	4
Guatemala	168,000	17	2,850	(3)
Hong Kong	251,000	89	114,000	59
India	83,100	12	34,900	5
Israel	246,000	477	38,400	39
Japan	13,800	31	17,300	19
Mexico	199,000	43	205,000	32
Netherlands	460	8	307	3
Switzerland	9,570	48	7,360	29
Thailand	28,200	5	34,400	6
United Kingdom	19,000	19	4,080	7
Other	76,500	57	141,000	67
Total	1,550,000	1,160	699,000	335
Reexports:				
Belgium	2,650,000	801	3,860,000	1,270
Canada	109,000	59	124,000	64
Dominican Republic	102,000	9	78,700	12
Hong Kong	2,470,000	381	2,670,000	471
India	1,230,000	157	1,420,000	234
Israel	4,290,000	1,250	5,700,000	1,930
Japan	181,000	35	185,000	46
Malaysia	64,200	6	28,800	5
Mexico	12,900	3	6,980	2
Singapore	158,000	20	204,000	30
Switzerland	382,000	191	409,000	283
Thailand	368,000	55	266,000	55
United Arab Emirates	253,000	71	220,000	57
United Kingdom	364,000	134	397,000	140
Other	117,000	59	207,000	92
Total	12,700,000	3,230	15,800,000	4,690
Grand total	14,300,000	4,400	16,500,000	5,020

[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY[1]

Kind, range, and country of origin	2002 Quantity (carat)	2002 Value[2] (millions)	2003 Quantity (carat)	2003 Value[2] (millions)
Rough or uncut, natural:[3]				
Belgium	17,800	$12	7,160	$4
Botswana	6,350	18	2,850	5
Brazil	20,000	15	65,100	29
Canada	9,900	2	13,700	18
Congo (Brazzaville)	9,630	14	10,400	9
Congo (Kinshasa)	27,800	24	20,400	31
Ghana	3,180	3	7,280	(4)
Guinea	6,850	19	3,760	9
Guyana	54,900	6	173,000	15
Hong Kong	353	(4)	739	1
Israel	5,590	15	53,200	9
Russia	26,700	6	20,000	10
South Africa	436,000	353	582,000	463
United Kingdom	344,000	69	441,000	61
Venezuela	15,100	5	3,230	3
Other	29,600	7	101,000	41
Total	1,010,000	567	1,500,000	707
Cut but unset, not more than 0.5 carat:				
Australia	2,650	1	825	(4)
Belgium	770,000	227	775,000	282
Brazil	7,660	2	5,810	1
Canada	4,960	1	4,900	5
China	70,400	6	73,000	6
Dominican Republic	12,900	1	12,200	1
Hong Kong	403,000	64	374,000	59
India	11,500,000	1,890	10,500,000	1,750
Israel	997,000	454	1,050,000	525
Japan	2,500	1	1,910	1
Mexico	249,000	12	160,000	5
Singapore	4,110	1	2,710	1
Sri Lanka	7,110	2	4,660	1
Switzerland	6,600	2	47,800	8
Thailand	99,600	11	68,200	10
United Arab Emirates	82,300	18	198,000	31
United Kingdom	12,000	4	2,530	2
Other	23,500	7	70,400	18
Total	14,300,000	2,710	13,400,000	2,710
Cut but unset, more than 0.5 carat:				
Belgium	1,280,000	2,060	1,260,000	2,310
Canada	7,520	27	15,800	51
France	2,250	17	3,040	11
Hong Kong	89,800	153	76,500	124
India	1,120,000	742	1,210,000	815
Israel	3,040,000	5,300	3,000,000	5,540
Japan	2,960	7	2,810	7
Mauritius	3,230	7	2,500	5
Russia	45,200	78	58,600	101
South Africa	30,600	127	35,100	149
Switzerland	13,500	101	15,100	158
Thailand	5,140	5	19,400	17
United Arab Emirates	7,520	8	10,200	10
United Kingdom	21,000	100	16,600	95
Other	27,600	67	27,200	59
Total	5,690,000	8,800	5,760,000	9,460

[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Includes some natural advanced diamond.
[4]Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND,
BY KIND AND COUNTRY[1]

Kind and country	2002 Quantity (carats)	2002 Value[2] (millions)	2003 Quantity (carats)	2003 Value[2] (millions)
Emerald:				
Australia	10,200	(3)	84	(3)
Belgium	26,800	$1	8,150	$1
Brazil	4,940,000	6	262,000	5
China	18,100	(3)	10,800	(3)
Colombia	683,000	69	522,000	54
Germany	15,200	1	56,900	1
Hong Kong	102,000	4	101,000	5
India	2,100,000	20	1,460,000	21
Israel	97,900	20	128,000	23
Japan	1,090	(3)	552	(3)
Sri Lanka	95	(3)	--	--
Switzerland	75,200	9	27,300	6
Taiwan	33	(3)	--	--
Thailand	538,000	7	419,000	7
United Kingdom	44,500	4	3,890	2
Zambia	408	(3)	214	(3)
Other	18,000	2	18,300	1
Total	8,670,000	143	3,020,000	126
Ruby:				
Belgium	15,000	2	8,330	1
Brazil	301	(3)	13,800	(3)
Burma	11,000	3	354	3
China	45,600	(3)	4,810	(3)
Colombia	--	--	1,250	(3)
Germany	18,200	1	14,900	1
Hong Kong	140,000	4	181,000	7
India	1,110,000	5	1,910,000	5
Israel	32,700	2	7,190	1
Japan	2,300	(3)	6,860	(3)
Pakistan	--	--	1,080	(3)
Sri Lanka	3,210	(3)	12,500	2
Switzerland	13,800	15	42,100	12
Thailand	2,220,000	50	2,260,000	47
United Kingdom	20,800	4	3,540	2
Other	24,300	1	88,000	8
Total	3,660,000	88	4,550,000	87
Sapphire:				
Australia	82,700	1	5,080	(3)
Belgium	8,440	1	10,400	1
Brazil	1,250	(3)	1,040	(3)
Burma	669	4	23,200	1
Canada	664	(3)	4,350	(3)
China	28,800	(3)	12,500	(3)
Colombia	--	--	248	(3)
France	1,710	1	18,700	3
Germany	143,000	2	35,800	3
Hong Kong	251,000	7	234,000	6
India	828,000	4	1,150,000	5
Israel	26,700	2	26,500	3
Sri Lanka	274,000	25	314,000	30
Switzerland	31,600	8	75,100	6
Thailand	5,040,000	77	6,010,000	73
United Kingdom	32,700	4	21,800	3
Other	28,700	3	88,400	2
Total	6,780,000	139	8,040,000	136

See footnotes at end of table.

TABLE 8--Continued
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

Kind and country	2002 Quantity (carats)	2002 Value[2] (millions)	2003 Quantity (carats)	2003 Value[2] (millions)
Other:				
Rough, uncut:				
Australia	NA	$3	NA	$4
Brazil	NA	10	NA	9
China	NA	3	NA	2
Colombia	NA	(3)	NA	1
Fiji	NA	2	NA	2
Hong Kong	NA	1	NA	1
India	NA	1	NA	3
Indonesia	NA	2	NA	3
Kenya	NA	(3)	NA	(3)
Nigeria	NA	(3)	NA	(3)
Pakistan	NA	3	NA	1
Philippines	NA	1	NA	2
Russia	NA	(3)	NA	(3)
South Africa	NA	1	NA	1
Switzerland	NA	(3)	NA	(3)
Taiwan	NA	(3)	NA	(3)
Tanzania	NA	1	NA	2
Thailand	NA	2	NA	2
United Kingdom	NA	1	NA	(3)
Zambia	NA	1	NA	(3)
Other	NA	8	NA	31
Total	NA	41	NA	40
Cut, set and unset:				
Australia	NA	16	NA	13
Austria	NA	2	NA	1
Brazil	NA	8	NA	8
Canada	NA	1	NA	1
China	NA	26	NA	27
Columbia	NA	1	NA	(3)
French Polynesia	NA	7	NA	6
Germany	NA	18	NA	21
Hong Kong	NA	32	NA	34
India	NA	75	NA	77
Indonesia	NA	(3)	NA	2
Israel	NA	5	NA	6
Japan	NA	11	NA	20
Mexico	NA	1	NA	(3)
South Africa	NA	1	NA	1
Sri Lanka	NA	6	NA	4
Switzerland	NA	2	NA	11
Taiwan	NA	2	NA	2
Tanzania	NA	7	NA	6
Thailand	NA	31	NA	36
United Kingdom	NA	8	NA	1
Other	NA	6	NA	6
Total	NA	265	NA	281

NA Not available. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 9
VALUE OF U.S. IMPORTS OF LABORATORY-CREATED AND IMITATION GEMSTONES, BY COUNTRY[1,2]

(Thousand dollars)

Country	2002	2003
Laboratory-created, cut but unset:		
Australia	27	36
Austria	2,730	477
Belgium	72	18
Brazil	143	48
China	10,300	10,100
France	831	881
Germany	9,630	11,300
Hong Kong	1,950	1,230
India	822	530
Italy	50	74
Japan	28	187
Korea, Republic of	727	712
Netherlands	65	35
Singapore	79	35
Spain	14	19
Sri Lanka	844	1,610
Switzerland	6,360	7,220
Taiwan	312	234
Thailand	1,670	1,180
Other	913	385
Total	37,600	36,300
Imitation:[3]		
Austria	39,900	39,600
China	2,260	2,430
Czech Republic	8,850	6,100
Germany	1,300	1,120
Hong Kong	1,560	1,140
India	1,280	567
Italy	139	137
Japan	247	376
Korea, Republic of	467	674
Spain	72	133
Taiwan	164	72
Other	434	430
Total	56,700	52,700

[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Includes pearls.

Source: U.S. Census Bureau.

TABLE 10
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES[1]

(Thousand carats and thousand dollars)

Stones	2002 Quantity	2002 Value[2]	2003 Quantity	2003 Value[2]
Diamonds:				
Rough or uncut	1,010	567,000	1,500	707,000
Cut but unset	19,900	11,500,000	19,100	12,200,000
Emeralds, cut but unset	8,670	143,000	3,020	126,000
Coral and similar materials, unworked	NA	10,400	NA	11,100
Rubies and sapphires, cut but unset	10,400	226,000	12,600	222,000
Pearls:				
Natural	NA	1,490	NA	601
Cultured	NA	35,000	NA	39,100
Imitation	NA	968	NA	2,920
Other precious and semiprecious stones:				
Rough, uncut	812,000	24,200	1,360,000	21,900
Cut, set and unset	NA	229,000	NA	241,000
Other	NA	6,580	NA	6,440
Laboratory-created:				
Cut but unset	251,000	37,600	224,000	36,300
Other	NA	5,610	NA	6,920
Imitation gemstone[3]	NA	55,700	NA	49,800
Total	XX	12,900,000	XX	13,600,000

NA Not available. XX Not applicable.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Does not include pearls.

Source: U.S. Census Bureau.

TABLE 11

NATURAL DIAMOND: ESTIMATED WORLD PRODUCTION, BY COUNTRY AND TYPE[1, 2, 3]

(Thousand carats)

Country and type[4]	1999	2000	2001	2002	2003
Gemstones:					
Angola	3,360	3,914 [5]	4,653 [5]	4,520 [r]	4,770
Australia	13,403 [r, 5]	11,956 [r, 5]	11,779 [r, 5]	15,142 [r, 5]	14,900
Botswana	17,200	18,500	19,800	21,300	22,800
Brazil	900 [5]	1,000 [5]	700 [r, 5]	500 [r, 5]	500
Canada	2,429 [5]	2,534 [r, 5]	3,716 [r, 5]	4,984 [5]	11,200
Central African Republic	311	346	337 [r]	311 [r]	300
China	230	230	235	235	235
Congo (Kinshasa)	4,120	3,500	3,640 [r]	4,400 [r]	5,400
Cote d' Ivoire	270	210	207 [r]	204 [r]	205
Ghana	546	792	936	770	800
Guinea	287	278	273 [r]	368 [r]	368
Guyana	45 [5]	82 [5]	179 [5]	248 [r, 5]	250
Liberia	120	100	100	48 [r]	36
Namibia	1,630	1,450	1,487 [5]	1,350	1,650
Russia	11,500	11,600	11,600	11,500	12,000
Sierra Leone	7 [r]	58 [r]	167 [r]	147 [r, 5]	214
South Africa	4,000	4,320	4,470	4,350	5,070
Tanzania	200	301	216	181 [r]	198
Venezuela	59 [5]	29 [5]	14 [5]	46 [r, 5]	30
Zimbabwe	15	8	--	--	--
Other[6]	20	24	25	25	24
Total	60,600 [r]	61,200 [r]	64,500 [r]	70,600 [r]	80,900
Industrial:					
Angola	373	435	517	502 [r]	530
Australia	16,381 [5]	14,612 [r, 5]	14,397 [r, 5]	18,500 [5]	18,200
Botswana	5,730	6,160	6,600	7,100	7,600
Central African Republic	120	115	112 [r]	104 [r]	100
China	920	920	950	955	955
Congo (Kinshasa)	16,000	14,200	14,560 [r, 5]	17,456 [r, 5]	21,600
Cote d' Ivoire	128	110	102 [r]	102 [r]	102
Ghana	136	198	234	193	200
Guinea	96	91	91 [r]	123 [r]	123
Liberia	80	70	70	32 [r]	24
Namibia	--	106	--	--	--
Russia	11,500	11,600	11,600	11,500	12,000
Sierra Leone	2 [r]	19 [r]	56 [r]	205 [r, 5]	296
South Africa	6,010	6,470	6,700	6,530	7,600
Tanzania	35 [5]	53 [5]	38 [5]	32 [r, 5]	35
Venezuela	36 [5]	80 [5]	28 [r, 5]	61 [r, 5]	50
Zimbabwe	30	15	--	--	--
Other[7]	52	64	66	68	67
Total	57,600 [r]	55,300 [r]	56,100 [r]	63,500 [r]	69,500
Grand total	118,000 [r]	117,000 [r]	121,000 [r]	134,000 [r]	150,000

[r]Revised. -- Zero.

[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through June 10, 2004.

[3]In addition to the countries listed, Nigeria and the Republic of Korea produce natural diamond and synthetic diamond, respectively, but information is inadequate to formulate reliable estimates of output levels.

[4]Includes near-gem and cheap-gem qualities.

[5]Reported figure.

[6]Includes Gabon, India, and Indonesia.

[7]Includes India and Indonesia.

GEMSTONES

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Domestic survey data and tables were prepared by Nicholas A. Muniz, statistical assistant, and the world production table was prepared by Glenn J. Wallace, international data coordinator.

In this report, the terms "gem" and "gemstone" mean any mineral or organic material (such as amber, pearl, petrified wood, and shell) used for personal adornment, display, or object of art because it possesses beauty, durability, and rarity. Of more than 4,000 mineral species, only about 100 possess all these attributes and are considered to be gemstones. Silicates other than quartz are the largest group of gemstones; oxides and quartz are the second largest (table 1). Gemstones are subdivided into diamond and colored gemstones, which in this report designates all natural nondiamond gems. In addition, laboratory-created gemstones, cultured pearls, and gemstone simulants are discussed but are treated separately from natural gemstones (table 2). Trade data in this report are from the U.S. Census Bureau. All percentages in the report were computed using unrounded data. Current information on industrial-grade diamond and industrial-grade garnet can be found in the U.S. Geological Survey (USGS) Minerals Yearbook, volume I, Metals and Minerals, chapters on industrial diamond and industrial garnet.

In 2004, the estimated value of natural gemstones produced in the United States was $14.5 million, and the estimated value of U.S. laboratory-created gemstone production was $30.7 million. The total estimated value of U.S. gemstone production was $45.2 million. The estimated value of U.S. gemstone imports was $15.5 billion, and the value of combined U.S. gemstone exports and reexports was estimated to be $7.23 billion.

Gemstones have fascinated humans since prehistoric times. They have been valued as treasured objects throughout history by all societies in all parts of the world. Amber, amethyst, coral, diamond, emerald, garnet, jade, jasper, lapis lazuli, pearl, rock crystal, ruby, serpentine, and turquoise are some of the first stones known to have been used for making jewelry. These stones served as symbols of wealth and power. Today, gems are worn more for pleasure or in appreciation of their beauty than to demonstrate wealth. In addition to jewelry, gemstones are used for collections, decorative art objects, and exhibits.

Production

Commercial mining of gemstones has never been extensive in the United States. More than 60 varieties of gemstones have been produced commercially from domestic mines, but most of the deposits have been relatively small compared with other mining operations. In the United States, much of the current gemstone mining is conducted by individual collectors, gem clubs, and hobbyists rather than by businesses.

The commercial gemstone industry in the United States consists of individuals and companies that mine gemstones or harvest shell and pearl, firms that manufacture laboratory-created gemstones, and individuals and companies that cut and polish natural and laboratory-created gemstones. The domestic gemstone industry is focused on the production of colored gemstones and on the cutting and polishing of large diamond stones. Industry employment is estimated to range from 1,000 to 1,500 workers (U.S. International Trade Commission, 1997, p. 1).

Most natural gemstone producers in the United States are small businesses that are widely dispersed and operate independently. The small producers probably have an average of less than three employees, including those who only work part time. The number of gemstone mines operating from year to year fluctuates because the uncertainty associated with the discovery and marketing of gem-quality minerals makes it difficult to obtain financing for developing and sustaining economically viable deposits (U.S. International Trade Commission, 1997, p. 23).

The total value of natural gemstones produced in the United States during 2004 was estimated to be at least $14.5 million (table 3). The production value increased by 15% from that of the preceding year.

The estimate of 2004 U.S. gemstone production was based on a survey of more than 230 domestic gemstone producers conducted by the USGS. The survey provided a foundation for projecting the scope and level of domestic gemstone production during the year. However, the USGS survey did not represent all gemstone activity in the United States, which includes thousands of professional and amateur collectors. Consequently, the USGS supplemented its survey with estimates of domestic gemstone production from related published data, contacts with gemstone dealers and collectors, and information garnered at gem and mineral shows.

Natural gemstone materials indigenous to the United States are collected, produced, and/or marketed in every State. During 2004, all 50 States produced at least $1,000 worth of gemstone materials. Seven States accounted for 79% of the total value, as reported by survey respondents. These States, in order of declining value of production, were Tennessee, Arizona, Oregon, California, Idaho, Montana, and Nevada. Some States were known for the production of a single gemstone material—Tennessee for freshwater pearls, for example. Other States produced a variety of gemstones, for example Arizona, whose gemstone deposits included agate, amethyst, azurite, chrysocolla, garnet, jade, jasper, malachite, obsidian, onyx, opal, peridot, petrified wood, smithsonite, and turquoise. There is also a wide variety of gemstones found and produced in California, Idaho, Montana, and North Carolina.

During 2004, the United States had only one operation in known diamond-bearing areas from which diamonds were produced. That diamond operation is in Crater of Diamonds State Park near Murfreesboro in Pike County, AR, where a dig-for-fee operation for tourists and rockhounds is maintained by the State of Arkansas. Crater of Diamonds is the only diamond mine in the world that is open to the public. The diamonds occur in a lamproite breccia tuff associated with a volcanic pipe and in the soil developed from the lamproite breccia tuff. In 2004, 383 diamond stones with an average weight of 0.2 carats were recovered at Crater of Diamonds State Park. Since the diamond-bearing pipe and the adjoining area became a State park in 1972, 22,833 diamond stones have been recovered (Rachel Engebrecht, park interpreter, Crater of Diamonds State Park, written commun., July 11, 2004). Exploration has demonstrated that there is about 78.5 million metric tons (Mt) of diamond-bearing rock in this diamond deposit (Howard, 1999, p. 62). An Arkansas law, enacted early in 1999, prohibits commercial diamond mining in the park (Diamond Registry Bulletin, 1999).

The Kelsey Lake diamond mine was a commercially operated diamond mine, located close to the Colorado-Wyoming State line near Fort Collins, CO. Diamond was produced at Kelsey Lake through April 2002, but the mine has been in care-and-maintenance mode since then with no additional production reported. The Kelsey Lake property includes nine known kimberlite pipes, of which three have been tested and have shown that diamonds are present. The remaining six pipes have yet to be fully explored and tested for their diamond potential. Of the diamonds recovered, 50% to 65% was clear gem quality, and almost one-third was one carat or larger in size. The identified resources are at least 17 Mt grading an average of 4 carats per 100 metric tons (Taylor Hard Money Advisers, 2000§[1]).

Studies by the Wyoming Geological Survey have shown that Wyoming has the potential for a $1 billion diamond mining business. Wyoming has many of the same geologic conditions as Canada, and there is evidence of hundreds of kimberlite pipes in the State. Twenty diamondiferous kimberlite pipes and one diamondiferous mafic breccia pipe have been identified in southern Wyoming. Two of the largest kimberlite fields, State Line and Iron Mountain, and the largest lamproite field in the United States, Leucite Hills, are in Wyoming. There has been slight interest in the southern Wyoming and northern Colorado area by several diamond mining firms, but the only diamond mine developed in the area thus far is the Kelsey Lake Mine. Individual diamond gems worth $89,000 and $300,000 have been found there (Associated Press, 2002§).

The success of Canadian diamond mines has made people focus on whether there are also commercially producible diamond deposits in the United States. Currently, there are no operating commercial diamond mines in the United States. Australian and Canadian companies are now conducting diamond exploration in Alaska and Minnesota. Alaska has similar geologic terrain to the Northwest Territories; and garnet and other diamond indicator minerals, as well as 17 microscopic diamonds have been found near Anchorage. Two Canadian companies have invested $1 million in an exploration drilling program. Geologists from the University of Minnesota teamed with an Australian mining company are conducting a soil sampling program in Minnesota for mineral exploration, including diamond. The samples are being analyzed by Australia's WMC Resources Ltd. The scientists believe that there is good chance of success owing to Minnesota's similar geology to Canada (Diamond Registry Bulletin, 2005a).

In another exploration venture during the second half of 2004, Delta Mining and Exploration Corp. found a diamond-bearing kimberlite in an 80-acre site known as the Homestead property near Lewistown, MT. Preliminary tests have shown the presence of microscopic diamonds. The firm is now planning a $700,000 soil sampling program, as further exploration. Diamonds have been found in the stream beds and glacial valleys of Montana for years. One notable find was the 14-carat Lewis and Clark diamond found near Craig in 1990 (Associated Press, 2004§).

In addition to natural gemstones, laboratory-created gemstones and gemstone simulants are produced in the United States. Laboratory-created or synthetic gemstones have the same chemical, optical, and physical properties as the natural materials. Simulants have an appearance similar to that of a natural gemstone material, but they have different chemical, optical, and physical properties. Laboratory-created gemstones produced in the United States include alexandrite, diamond, emerald, moissanite, ruby, sapphire, and turquoise. Simulants of coral, lapis lazuli, malachite, and turquoise also are manufactured in the United States. In addition, certain colors of laboratory-created sapphire and spinel, used to represent other gemstones, are classified as simulants.

Laboratory-created gemstone production in the United States was valued at more than $30.7 million during 2004; simulant gemstone output was even greater and was estimated to be valued at more than $100 million. Five firms in five States, representing virtually the entire U.S. laboratory-created gemstone industry, reported production to the USGS. The States with reported laboratory-created gemstone production, in descending production value order, were North Carolina, Florida, Massachusetts, Michigan, and Arizona.

Gemesis Corp., a company in Sarasota, FL, produced consistent quality laboratory-created gem diamond and reported a fifth year of production in 2004. The laboratory-created diamonds are produced using equipment, expertise, and technology developed by a team of scientists from Russia and the University of Florida. The weight of the laboratory-created diamond stones range from 1.5 to 2 carats, and most of the stones are yellow, brownish yellow, colorless, and green (Weldon, 1999§). Gemesis uses diamond-growing machines, each machine capable of growing 3-carat rough diamonds by generating high pressures and high temperatures (HPHT) that recreate the conditions in the Earth's mantle, where natural diamonds form. Gemesis eventually plans to have 250 diamond-growing machines installed at their facility near Sarasota, FL (Davis, 2003); at that point, Gemesis could be producing as much as 30,000 to 40,000 stones each year, and annual revenues may hit $70 million to $80 million (Diamond Registry Bulletin, 2001). Gemesis diamonds became available for retail purchase in jewelry stores and on the Internet in fall 2003. The prices of the Gemesis laboratory-created diamonds are below those of natural diamond but above the prices of simulated diamond (Weldon, 2003§).

Apollo Diamond, Inc., a company near Boston, MA, has developed a method for growing gem-quality diamond by chemical vapor deposition (CVD). Robert Linares of Apollo Diamond received a patent for the process in June 2003. The CVD technique transforms carbon into plasma, which then is precipitated onto a substrate as diamond. CVD has been used for more that a decade to cover large surfaces with microscopic diamond crystals, but until this process, no one had discovered the combination of temperature, gas composition, and pressure that resulted in the growth of a single diamond crystal. CVD diamond precipitates as nearly 100% pure, almost flawless diamond, and therefore may not be discernible from natural diamond by some tests (Davis, 2003). Apollo Diamond is producing 1-carat stones thus far, but hopes to be making 2-carat stones by 2006. The company is planning to start selling their

[1]References that include a section mark (§) are found in the Internet References Cited section.

diamonds in the jewelry market during the last half of 2005 at costs 10% to 30% below those of comparable natural diamonds (Hastings, 2005).

In early 2004, scientists at the Carnegie Institution's Geophysical Laboratory published a study that showed researchers grew diamond crystals by a special CVD process at very high growth rates. They were able to grow gem-sized crystals in a day; a growth rate 100 times faster than other methods used to date. The lead author of the study said that the diamonds were much harder to polish than conventional diamond crystals produced by HPHT methods. This is a new way of producing diamond crystals for such new applications as diamond-based electronic devices and next-generation cutting tools (Willis, 2004). By early 2005, the Carnegie Institution's Geophysical Laboratory and the University of Alabama had jointly developed and patented the CVD process and apparatus to produce 10-carat, ½-inch-thick single diamond crystals at very rapid growth rates (100 micrometers per hour). This faster CVD method uses microwave plasma technology, and it allows multiple crystals to be grown simultaneously. This size is about five times that of commercially available lab-created diamonds produced by HPHT and other CVD techniques. Dr. Russell Hemley of the Carnegie Institute stated, "High-quality crystals over 3 carats are very difficult to produce using the conventional approach. Several groups have begun to grow diamond single crystals by CVD, but large, colorless, and flawless ones remain a challenge. Our fabrication of 10-carat, half-inch, CVD diamonds is a major breakthrough" (Willis, 2004; Carnegie Institution of Washington, 2005; Science Blog, 2005§). Both Apollo Diamond and the Carnegie Institution have noted that their diamonds produced by the CVD method are harder than natural diamonds and diamonds produced by HPHT methods.

In 2004, the North Carolina company Charles & Colvard, Ltd. entered its seventh year of marketing moissanite, a gem-quality laboratory-created silicon carbide it produces. Moissanite is also an excellent diamond simulant, but it is being marketed for its own gem qualities. Moissanite exhibits a higher refractive index (brilliance) and higher luster than diamond. Its hardness is between corundum (ruby and sapphire) and diamond, which gives it durability (Charles & Colvard, Ltd., 2005§).

Consumption

Although the United States accounted for little of the total global gemstone production, it was the world's leading gemstone market. U.S. gemstone markets accounted for more than an estimated 35% of world gemstone demand in 2004. The U.S. market for unset gem-quality diamond during the year was estimated to have exceeded \$14.6 billion. Domestic markets for natural, unset nondiamond gemstones totaled nearly \$859 million.

In the United States, about two-thirds of domestic consumers designate diamond as their favorite gemstone when surveyed. In 2004, the top 10 selling colored gemstones, in descending order, were blue sapphire, fancy sapphire, ruby, tanzanite, emerald, pink tourmaline, amethyst, blue topaz, peridot, and pearl. Tsavorite garnet, aquamarine, opal, and green tourmaline dropped out of the top 10 from the previous year. Only 13% of the jewelry retailers said their sales were down in 2004 compared with 25% in 2003 (Wade, 2004; Prost, 2005). During 2004, U.S. retail jewelry store sales reached \$28.3 billion, an increase of 5% compared with the previous year (by value). Jewelers' sales for the month of December 2004 were \$6.7 billion, a 2% increase compared with that of December 2003 (Rapaport Diamond Report, 2005). Global retail sales of diamond jewelry increased by about 6.2% in 2004 compared with the previous year (Diamond Registry Bulletin, 2005d). The U.S. market accounted for more than 50% of the global diamond jewelry retail market in 2004.

Prices

Gemstone prices are governed by many factors and qualitative characteristics, including beauty, clarity, defects, demand, durability, and rarity. Diamond pricing, in particular, is complex; values can vary significantly depending on time, place, and the subjective evaluations of buyers and sellers. There are more than 14,000 categories used to assess rough diamond and more than 100,000 different combinations of carat, clarity, color, and cut values used to assess polished diamond (Pearson, 1998).

Colored gemstone prices are generally influenced by market supply and demand considerations, and diamond prices are supported by producer controls on the quantity and quality of supply. Values and prices of gemstones produced and/or sold in the United States are listed in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported, exported, or reexported are listed in tables 6 through 10.

De Beers Group companies are a significant force affecting gem diamond prices worldwide because they mine more than 40% of the diamond produced each year (De Beers Group, 2004§). De Beers companies also sort and valuate about two-thirds (by value) of the world's annual supply of rough diamond through De Beers' subsidiary Diamond Trading Co. (DTC), which has marketing agreements with other producers (De Beers Group, 2003§).

Foreign Trade

During 2004, total U.S. gemstone trade with all countries and territories was valued at more than \$22.1 billion, which was an increase of 18% from that of the previous year. Diamond accounted for about 96% of the 2004 gemstone trade total. In 2004, U.S. exports and reexports of diamond were shipped to 89 countries and territories, and imports of all gemstones were received from 169 countries and territories (tables 6-10). During 2004, U.S. trade in cut diamond increased by about 14% compared with the previous year, and the United States remained the world's leading diamond importer. The United States is a significant international diamond transit center as well as the world's leading gem diamond market. The large volume of reexports shipped to other centers reveals the significance that the United States has in the world's diamond supply network (table 6).

In 2004, trade in laboratory-created gemstone increased by almost 13% for the United States compared with the previous year. Laboratory-created gemstone imports from Austria, China, Germany, Hong Kong, Sri Lanka, Switzerland, and Thailand made up almost 92% (by value) of the total domestic imports of laboratory-created gemstones during the year. Prices of certain laboratory-created gemstone imports, such as amethyst, were very competitive. The marketing of imported laboratory-created gemstones and enhanced gemstones as natural gemstones and the mixing of laboratory-created materials with natural stones in imported parcels continued to be problems for some domestic producers in 2004. There also were problems with some simulants being marketed as laboratory-created gemstones during the year.

World Industry Structure

The gemstone industry worldwide has two distinct sectors—diamond mining and marketing and the production and sale of colored gemstones. Most diamond supplies are controlled by a few major mining companies; prices are supported by managing the quality and quantity of the gemstones relative to demand, a function performed by De Beers through DTC. Unlike diamond, colored gemstones are primarily produced at relatively small, low-cost operations with few dominant producers; prices are influenced by consumer demand and supply availability.

In 2004, world diamond production totaled about 156 million carats—89.4 million carats gem quality and 66.6 million carats industrial grade (table 11). Most production was concentrated in a few regions—Africa [Angola, Botswana, Congo (Kinshasa), Namibia, and South Africa], Asia (northeastern Siberia and Yakutia in Russia), Australia, North America (Northwest Territories in Canada), and South America (Brazil and Venezuela). In 2004, Russia led the world in total diamond output quantity (combined gemstone and industrial). Botswana was the world's leading gemstone diamond producer, followed by Russia, Canada, and Australia, in descending quantity order.

Russian diamond production figures were released for the first time in December 2004. Production information had been kept as a state secret since the first diamond discovery in Siberia in 1955 (Diamond Registry Bulletin, 2005e).

De Beers reported that its sales of rough diamond for 2004 were $5.6 billion, which was up by 3% from $5.5 billion in 2003 (Diamond Registry Bulletin, 2004b; Diamond Registry Bulletin, 2005b).

Israel's polished diamond net exports increased by 14.4% to $6.33 billion during 2004, and its exports of rough diamond increased by 31% to $2.92 billion. The United States remained the leading diamond trading partner for Israel. Israel's rough diamond imports from the DTC were $932 million in 2004, which was 18% of their total rough imports. This was a drop from 22% in 2003 (Diamond Registry Bulletin, 2005c).

Additional events in 2004 significant to diamond mining, production, and marketing worldwide include the following:

- The Ekati Diamond Mine, Canada's first operating commercial diamond mine, completed its sixth full year of production. In 2004, Ekati produced 4.08 million carats of diamond from 4.54 Mt of ore (BHP Billiton Ltd., 2005). BHP Billiton Ltd. has an 80% controlling ownership of the Ekati, which is located in Northwest Territories in Canada. Ekati has estimated reserves of 60.3 Mt of ore in kimberlite pipes that contain 54.3 million carats of diamond, and Ekati projected the mine life to be 25 years. Ekati diamonds are sold by BHP's Antwerp sales office. The Ekati Mine is now producing from the Koala, Panda, and Misery kimberlite pipes. In November 2002, BHP began using underground mining techniques to recover diamonds from deeper portions of the Koala kimberlite pipe, which was first open-pit mined (Diamond Registry Bulletin, 2002). Plans were approved for underground mining of deeper portions of the adjacent Panda kimberlite pipe, and initial production was expected in early 2005 (BHP Billiton Ltd., 2004).
- The Diavik Diamond Mine, also in the Northwest Territories, completed its second full year of production. In 2004, Diavik produced 7.57 million carats of diamond from its A154 North ore body and the adjacent A154 South pipe. Both pipes are located within the same pit (Diavik Diamond Mines Inc., 2005). The Diavik Diamond Mine has estimated its reserves to be 25.6 Mt of ore in kimberlite pipes, containing 107 million carats of diamond, and Diavik projected the mine life to be 16 to 22 years. Diavik is an unincorporated joint venture between Diavik Diamond Mines Inc. (60%) and Aber Diamond Mines Ltd. (40%). The mine is expected to produce about 107 million carats of diamond at a rate of 8 million carats per year worth about $63 per carat (Diavik Diamond Mines Inc., 2000, p. 10-12).

In 2002, an international rough diamond certification system called the Kimberley Process Certification Scheme (KPCS) was implemented to solve the problem of conflict diamonds—rough diamonds used by rebel forces and their allies to help finance warfare aimed at subverting governments recognized as legitimate by the United Nations (UN). The KPCS was agreed upon by UN member nations, the diamond industry, and involved nongovernmental organizations. The KPCS includes the following key elements: the use of forgery-resistant certificates and tamper-proof containers for shipments of rough diamonds; internal controls and procedures that provide credible assurance that conflict diamonds do not enter the legitimate diamond market; a certification process for all exports of rough diamonds; the gathering, organizing, and sharing of import and export data on rough diamonds with other participants of relevant production; credible monitoring and oversight of the international certification scheme for rough diamonds; effective enforcement of the provisions of the certification scheme through dissuasive and proportional penalties for violations; self regulation by the diamond industry that fulfills minimum requirements; and the sharing of information with all other participants on relevant rules, procedures, and legislation as well as examples of national certificates used to accompany shipments of rough diamonds (Weldon, 2001§). Canada acted as the chair and secretariat of the KPCS for the first 2 years, and in October, Russia assumed these duties. The KPCS will not be fully implemented until all participating countries have passed the necessary laws to carry it out. The Kimberley Process presently comprises 43 participants, and these participants account for approximately 99.8% of the global production of rough diamonds (Kimberley Process, 2005§). Discussions about the possible participation of several other countries are ongoing.

In the United States, the Clean Diamond Trade Act, which will implement effective measures to stop trade in conflict diamonds, was passed by the U.S. House of Representatives on April 8, 2003, and by the U.S. Senate on April 10, 2003. The President signed the Act into law on April 25, 2003. Enactment of the Clean Diamond Trade Act made the United States a full participant in the KPCS (U.S. House of Representatives, 2003§). U.S. participation is critical to the success of the KPCS in excluding conflict diamonds from the legitimate supply chain because the United States is the world's leading gem diamond market. The industry and trade associations have played an active role in achieving this progress in ending the problem of conflict diamonds (Professional Jeweler, 2003§).

At the end of 2003, De Beers and the U.S. Department of Justice began work toward settlement of its long-running dispute over alleged illegal price fixing. On July 13, De Beers Centenary AG pled guilty in Federal court in Ohio to conspiring to fix the price of industrial diamond in the United States and elsewhere, resolving a 1994 case. De Beers was sentenced to pay a $10 million fine. With this settlement, De Beers is now free to enter the U.S. market (Diamond Registry Bulletin, 2004c, d).

Worldwide, the value of production of natural gemstones other than diamond was estimated to have exceeded $2 billion in 2004. Most nondiamond gemstone mines are small, low-cost, and widely dispersed operations in remote regions of developing nations. Foreign countries with major gemstone deposits other than diamond are Afghanistan (aquamarine, beryl, emerald, kunzite, lapis lazuli, ruby, and tourmaline), Australia (beryl, opal, and sapphire), Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline), Burma (beryl, jade, ruby, sapphire, and topaz), Colombia (beryl, emerald, and sapphire), Kenya (beryl, garnet, and sapphire), Madagascar (beryl, rose quartz, sapphire, and tourmaline), Mexico (agate, opal, and topaz), Sri Lanka (beryl, ruby, sapphire, and topaz), Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline), and Zambia (amethyst and beryl). In addition, pearls are cultured throughout the South Pacific and in other equatorial waters; Australia, China, French Polynesia, and Japan are key producers.

The U.S. colored gemstone market posted an overall increase in sales during 2004 compared with the previous years sales. The popularity of colored gemstones, colored laboratory-created gemstones, and "fancy" colored diamonds continued to increase in 2004. This was indicated by the increased U.S. imports for consumption values in most colored stone categories (emerald, coral, rubies, sapphires, other precious and semiprecious stones, and laboratory-created) in 2004 compared with the values from the previous year (table 10). Colored stone popularity also was evidenced by their general slight sales increase in 2004 (Prost, 2005).

Tanzanite continued its popularity, moving back to fourth best selling stone in 2004 after moving up to third best selling stone in 2003. This popularity is in part owing to the American Gem Trade Association (a United States and Canadian trade association) adding tanzanite to the traditional list of birthstones for December in 2002. It is by far the most popular of blue and violet-blue gemstones after sapphire. Tanzanite is characterized by combinations of royal blue and burgundy hues, which have an almost universal appeal. While some tanzanite displays a trace of blue when it is originally mined, most crystals emerge from the Earth with a muted gray-green color. All tanzanite has been subjected to a heat process to produce the violet-blue hues. The only known source of tanzanite is a 5-square-mile area in the hills of Merelani, 10 miles south of the Kilimanjaro International Airport, between Moshi and Arusha in Tanzania. Its rarity appears to also add to tanzanite's growing popularity among consumers.

Though U.S. shell production increased by 61% in 2004 compared with 2003, shell is not expected to ever be the large segment of U.S. gemstone production it was for several years in the past. The U.S. shell material from mussels is used as seed material for culturing pearls. The lower shell production is owing to overharvesting in past years, the killing off of U.S. native mussel species by invasive exotic species, and a decline in market demand. During the past 10 years, the United States has lost about three-quarters of the native mussel population, and one-half of the approximately 300 total U.S. native mussel species are now listed as endangered species. The zebra mussel is the invasive exotic species that has done most of the damage, and it has been introduced into U.S. rivers and waterways in discharged ballast water from transoceanic ships (Iowa Department of Natural Resources, 2001§; Scott Gritterf, fisheries biologist, Iowa Department of Natural Resources, oral commun., November 14, 2002). The market still has not completely recovered from the die-off of Japanese oysters. Seed material had been stockpiled in Japan, and now producers in Japan are using manmade seed materials or seed materials from China and other sources in addition to the stockpiled material. There also has been an increase in the popularity of darker and colored pearls that do not use U.S. seed material (Ted Kroll, assistant director of fisheries, Kentucky Department of Fish and Wildlife, oral commun., November 15, 2002). In some regions of the United States, shell from mussels is beginning to be used as a gemstone based on its own merit, rather than as seed material for pearls. This shell material is being used in beads, jewelry, and watch faces.

Outlook

There are indications that there may be continued growth in U.S. diamond and jewelry markets in 2005. Historically, diamonds have proven to hold their value despite wars or economic depressions (Schumann, 1998, p. 8).

Diamond exploration is continuing in Canada, and many new deposits have been found. There are several other commercial diamond projects and additional discoveries located in Alberta, British Columbia, Northwest Territories, Nunavut, Ontario, and Quebec. Canada produced about 14% of the world's diamond in 2004, and in price per carat of diamond produced, Canada outranked many of the world's traditionally major diamond-mining countries (Diamond Registry Bulletin, 2004a). Canadian production continues to increase, and Canada is now third in production of gemstone diamond, after Botswana and Russia.

Independent producers, such as Argyle Diamond Mines in Australia and Ekati and Diavik in Canada, will continue to bring a greater measure of competition to global markets. More competition presumably will bring more supplies and lower prices. Further consolidation of diamond producers and larger amounts of rough diamond being sold outside DTC will continue as the diamond industry adjusts to De Beers' reduced influence on the industry.

More laboratory-created gemstones, simulants, and treated gemstones will enter the marketplace and necessitate more transparent trade industry standards to maintain customer confidence.

Internet sales of diamonds, gemstones, and jewelry has grown tremendously during 2004, and they will continue to grow and increase in popularity, as will other forms of e-commerce that emerge to serve the diamond and gemstone industry. This will take place as the gemstone industry and its customers become more comfortable with and learn the applications of new e-commerce tools (Diamond Registry Bulletin, 2004e, f).

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TABLE 1
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0-2.5	1.0-1.1	Single	1.54	Synthetic or pressed plastics, kaurigum	Fossil resin, color, low density, soft and trapped insects.
Apatite	Chlorocalcium phosphate	Colorless, pink, yellow, green, blue, violet	Small	Low	5.0	3.16-3.23	Double	1.63-1.65	Amblygonite, andalusite, brazilianite, precious beryl, titanite, topaz, tourmaline	Crystal habit, color, hardness, appearance.
Azurite	Copper carbonate hydroxide	Azure, dark blue, pale blue	Small to medium	do.	3.5-4.0	3.7-3.9	do.	1.72-1.85	Dumortierite, hauynite, lapis lazuli, lazulite, sodalite	Color, softness, crystal habits and associated minerals.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	do.	High	6.0-6.5	3.64-3.68	do.	1.76-1.80	Sapphire, tanzanite, blue diamond, blue tourmaline, cordierite	Strong blue in ultraviolet light.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5-8.0	2.63-2.80	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	Red	Small	Very high	7.5-8.0	2.63-2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald	do.	Green	Medium	do.	7.5	2.63-2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5-8.0	2.63-2.80	do.	1.58	Genuine emerald	Lack of flaws, brilliant fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5-8.0	2.63-2.80	do.	1.58	Citrine, topaz, glass, doublets	Weak-colored.
Goshenite	do.	Colorless	do.	Low	7.5-8.0	2.63-2.80	do.	1.58	Quartz, glass, white sapphire, white topaz	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5-8.0	2.63-2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49-1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.60	do.	Banded, translucent.
Charoite	Hydrated sodium calcium hydroxi-fluoro-silicate	Lilac, violet, or white	Small to medium	do.	5.0-6.0	2.54-2.78	XX	1.55-1.56	Purple marble	Color, locality.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day light, red by artificial light	Small (CIS[3]); medium (Sri Lanka)	High	8.5	3.50-3.84	Double	1.75	Synthetic	Strong dichroism, color varies from red to green, hardness.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Chrysoberyl—Continued:										
Cats-eye	Beryllium aluminate	Greenish to brownish	Small to large	High	8.5	3.50-3.84	Double	1.75	Synthetic, shell	Density, translucence, chatoyance.
Chrysolite	do.	Yellow, green, and/or brown	Medium	Medium	8.5	3.50-3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Chrysocolla	Hydrated copper silicate	Green, blue	Any	Low	2.0-4.0	2.0-2.4	XX	1.46-1.57	Azurite, dyed chalcedony, malachite, turquoise, variscite	Lack of crystals, color, fracture, low density and softness.
Coral	Calcium carbonate	Orange, red, white, black, purple, or green	Branching, medium	do.	3.5-4.0	2.6-2.7	Double	1.49-1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95-4.10	do.	1.78	Synthetics, including spinel, garnet	Inclusions, fluorescence.
Sapphire, blue	do.	Blue	Medium	High	9.0	3.95-4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, colorless, orange, green, or violet	Medium to large	Medium	9.0	3.95-4.10	do.	1.78	Synthetics, glass and doublets, morganite	Inclusions, double refreaction, refractive index.
Sapphire and ruby, stars	do.	Red, pink, violet, blue, or gray	do.	High to low	9.0	3.95-4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.
Sapphire or ruby, synthetic	do.	Yellow, pink, or blue	Up to 20 carats	Low	9.0	3.95-4.10	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Cubic zirconia	Zirconium and yttrium oxides	Colorless, pink, blue, lavender, yellow	Small	do.	8.25-8.5	5.8	Single	2.17	Diamond, zircon, titania, moissanite	Hardness, density, lack of flaws and inclusions, refractive index.
Diamond	Carbon	White, blue-white, yellow, brown, green, red, pink, blue	Any	Very high	10.0	3.516-3.525	do.	2.42	Zircon, titania, cubic zirconia, moissanite	High index, dispersion, hardness, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green-blue	Large	Low	6.0-6.5	2.56	XX	1.52	Jade, turquoise	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play (schiller)	do.	do.	6.0-6.5	2.56	XX	1.56	do.	Do.
Moonstone	do.	Colorless, white, gray, or yellow with white, blue, or bronze schiller	do.	do.	6.0-6.5	2.77	XX	1.52-1.54	Glass, chalcedony, opal	Pale sheen, opalescent.
Sunstone	do.	Orange, red brown, colorless with gold or red glittery schiller	Small to medium	do.	6.0-6.5	2.77	XX	1.53-1.55	Aventurine, glass	Red glittery schiller.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Garnet	Complex silicate	Brown, black, yellow, green, red, or orange	Small to medium	Low to high	6.5-7.5	3.15-4.30	Single strained	1.79-1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Hematite	Iron oxide	Black, black-gray, brown-red	Medium to large	Low	5.5-6.5	5.12-5.28	XX	2.94-3.22	Davidite, cassiterite, magnetite, neptunite, pyrolusite, wolframite	Crystal habit, streak, hardness.
Jade:										
Jadeite	Complex silicate	Green, yellow, black, white, or mauve	Large	Low to very high	6.5-7.0	3.3-3.5	Crypto-crystalline	1.65-1.68	Nephrite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0-6.5	2.96-3.10	do.	1.61-1.63	Jadeite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Do.
Jet (gagate)	Lignite	Deep black, dark brown	do.	Low	2.5-4.0	1.19-1.35	XX	1.64-1.68	Anthracite, asphalt, cannel coal, onyx, schorl, glass, rubber	Luster, color.
Lapis lazuli	Sodium calcium aluminum silicate	Dark azure-blue to bright indigo blue or even a pale sky blue.	do.	do.	5.0-6.0	2.50-3.0	XX	1.50	Azurite, dumortierite, dyed howlite, lazulite, sodalite, glass	Color, crystal habit, associated minerals, luster, and localities.
Malachite	Hydrated copper carbonate	Light to black-green banded	do.	do.	3.5-4.0	3.25-4.10	XX	1.66-1.91	Brochantite, chrysoprase, opaque green gemstones	Color banding, softness, associated minerals.
Moissanite	Silicon carbide	Colorless and pale shades of green, blue, yellow	Small	Low to medium	9.25	3.21	Double	2.65-2.69	Diamond, zircon, titania, cubic zirconia	Hardness, dispersion, lack of flaws and inclusions, refractive index.
Obsidian	Amorphous, variable (usually felsic)	Black, gray, brown, dark green, white, transparent	Large	Low	5.0-5.5	2.35-2.60	XX	1.45-1.55	Aegirine-augite, gadolinite, gagate, hematite, pyrolusite, wolframite	Color, conchoidal fracture, flow bubbles, softness, and lack of crystal faces.
Opal	Hydrated silica	Reddish orange, colors flash in white gray, black, red, or yellow	do.	Low to high	5.5-6.5	1.9-2.3	Single	1.45	Glass, synthetics, triplets, chalcedony	Color play (opalescence).
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5-7.0	3.27-3.37	Double (strong)	1.65-1.69	Tourmaline, chrysoberyl	Strong double refraction, low dichroism.
Quartz:										
Agate	Silicon dioxide	Any	Large	Low	7.0	2.58-2.64	XX	XX	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Quartz—Continued:										
Amethyst	Silicon dioxide	Purple	Large	Medium	7.0	2.65-2.66	Double	1.55	Glass, plastic, fluorite	Macrocrystalline, color, refractive index, transparent, hardness.
Aventurine	do.	Green, red-brown, gold-brown, with metallic iridescent reflection	do.	Low	7.0	2.64-2.69	do.	1.54-1.55	Iridescent analcime, aventurine feldspar, emerald, aventurine glass	Macrocrystalline, color, metallic iridescent flake reflections, hardness.
Cairngorm	do.	Smoky orange or yellow	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Carnelian	do.	Flesh red to brown red	do.	do.	6.5-7.0	2.58-2.64	do.	1.53-1.54	Jasper	Cryptocrystalline, color, hardness.
Chalcedony	do.	Bluish, white, gray	do.	do.	6.5-7.0	2.58-2.64	do.	1.53-1.54	Tanzanite	Do.
Chrysoprase	do.	Green, apple-green	do.	do.	6.5-7.0	2.58-2.64	do.	1.53-1.54	Chrome chalcedony, jade, prase opal, prehnite, smithsonite, variscite, artifically colored green chalcedony	Do.
Citrine	Silica	Yellow	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Crystal:										
Rock	do.	Colorless	do.	do.	7.0	2.65-2.66	do.	1.55	Topaz, colorless sapphire	Do.
Jasper	do.	Any, striped, spotted, or sometimes uniform	do.	do.	7.0	2.58-2.66	XX	XX	do.	Cryptocrystalline, opaque, vitreous luster, hardness.
Onyx	do.	Many colors	do.	do.	7.0	2.58-2.64	XX	XX	do.	Cryptocrystalline, uniformly banded, hardness.
Petrified wood	do.	Brown, gray, red, yellow	do.	do.	6.5-7.0	2.58-2.91	Double	1.54	Agate, jasper	Color, hardness, wood grain.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Tiger's eye	do.	Golden yellow, brown, red, blue-black	do.	do.	6.5-7.0	2.58-2.64	XX	1.53-1.54	XX	Macrocrystalline, color, hardness, hatoyancy.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Rhodochrosite	Manganese carbonate	Rose-red to yellowish, stripped	Large	Low	4.0	3.45-3.7	Double	1.6-1.82	Fire opal, rhodonite, tugtupite, tourmaline	Color, crystal habit, reaction to acid, perfect rhombohedral cleavage.
Rhodonite	Manganese iron calcium silicate	Dark red, flesh red, with dendritic inclusions of black manganese oxide	do.	do.	5.5-6.5	3.40-3.74	do.	1.72-1.75	Rhodochrosite, thulite, hessonite, spinel, pyroxmangite, spessartine, tourmaline	Color, black inclusions, lack of reaction to acid, hardness.
Shell:										
Mother-of-pearl	Calcium carbonate	White, cream, green, blue-green, with iridescent play of color	Small	do.	3.5	2.6-2.85	XX	XX	Glass and plastic imitation	Luster, iridescent play of color.
Pearl	do.	White, cream to black, sometimes with hint of pink, green, purple	do.	Low to high	2.5-4.5	2.6-2.85	XX	XX	Cultured and glass or plastic imitation	Luster, iridescence, x-structure, ray.
Spinel	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5-3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5-3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5-7.0	3.13-3.20	do.	1.66	Synthetic spinel	Refractive index, color, pleochroism.
Kunzite	do.	Pink to lilac	do.	do.	6.5-7.0	3.13-3.20	do.	1.66	Amethyst, morganite	Do.
Tanzanite	Complex silicate	Blue to lavender	Small	High	6.0-7.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism, color.
Topaz	do.	White, blue, green, pink, yellow, gold	Medium	Low to medium	8.0	3.4-3.6	do.	1.62	Beryl, quartz	Color, density, hardness, refractive index, perfect in basal cleavage.
Tourmaline	do.	Any, including mixed	do.	do.	7.0-7.5	2.98-3.20	do.	1.63	Peridot, beryl, garnet corundum, glass	Double refraction, color, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green with black, brown-red inclusions	Large	Low	6.0	2.60-2.83	do.	1.63	Chrysocolla, dyed howlite, dumortierite, glass, plastics, variscite	Difficult if matrix not present, matrix usually limonitic.
Unakite	Granitic rock, feldspar, epidote, quartz	Olive green, pink, and blue-gray	do.	do.	6.0-7.0	2.60-3.20	XX	XX	XX	Olive green, pink, gray-blue colors.
Zircon	Zirconium silicate	White, blue, brown, yellow, or green	Small to medium	Low to medium	6.0-7.5	4.0-4.8	Double (strong)	1.79-1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

XX Not applicable.

[1]Small: up to 5 carats; medium: 5 to 50 carats; large: more than 50 carats.

[2]Low: up to $25 per carat; medium: up to $200 per carat; high: more than $200 per carat.

[3]Commonwealth of Independent States.

TABLE 2
LABORATORY-CREATED GEMSTONE PRODUCTION METHODS

Gemstone	Production method	Company/producer	Date of first production
Alexandrite	Flux	Creative Crystals	1970s.
Do.	Melt pulling	J.O. Crystal	1990s.
Do.	do.	Kyocera	1980s.
Do.	Zone melt	Seiko	1980s.
Cubic zirconia	Skull melt	Various producers	1970s.
Emerald	Flux	Chatham	1930s.
Do.	do.	Gilson	1960s.
Do.	do.	Kyocera	1970s.
Do.	do.	Seiko	1980s.
Do.	do.	Lennix	1980s.
Do.	do.	Russia	1980s.
Do.	Hydrothermal	Lechleitner	1960s.
Do.	do.	Regency	1980s.
Do.	do.	Biron	1980s.
Do.	do.	Russia	1980s.
Ruby	Flux	Chatham	1950s.
Do.	do.	Kashan	1960s.
Do.	do.	J.O. Crystal	1980s.
Do.	do.	Douras	1990s.
Do.	Zone melt	Seiko	1980s.
Do.	Melt pulling	Kyocera	1970s.
Do.	Verneuil	Various producers	1900s.
Sapphire	Flux	Chatham	1970s.
Do.	Zone melt	Seiko	1980s.
Do.	Melt pulling	Kyocera	1980s.
Do.	Verneuil	Various producers	1900s.
Star ruby	do.	Linde	1940s.
Do.	Melt pulling	Kyocera	1980s.
Do.	do.	Nakazumi	1980s.
Star sapphire	Verneuil	Linde	1940s.

TABLE 3
VALUE OF U.S. GEMSTONE PRODUCTION, BY TYPE[1]

(Thousand dollars)

Gem materials	2003	2004
Beryl	18	18
Coral, all types	118	261
Diamond	(2)	(2)
Garnet	56	207
Gem feldspar	659	659
Geode/nodules	(3)	(3)
Opal	(3)	(3)
Quartz:		
Macrocrystalline[4]	228	206
Cryptocrystalline[5]	391	383
Sapphire/ruby	474	473
Shell	2,490	4,000
Topaz	(3)	(3)
Tourmaline	48	45
Turquoise	827	699
Other	6,870 r	7,160
Total	12,500	14,500

[r]Revised.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Included with "Other."

[3]Included in "Total."

[4]Macrocrystalline quartz (crystals recognizable with the naked eye) includes amethyst, amethyst quartz, aventurine, blue quartz, citrine, hawk's eye, pasiolite, prase, quartz cat's eye, rock crystal, rose quartz, smoky quartz, and tiger's eye.

[5]Cryptocrystalline (microscopically small crystals) includes agate carnelian, chalcedony, chrysoprase, fossilized wood, heliotrope, jasper, moss agate, onyx, and sard.

TABLE 4
PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY IN 2004 [1]

Carat weight	Description, color [2]	Clarity [3] (GIA terms)	Representative prices		
			January [4]	June [5]	December [6]
0.25	G	VS1	$1,200	$1,200	$1,200
do.	G	VS2	1,150	1,150	1,150
do.	G	SI1	975	975	975
do.	H	VS1	1,100	1,100	1,100
do.	H	VS2	1,000	1,000	1,000
do.	H	SI1	925	925	925
0.50	G	VS1	3,200	3,200	3,200
do.	G	VS2	2,800	2,800	2,800
do.	G	SI1	2,400	2,400	2,400
do.	H	VS1	2,800	2,800	2,800
do.	H	VS2	2,400	2,400	2,400
do.	H	SI1	2,200	2,200	2,200
0.75	G	VS1	3,600	3,600	3,600
do.	G	VS2	3,500	3,500	3,500
do.	G	SI1	3,200	3,200	3,200
do.	H	VS1	3,300	3,300	3,300
do.	H	VS2	3,200	3,200	3,200
do.	H	SI1	2,900	2,900	2,900
1.00	G	VS1	5,800	5,800	5,800
do.	G	VS2	5,500	5,500	5,500
do.	G	SI1	4,800	4,800	4,800
do.	H	VS1	5,200	5,200	5,200
do.	H	VS2	4,900	4,900	4,900
do.	H	SI1	4,700	4,700	4,700

[1] Data are rounded to no more than three significant digits.

[2] Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; G, H, I—traces of color.

[3] Clarity: IF—no blemishes; VVS1—very, very slightly included; VS1—very slightly included; VS2—very slightly included, but not visible; SI1—slightly included.

[4] Source: Jewelers' Circular Keystone, v. 174, no. 2, February 2003, p. 44.

[5] Source: Jewelers' Circular Keystone, v. 174, no. 7, July 2003, p. 52.

[6] Source: Jewelers' Circular Keystone, v. 175, no. 1, January 2004, p. 28.

TABLE 5

PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES IN 2004

Gemstone	Price range per carat	
	January[1]	December[2]
Amethyst	$7-14	$7-15
Blue sapphire	650-1,200	685-1,250
Blue topaz	3-5	3-5
Emerald	1,800-2,800	1,900-3,200
Green tourmaline	45-60	45-60
Pearl:[3]		
Cultured saltwater	5	5
Natural	210	210
Pink tourmaline	60-125	60-125
Rhodolite garnet	18-30	18-30
Ruby	800-1,125	800-1,125
Tanzanite	225-300	250-400

[1]Source: The Guide, spring/summer 2004, p. 14, 30, 45, 61, 72, 86, 96, 98, 104, 123, and 135. These figures are approximate current wholesale purchase prices paid by retail jewelers on a per stone basis for fine-quality stones.

[2]Source: The Guide, fall/winter 2004-2005, p. 14, 30, 45, 61, 72, 86, 96, 98, 104, 123, and 135. These figures are approximate current wholesale purchase prices paid by retail jewelers on a per stone basis for fine-quality stones.

[3]Prices are per 4.6-milimeter pearl.

TABLE 6
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY[1]

Country	2003 Quantity (carats)	2003 Value[2] (millions)	2004 Quantity (carats)	2004 Value[2] (millions)
Exports:				
Belgium	14,200	$11	189,000	$99
Canada	78,200	47	68,500	47
Costa Rica	18,800	1	31,800	3
France	3,150	7	16,300	11
Germany	4,790	4	1,370	1
Guatemala	2,850	(3)	5,990	1
Hong Kong	114,000	59	529,000	219
India	34,900	5	151,000	31
Israel	38,400	39	340,000	204
Japan	17,300	19	22,600	26
Mexico	205,000	32	397,000	124
Netherlands	307	3	421	3
Netherlands Antilles	19,000	21	47,200	23
Singapore	1,590	6	12,300	5
Switzerland	7,360	29	18,300	47
Thailand	34,400	6	68,500	15
United Arab Emirates	9,290	3	15,700	4
United Kingdom	4,080	7	26,300	28
Other	92,200 r	36 r	58,600	39
Total	699,000	335	2,000,000	932
Reexports:				
Armenia	--	--	61,800	3
Belgium	3,860,000	1,260 r	4,140,000	1,310
Canada	124,000	64	217,000	106
Dominican Republic	78,700	12	104,000	23
France	16,200	30	155,000	31
Guatemala	114,000	13	91,100	8
Hong Kong	2,670,000	471	2,620,000	489
India	1,420,000	234	1,710,000	335
Israel	5,700,000	1,920 r	6,340,000	2,570
Japan	185,000	46	181,000	46
Malaysia	28,800	5	41,100	9
Mexico	6,980	2	37,000	5
Singapore	204,000	30	262,000	46
South Africa	24,600	15	49,000	13
Switzerland	409,000	283	518,000	285
Thailand	266,000	55	284,000	70
United Arab Emirates	220,000	57	380,000	101
United Kingdom	397,000	140	487,000	171
Other	51,700 r	34 r	93,200	46
Total	15,800,000	4,670 r	17,800,000	5,670
Grand total	16,500,000	5,010 r	19,800,000	6,600

rRevised. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY[1]

	2003		2004	
Kind, range, and country of origin	Quantity (carat)	Value[2] (millions)	Quantity (carat)	Value[2] (millions)
Rough or uncut, natural:[3]				
Angola	5,630	$21	6,590	$19
Australia	90,000	14	12,200	8
Belgium	7,160	4	28,100	6
Botswana	2,850	5	144,000	48
Brazil	65,100	29	9,530	8
Canada	13,700	18	36,500	38
Congo (Brazzaville)	10,400	9	9,140	8
Congo (Kinshasa)	20,400	31	20,900	17
Guyana	173,000	15	157,000	16
India	1,330	(4)	34,500	3
Israel	53,200	9	12,300	14
Namibia	611	(4)	28,700	1
Russia	20,000	10	250,000	20
South Africa	582,000	463	430,000	508
United Kingdom	441,000	61	15,300	18
Other	18,200 r	18 r	11,500	21
Total	1,500,000	707	1,210,000	753
Cut but unset, not more than 0.5 carat:				
Belgium	775,000	282	786,000	275
Canada	4,900	5	4,800	4
China	73,000	6	67,100	10
Congo (Kinshasa)	3,850	(4)	5,920	(4)
Dominican Republic	12,200	1	37,200	4
France	65	(4)	4,860	(4)
Hong Kong	374,000	59	200,000	43
India	10,500,000	1,750	9,720,000	1,770
Israel	1,050,000	525	969,000	477
Italy	2,860	(4)	3,960	(4)
Mexico	160,000	5	14,400	(4)
Russia	29,400	5	21,500	5
Singapore	2,710	1	9,460	2
Switzerland	47,800	8	7,390	2
Thailand	68,200	10	189,000	36
United Arab Emirates	198,000	31	122,000	24
United Kingdom	2,530	2	4,580	2
Other	47,400 r	16 r	37,200	16
Total	13,400,000	2,710	12,200,000	2,670
Cut but unset, more than 0.5 carat:				
Belgium	1,260,000	2,310	1,230,000	2,450
Canada	15,800	51	23,600	67
France	3,040	11	27,800	50
Hong Kong	76,500	124	71,300	111
India	1,210,000	815	1,530,000	1,080
Israel	3,000,000	5,540	3,080,000	6,660
Italy	2,510	3	4,870	5
Namibia	6	(4)	6,010	9
Russia	58,600	101	62,200	121
South Africa	35,100	149	40,500	242
Switzerland	15,100	158	20,100	155
Thailand	19,400	17	21,300	23
United Arab Emirates	10,200	10	23,800	21
United Kingdom	16,600	95	13,800	84

See footnotes at end of table.

TABLE 7—Continued

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY[1]

	2003		2004	
Kind, range, and country of origin	Quantity (carat)	Value[2] (millions)	Quantity (carat)	Value[2] (millions)
Cut but unset, more than 0.5 carat—Continued:				
Other	30,000 r	68 r	35,700	126
Total	5,760,000	9,460	6,190,000	11,200

[r]Revised.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Includes some natural advanced diamond.

[4]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

Kind and country	2003 Quantity (carats)	2003 Value[2] (millions)	2004 Quantity (carats)	2004 Value[2] (millions)
Emerald:				
Afghanistan	--	--	5,860	$1
Belgium	8,150	$1	25,200	2
Brazil	262,000	5	355,000	4
China	10,800	(3)	227,000	1
Colombia	522,000	54	677,000	47
Germany	56,900	1	7,440	1
Hong Kong	101,000	5	57,100	4
India	1,460,000	21	1,880,000	18
Israel	128,000	23	259,000	21
Netherlands	--	--	50,200	(3)
South Africa	16	(3)	6,370	1
Swaziland	--	--	3,800	1
Switzerland	27,300	6	9,450	7
Thailand	419,000	7	424,000	8
United Arab Emirates	11,000	(3)	1,200	(3)
Zambia	214	(3)	2,620	(3)
Other	11,800 r	3 r	7,520	6
Total	3,020,000	126	4,000,000	122
Ruby:				
Belgium	8,330	1	6,450	2
Brazil	13,800	(3)	99,300	(3)
China	4,810	(3)	21,700	(3)
Dominican Republic	28,200	(3)	4,920	(3)
Germany	14,900	1	19,400	1
Hong Kong	181,000	7	52,100	4
India	1,910,000	5	1,300,000	4
Israel	7,190	1	41,300	1
Italy	2,540	2	6,570	(3)
Japan	6,860	(3)	25,200	(3)
Netherlands	--	--	50,200	(3)
South Africa	--	--	3,130	(3)
Sri Lanka	12,500	2	5,260	1
Thailand	2,260,000	47	2,090,000	43
United Arab Emirates	31,100	1	7,700	1
Other	74,400 r	19 r	12,100	16
Total	4,550,000	87	3,750,000	72
Sapphire:				
Australia	33,200 r	(3)	5,300	(3)
Bahrain	--	--	5,930	(3)
Belgium	10,400	1	4,480	1
China	12,500	(3)	120,000	(3)
Germany	35,800	3	41,000	2
Hong Kong	234,000	6	138,000	7
India	1,150,000	5	1,040,000	9
Israel	26,500	3	56,600	3
Japan	287	(3)	11,900	(3)
Netherlands	6,000	(3)	50,200	(3)
South Africa	76	(3)	13,300	(3)
Sri Lanka	314,000	30	455,000	42
Switzerland	75,100	6	29,900	11
Taiwan	725	(3)	10,700	(3)
Thailand	6,010,000	73	5,470,000	78

See footnotes at end of table.

TABLE 8—Continued

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

Kind and country	2003 Quantity (carats)	2003 Value[2] (millions)	2004 Quantity (carats)	2004 Value[2] (millions)
Sapphire—Continued:				
Turkey	--	--	11,200	(3)
United Arab Emirates	23,200	1	7,360	(3)
United Kingdom	21,800	3	7,820	3
Other	77,600 r	7 r	18,900	6
Total	8,040,000	136	7,500,000	163
Other:				
Rough, uncut:				
Australia	NA	$4	NA	$3
Brazil	NA	9	NA	8
Canda	NA	2	NA	3
China	NA	3	NA	3
Colombia	NA	1	NA	1
France	NA	1	NA	1
Germany	NA	3	NA	2
Hong Kong	NA	1	NA	1
India	NA	3	NA	1
Mexico	NA	(3)	NA	1
Netherlands	NA	1	NA	1
Pakistan	NA	1	NA	1
South Africa	NA	1	NA	7
Tanzania	NA	2	NA	1
Thailand	NA	1 r	NA	1
Other	NA	3 r	NA	4
Total	NA	35 r	NA	39
Cut, set and unset:				
Australia	NA	9 r	NA	9
Austria	NA	1	NA	3
Brazil	NA	8	NA	13
Canada	NA	1	NA	1
China	NA	34 r	NA	45
France	NA	1	NA	1
Germany	NA	32 r	NA	38
Hong Kong	NA	32 r	NA	35
India	NA	78 r	NA	82
Israel	NA	6	NA	4
Italy	NA	1	NA	1
Mexico	NA	(3)	NA	1
South Africa	NA	1	NA	5
Sri Lanka	NA	5	NA	7
Switzerland	NA	18 r	NA	10
Taiwan	NA	2	NA	2
Tanzania	NA	6	NA	7
Thailand	NA	37 r	NA	46
United Arab Emirates	NA	1	NA	2
Other	NA	4 r	NA	8
Total	NA	277 r	NA	320

[r]Revised. NA Not available. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 9

VALUE OF U.S. IMPORTS OF LABORATORY-CREATED AND IMITATION GEMSTONES, BY COUNTRY[1,2]

(Thousand dollars)

Country	2003	2004
Laboratory-created, cut but unset:		
Austria	477	2,410
Brazil	48	225
Canada	123	98
China	10,100	14,100
Cyprus	--	246
Czech Republic	5	114
France	881	989
Germany	11,300	13,800
Hong Kong	1,230	1,500
India	530	261
Italy	74	75
Japan	187	112
Korea, Republic of	712	649
Netherlands	35	232
Philippines	95	38
Sri Lanka	1,610	1,290
Switzerland	7,220	3,340
Taiwan	234	197
Thailand	1,180	1,090
United Kingdom	46	31
Other	223 r	96
Total	36,300	40,900
Imitation:[3]		
Austria	39,600	60,800
China	2,430	4,660
Czech Republic	6,100	7,000
Germany	1,120	974
Hong Kong	1,140	700
India	567	207
Italy	137	100
Japan	376	1,110
Korea, Republic of	674	774
Liechtenstein	--	28
Russia	70	53
Spain	133	165
Taiwan	72	220
Thailand	--	31
United Arab Emirates	21	62
Other	339 r	176
Total	52,700	77,000

[r]Revised. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Includes pearls.

Source: U.S. Census Bureau.

TABLE 10

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES[1]

(Thousand carats and thousand dollars)

Stones	2003		2004	
	Quantity	Value[2]	Quantity	Value[2]
Diamonds:				
Rough or uncut	1,510 r	707,000	1,210	753,000
Cut but unset	19,100	12,200,000	18,400	13,900,000
Emeralds, cut but unset	3,020	126,000	4,000	122,000
Coral and similar materials, unworked	5,910	11,100	6,120	11,500
Rubies and sapphires, cut but unset	12,600	222,000	11,200	234,000
Pearls:				
Natural	NA	601	NA	NA
Cultured	NA	39,100	NA	29,500
Imitation	NA	2,920	NA	3,780
Other precious and semiprecious stones:				
Rough, uncut	1,360,000	21,900	1,130,000	25,200
Cut, set and unset	NA	241,000	NA	279,000
Other	NA	6,440	NA	5,680
Laboratory-created:				
Cut but unset	224,000	36,300	249,000	40,900
Other	NA	6,920	NA	8,110
Imitation gemstone[3]	NA	49,800	NA	73,300
Total	XX	13,600,000	XX	15,500,000

[r]Revised. NA Not available. XX Not applicable.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Does not include pearls.

Source: U.S. Census Bureau.

TABLE 11

NATURAL DIAMOND: ESTIMATED WORLD PRODUCTION, BY COUNTRY AND TYPE[1, 2, 3]

(Thousand carats)

Country and type[4]	2000	2001	2002	2003	2004
Gemstones:					
Angola	3,880 r	4,640 r	4,520	4,500 r	5,400
Australia	11,956 5	11,779 5	15,142 5	14,900	9,279 5
Botswana	18,500	19,800	21,300	22,800	23,300
Brazil	1,000	700	500	500	500
Canada	2,534 5	3,716 5	4,937 r, 5	11,200	12,618 p, 5
Central African Republic	348 r	340 r	312 r	250 r	250
China	230	235	235	235	250
Congo (Kinshasa)	3,500	3,640	4,400	5,400	6,000
Cote d'Ivoire	210	207	204	152 r	152
Ghana	792	936	770	760 r	800
Guinea	278	273	368	484 r	468
Guyana	82 5	179 5	248 5	413 r, 5	450
Liberia	100	100	48	36	18
Namibia	1,450	1,487 5	1,562 r, 5	1,481 r, 5	2,000
Russia	17,500 r	17,500 r	17,400 r	20,000 r	21,400
Sierra Leone	58	167	147 5	250 r	309
South Africa	4,320	4,470	4,350	5,070	5,780
Tanzania	301	216	204 r	201 r	305
Venezuela	29 5	14 5	46 5	11 r, 5	40
Zimbabwe	8	--	--	--	16
Other[6]	24	25	25	24	24
Total	67,100 r	70,400 r	76,700 r	88,700 r	89,400
Industrial:					
Angola	431 r	516 r	502	500 r	600
Australia	14,612 5	14,397 5	18,500 5	18,200	11,341 5
Botswana	6,160	6,600	7,100	7,600	7,800
Central African Republic	116 r	113 r	104	83 r	83
China	920	950	955	955	960
Congo (Kinshasa)	14,200	14,560 5	17,456 5	21,600	22,000
Cote d'Ivoire	110	102	102	78 r	78
Ghana	198	234	193	190 r	200
Guinea	91	91	123	161 r	157
Liberia	70	70	32	24	12
Namibia	106	--	--	--	--
Russia	11,700 r	11,700 r	11,600 r	13,000 r	14,200
Sierra Leone	19	56	205 5	257 r	304
South Africa	6,470	6,700	6,530	7,600	8,670
Tanzania	53 5	38 5	36 r, 5	36 r, 5	55
Venezuela	80 5	28 5	61 5	24 r, 5	60
Zimbabwe	15	--	--	--	31
Other[7]	64	66	68	67	66
Total	55,400 r	56,200 r	63,600 r	70,400 r	66,600
Grand total	122,000 r	127,000 r	140,000 r	159,000 r	156,000

[p]Preliminary. [r]Revised. -- Zero.

[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through June 3, 2005.

[3]In addition to the countries listed, Nigeria and the Republic of Korea produce natural diamond and synthetic diamond, respectively, but information is inadequate to formulate reliable estimates of output levels.

[4]Includes near-gem and cheap-gem qualities.

[5]Reported figure.

[6]Includes Gabon, India, and Indonesia.

[7]Includes India and Indonesia.

science for a changing world

2005 Minerals Yearbook

GEMSTONES

U.S. Department of the Interior
U.S. Geological Survey

October 2006

GEMSTONES

By Donald W. Olson

Domestic survey data and tables were prepared by Nicholas A. Muniz, statistical assistant, and the world production table was prepared by Glenn J. Wallace, international data coordinator.

In 2005, the estimated value of natural gemstones produced in the United States was more than $13.4 million, and the estimated value of U.S. laboratory-created gemstone production was more than $51.1 million. The total estimated value of U.S. gemstone production was almost $64.6 million. The value of U.S. gemstone imports was $17.2 billion, and the value of combined U.S. gemstone exports and reexports was estimated to be $8.85 billion.

In this report, the terms "gem" and "gemstone" mean any mineral or organic material (such as amber, pearl, petrified wood, and shell) used for personal adornment, display, or object of art because it possesses beauty, durability, and rarity. Of more than 4,000 mineral species, only about 100 possess all these attributes and are considered to be gemstones. Silicates other than quartz are the largest group of gemstones in terms of chemical composition; oxides and quartz are the second largest (table 1). Gemstones are subdivided into diamond and colored gemstones, which in this report designates all natural nondiamond gems. In addition, laboratory-created gemstones, cultured pearls, and gemstone simulants are discussed but are treated separately from natural gemstones (table 2). Trade data in this report are from the U.S. Census Bureau. All percentages in the report were computed using unrounded data. Current information on industrial-grade diamond and industrial-grade garnet can be found in the U.S. Geological Survey (USGS) Minerals Yearbook, volume I, Metals and Minerals chapters on industrial diamond and industrial garnet, respectively.

Gemstones have fascinated humans since prehistoric times. They have been valued as treasured objects throughout history by all societies in all parts of the world. Amber, amethyst, coral, diamond, emerald, garnet, jade, jasper, lapis lazuli, pearl, rock crystal, ruby, serpentine, and turquoise are some of the first stones known to have been used for making jewelry. These stones served as symbols of wealth and power. Today, gems are worn more for pleasure or in appreciation of their beauty than to demonstrate wealth. In addition to jewelry, gemstones are used for collections, decorative art objects, and exhibits.

Legislation and Governments Programs

The Clean Diamond Trade Act was signed into law on April 25, 2003, by the President. This law provided the effective measures to stop trade in conflict diamonds in the United States, and its enactment made the United States a full participant in the Kimberley Process Certification Scheme (KPCS) (U.S. House of Representatives, 2003§). U.S. participation in the KPCS is critical to its success in excluding conflict diamonds from the legitimate supply chain because the United States is the world's leading gem-quality diamond market. The industry and trade associations have played an active role in achieving this progress in ending the problem of conflict diamonds (Professional Jeweler, 2003§[1]).

Production

U.S. gemstone production data were based on a survey of more than 230 domestic gemstone producers conducted by the USGS. The survey provided a foundation for projecting the scope and level of domestic gemstone production during the year. However, the USGS survey did not represent all gemstone activity in the United States, which includes thousands of professional and amateur collectors. Consequently, the USGS supplemented its survey with estimates of domestic gemstone production from related published data, contacts with gemstone dealers and collectors, and information garnered at gem and mineral shows.

Commercial mining of gemstones has never been extensive in the United States. More than 60 varieties of gemstones have been produced commercially from domestic mines, but most of the deposits have been relatively small compared with other mining operations. In the United States, much of the current gemstone mining is conducted by individual collectors, gem clubs, and hobbyists rather than by businesses.

The commercial gemstone industry in the United States consists of individuals and companies that mine gemstones or harvest shell and pearl, firms that manufacture laboratory-created gemstones, and individuals and companies that cut and polish natural and laboratory-created gemstones. The domestic gemstone industry is focused on the production of colored gemstones and on the cutting and polishing of large diamond stones. Industry employment is estimated to range from 1,000 to 1,500 workers (U.S. International Trade Commission, 1997, p. 1).

Most natural gemstone producers in the United States are small businesses that are widely dispersed and operate independently. The small producers probably have an average of less than three employees, including those who only work part time. The number of gemstone mines operating from year to year fluctuates because the uncertainty associated with the discovery and marketing of gem-quality minerals makes it difficult to obtain financing for developing and sustaining economically viable operations (U.S. International Trade Commission, 1997, p. 23).

The total value of natural gemstones produced in the United States during 2005 was estimated to be more than $13.4 million (table 3). The production value decreased by 7% from that of the preceding year.

[1]References that include a section mark (§) are found in the Internet References Cited section.

Natural gemstone materials indigenous to the United States are collected, produced, and/or marketed in every State. During 2005, all 50 States produced at least $1,000 worth of gemstone materials. Seven States accounted for 78% of the total value, as reported by survey respondents. These States, in order of declining value of production, were Tennessee, Arizona, Oregon, California, Arkansas, Montana, and Nevada. Some States were known for the production of a single gemstone material—Tennessee for freshwater pearls, for example. Other States produced a variety of gemstones, for example Arizona's gemstone deposits included agate, amethyst, azurite, chrysocolla, garnet, jade, jasper, malachite, obsidian, onyx, opal, peridot, petrified wood, smithsonite, and turquoise. There is also a wide variety of gemstones found and produced in California, Idaho, Montana, and North Carolina.

During 2005, the United States had only one operation in known diamond-bearing areas from which diamonds were produced. That diamond operation is in Crater of Diamonds State Park near Murfreesboro in Pike County, AR, where a dig-for-fee operation for tourists and rockhounds is maintained by the State of Arkansas. Crater of Diamonds is the only diamond mine in the world that is open to the public. The diamonds occur in a lamproite breccia tuff associated with a volcanic pipe and in the soil developed from the lamproite breccia tuff. In 2005, 536 diamond stones with an average weight of 0.193 carats were recovered at the Crater of Diamonds State Park. Since the diamond-bearing pipe and the adjoining area became a State park in 1972, 25,369 diamond stones with a total carat weight of 4,954.41 have been recovered (Tom Stolarz, park superintendent, Crater of Diamonds State Park, written commun., January 31, 2006). Exploration has demonstrated that there is about 78.5 million metric tons (Mt) of diamond-bearing rock in this diamond deposit (Howard, 1999, p. 62). An Arkansas law enacted early in 1999 prohibits commercial diamond mining in the park (Diamond Registry Bulletin, 1999).

There have been no commercially operated diamond mines in the United States since 2002. Diamond was produced at the Kelsey Lake diamond mine, located close to the Colorado-Wyoming State line near Fort Collins, CO, for several years until April 2002. The Kelsey Lake property includes nine known kimberlite pipes, three of which have been tested and have shown that diamonds are present. The remaining six pipes have yet to be fully explored and tested for their diamond potential. Of the diamonds recovered, 35% to 50% was industrial grade. The identified resources are at least 17 Mt grading an average of 4 carats per 100 metric tons (Taylor Hard Money Advisers, 2000§).

Studies by the Wyoming Geological Survey have shown that Wyoming has the potential for a $1 billion diamond mining business. Twenty diamondiferous kimberlite pipes and one diamondiferous mafic breccia pipe have been identified in southern Wyoming. Two of the largest kimberlite fields, State Line and Iron Mountain, and the largest lamproite field in the United States, Leucite Hills, are in Wyoming. Several diamond mining firms have been interested in the southern Wyoming and northern Colorado area, but the only diamond mine developed in the area thus far is the Kelsey Lake Mine (Associated Press, 2002§).

The success of Canadian diamond mines has stimulated interest in exploring for commercially feasible diamond deposits in the United States outside of Wyoming and Colorado. Australian and Canadian companies are now conducting diamond exploration in Alaska and Minnesota. Alaska has some similar geologic terrain to the Northwest Territories of Canada; in addition, certain varieties of garnet and other diamond indicator minerals as well as 17 microscopic diamonds have been found near Anchorage, AK. Two Canadian companies have invested $1 million in an exploratory drilling program. Geologists from the University of Minnesota teamed with an Australian mining company and were conducting a soil sampling program in Minnesota for mineral exploration, including diamond. The samples were being analyzed by Australia's WMC Resources Ltd. The scientists thought that there is a good chance of success owing to similarities between the geology in Minnesota and Canada (Diamond Registry Bulletin, 2005a).

In another exploration venture, Delta Mining and Exploration Corp. found a diamond-bearing kimberlite in an 32.4-hectare (80-acre) site known as the Homestead property near Lewistown, MT. Preliminary tests have shown the presence of microscopic diamonds. The company was planning a $700,000 soil sampling program as further exploration. Diamonds have been found in the stream beds and glacial valleys of Montana for years (Associated Press, 2004§).

In addition to natural gemstones, laboratory-created gemstones and gemstone simulants are produced in the United States. Laboratory-created or synthetic gemstones have the same chemical, optical, and physical properties as the natural materials. Simulants have an appearance similar to that of a natural gemstone material, but they have different chemical, optical, and physical properties. Laboratory-created gemstones produced in the United States include alexandrite, diamond, emerald, moissanite, ruby, sapphire, and turquoise. Simulants of coral, lapis lazuli, malachite, and turquoise also are manufactured in the United States. In addition, certain colors of laboratory-created sapphire and spinel, used to represent other gemstones, are classified as simulants.

Laboratory-created gemstone production in the United States was valued at more than $51.1 million during 2005; simulant gemstone output was even greater and was estimated to be valued at more than $100 million. Five companies in five States, representing virtually the entire U.S. laboratory-created gemstone industry, reported production to the USGS. The States with reported laboratory-created gemstone production, in descending order of production value, were North Carolina, Florida, Massachusetts, Michigan, and Arizona.

Gemesis Corp., a company in Sarasota, FL, consistently produced gem-quality laboratory-created diamond and reported a sixth year of production in 2005. The laboratory-created diamonds are produced using equipment, expertise, and technology developed by a team of scientists from Russia and the University of Florida. The weight of the laboratory-created diamond stones range from 1.5 to 2 carats, and most of the stones are yellow, brownish yellow, colorless, and green (Weldon, 1999§). Gemesis uses diamond-growing machines, each machine capable of growing 3-carat rough diamonds by generating high-pressure, high-temperature (HPHT) conditions that recreate the conditions in the Earth's mantle where natural diamonds form. Gemesis eventually plans to have 250 diamond-growing machines installed at the facility near Sarasota, FL (Davis, 2003); at that point, Gemesis could be producing as much as 30,000 to 40,000 stones each year, and annual revenues may reach $70 million to $80 million (Diamond Registry Bulletin, 2001). Gemesis diamonds became available for retail purchase in jewelry stores and on the Internet in fall 2003. The prices of the Gemesis laboratory-created diamonds are below those of natural diamond but above the prices of simulated diamond (Weldon, 2003§).

Apollo Diamond, Inc., near Boston, MA, has developed and patented a method for growing extremely pure, gem-quality diamond with flawless crystal structure by chemical vapor deposition (CVD). The CVD technique transforms carbon into plasma, which is then precipitated onto a substrate as diamond. CVD has been used for more than a decade to cover large surfaces with microscopic diamond crystals, but until this process, no one had discovered the combination of temperature, gas composition, and pressure that resulted in the growth of a single diamond crystal. CVD diamond precipitates as nearly 100% pure, almost flawless diamond, and therefore may not be distinguishable from natural diamond by some tests (Davis, 2003). In 2005, Apollo Diamond produced stones that range from 1 to 2 carats and expected to expand to larger stones in the future (Maney, 2005§). The company planned to start selling diamonds in the jewelry market at costs 10% to 30% below those of comparable natural diamonds (Hastings, 2005). Apollo planned to open the Apollo Diamond Web store to the general public in 2006 (Apollo Diamond, Inc., 2005§). Besides its use as a gemstone, CVD diamond's highest value is as a material for high-tech uses, such as in computer technology (Maney, 2005§).

In early 2004, scientists at the Carnegie Institution of Washington's Geophysical Laboratory published the results of a study in which researchers grew diamond crystals by a special CVD process at very high growth rates. They were able to grow gem-sized crystals in a day—a growth rate 100 times faster than other methods used before. This is a new way of producing diamond crystals for such new applications as diamond-base electronic devices and next generation cutting tools (Willis, 2004). By early 2005, the Geophysical Laboratory and the University of Alabama had jointly developed and patented the CVD process and apparatus to produce ½-inch-thick 10-carat single diamond crystals at very rapid growth rates (100 micrometers per hour). This faster CVD method uses microwave plasma technology and allows multiple crystals to be grown simultaneously. This size is about five times that of commercially available laboratory-created diamonds produced by HPHT methods and other CVD techniques. Dr. Russell Hemley, a researcher at the Carnegie Institution, stated, "High-quality crystals over 3 carats are very difficult to produce using the conventional approach. Several groups have begun to grow diamond single crystals by CVD, but large, colorless, and flawless ones remain a challenge. Our fabrication of 10-carat, half-inch CVD diamonds is a major breakthrough" (Willis, 2004; Carnegie Institution of Washington, 2005; Science Blog, 2005§).

Both Apollo Diamond and the Carnegie Institution have noted that their diamonds produced by the CVD method are harder than natural diamonds and diamonds produced by HPHT methods.

In 2005, the North Carolina company Charles & Colvard, Ltd. entered its eighth year of producing and marketing moissanite, a gem-quality laboratory-created silicon carbide. Moissanite is also an excellent diamond simulant, but it is being marketed for its own gem qualities. Moissanite exhibits a higher refractive index (brilliance) and higher luster than diamond. Its hardness is between those of corundum (ruby and sapphire) and diamond, which gives it durability (Charles & Colvard, Ltd., 2005§).

Although U.S. shell production decreased by 11% in 2005 compared with that of 2004, shell is not expected to ever be the large segment of U.S. gemstone production it was for several years in the past. U.S. shell material from mussels is used as seed material for culturing pearls. The lower shell production is owing to overharvesting in past years, the killing off of U.S. native mussel species by invasive exotic species, and a decline in market demand. During the past 10 years, the United States has lost about three-quarters of the native mussel population, and one-half of the approximately 300 total U.S. native mussel species are now listed as endangered species. The zebra mussel is the invasive exotic species that has done most of the damage, and it has been introduced into U.S. rivers and waterways in discharged ballast water from transoceanic ships (Iowa Department of Natural Resources, 2001§; Scott Gritterf, fisheries biologist, Iowa Department of Natural Resources, oral commun., November 14, 2002). The market still has not completely recovered from the die-off of Japanese oysters. Seed material had been stockpiled in Japan, and now producers in Japan are using manmade seed materials or seed materials from China and other sources in addition to the stockpiled material. There also has been an increase in the popularity of darker and colored pearls that do not use U.S. seed material (Ted Kroll, assistant director of fisheries, Kentucky Department of Fish and Wildlife, oral commun., November 15, 2002). In some regions of the United States, shell from mussels is beginning to be used as a gemstone based on its own merit rather than as seed material for pearls. This shell material is being used in beads, jewelry, and watch faces.

Consumption

Although the United States accounted for little of the total global gemstone production, it was the world's leading gemstone market. U.S. gemstone markets accounted for more than an estimated 35% of world gemstone demand in 2005. The U.S. market for unset gem-quality diamond during the year was estimated to have exceeded $16.2 billion. Domestic markets for natural, unset nondiamond gemstones totaled more than $996 million.

In the United States, about two-thirds of domestic consumers designate diamond as their favorite gemstone when surveyed. In 2005, the top 10 selling colored gemstones, in descending order, were blue sapphire; ruby; blue topaz; fancy sapphire; amethyst; peridot; tanzanite; emerald; aquamarine, citrine, and opal (tied for ninth place); and rhodolite garnet. Pink tourmaline and pearl dropped out of the top 10 from the previous year. During 2005, 50% of the jewelry retailers said their sales were up compared with 45% of retailers in 2004 (Prost, 2005; Wade, 2006). U.S. retail jewelry sales reached approximately $60 billion in 2005, with about 56% of that value involving diamond jewelry (SeekingAlpha, 2006§). U.S. online jewelry sales increased by more than 25% in 2005 to nearly $2.1 billion; this represents about 3.5% of all jewelry sold in the United States (IDEX Magazine, 2006§). The U.S. market accounted for more than 50% of the global diamond jewelry retail market in 2005.

The U.S. colored gemstone market posted an overall increase in sales during 2005 compared with the previous year's sales. The popularity of colored gemstones, colored laboratory-created gemstones, and "fancy" colored diamonds continued to increase in 2005. This was indicated by increased values of U.S. imports for consumption in most colored stone categories (emerald, coral, rubies, sapphires, other precious and semiprecious stones, and laboratory-created gems) in 2005 compared with the values from the previous year (table 10). Colored stone popularity also was evidenced by their general sales increase in 2005 (Wade, 2006).

The Gemological Institute of America (GIA) terminated the employment of four of its graders for improprieties in its New York, NY, laboratory, and the lab chief resigned. The improprieties were violations of the GIA code of ethics by clients of the lab, in particular, improper attempts to influence the outcome of grading reports. GIA is the world's foremost authority in gemology, diamond and gem grading and identification, jewelry education, and gemology research. The majority of GIA employees remain above reproach, and the GIA remains the leading lab in the industry. The incident had the potential to damage confidence in gem grading, but because of a thorough and immediate investigation into the situation, that did not happen (Diamond Registry Bulletin, 2005c, f).

Prices

Gemstone prices are governed by many factors and qualitative characteristics, including beauty, clarity, defects, demand, durability, and rarity. Diamond pricing, in particular, is complex; values can vary significantly depending on time, place, and the subjective valuations of buyers and sellers. There are more than 14,000 categories used to assess rough diamond and more than 100,000 different combinations of carat, clarity, color, and cut values used to assess polished diamond (Pearson, 1998).

Colored gemstone prices are generally influenced by market supply and demand considerations, and diamond prices are supported by producer controls on the quantity and quality of supply. Values and prices of gemstones produced and/or sold in the United States are listed in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported, exported, or reexported are listed in tables 6 through 10.

De Beers Group companies are a significant force affecting the price of gem-quality diamond worldwide because they mine more than 40% of the gem-quality diamond produced each year (De Beers Group, 2005§). De Beers companies also sort and valuate about two-thirds (by value) of the world's annual supply of rough diamond through De Beers' subsidiary Diamond Trading Co. (DTC), which has marketing agreements with other producers (De Beers Group, 2003§).

The yearly average diamond price index of the Diamond High Council of Antwerp increased in 2005 by 7.8% to 330.4 for 1-carat diamonds and by 1.3% to 262.2 for ½-carat diamonds. The diamond price index measures price changes relative to the baseline of 100 set by the 1985 price (Diamond Registry Bulletin, 2006c).

Foreign Trade

During 2005, total U.S. gemstone trade with all countries and territories was valued at more than $26.0 billion, which was an increase of 17.7% from that of the previous year. Diamond accounted for about 95% of the 2005 gemstone trade total. In 2005, U.S. exports and reexports of diamond were shipped to 89 countries and territories, and imports of all gemstones were received from 103 countries and territories (tables 6-10). During 2005, U.S. trade in cut diamond and unworked diamond increased by 14.6% and 21.9% respectively, compared with the previous year. The United States remained the world's leading diamond importer. The United States is a significant international diamond transit center as well as the world's leading gem-quality diamond market. The large volume of reexports shipped to other centers reveals the significance that the United States has in the world's diamond supply network (table 6).

Trade in laboratory-created gemstone increased by 0.3% for the United States in 2005 compared with the previous year. Laboratory-created gemstone imports from Austria, China, France, Germany, Hong Kong, Sri Lanka, Switzerland, and Thailand made up almost 93% (by value) of the total domestic imports of laboratory-created gemstones during the year. Prices of certain imported laboratory-created gemstones, such as amethyst, were very competitive. The marketing of imported laboratory-created gemstones and enhanced gemstones as natural gemstones and the mixing of laboratory-created materials with natural stones in imported parcels continued to be problems for some domestic producers in 2005. There also were problems with some simulants being marketed as laboratory-created gemstones during the year.

World Industry Structure

The gemstone industry worldwide has two distinct sectors—diamond mining and marketing and colored gemstone production and sales. Most diamond supplies are controlled by a few major mining companies; prices are supported by managing the quality and quantity of the gemstones relative to demand, a function performed by De Beers through DTC. Unlike diamond, colored gemstones are primarily produced at relatively small, low-cost operations with few dominant producers; prices are influenced by consumer demand and supply availability.

In 2005, world natural diamond production totaled about 183 million carats—102 million carats gem quality and 81.0

million carats industrial grade (table 11). Most production was concentrated in a few regions—Africa [Angola, Botswana, Congo (Kinshasa), Namibia, and South Africa], Asia (northeastern Siberia and Yakutia in Russia), Australia, North America (Northwest Territories in Canada), and South America (Brazil and Venezuela). In 2005, Australia led the world in total diamond output quantity (combined gemstone and industrial). Botswana was the world's leading gemstone diamond producer, followed by Russia, Australia, Canada, Congo (Kinshasa), South Africa, and Angola in descending quantity order. These seven countries produced 95.1% of the world's gemstone diamond output in 2005.

De Beers reported that its sales of rough diamond for 2005 were $6.54 billion, which was up by 15% from $5.7 billion in 2004 (Diamond Registry Bulletin, 2004a, 2005b, 2006b).

In 2002, the international rough-diamond certification system KPCS was implemented to solve the problem of conflict diamonds—rough diamonds used by rebel forces and their allies in several countries to help finance warfare aimed at subverting governments recognized as legitimate by the United Nations (UN). The KPCS was agreed upon by UN member nations, the diamond industry, and involved nongovernmental organizations. The KPCS includes the following key elements: the use of forgery-resistant certificates and tamper-proof containers for shipments of rough diamonds; internal controls and procedures that provide credible assurance that conflict diamonds do not enter the legitimate diamond market; a certification process for all exports of rough diamonds; the gathering, organizing, and sharing of import and export data on rough diamonds with other participants of relevant production; credible monitoring and oversight of the international certification scheme for rough diamonds; effective enforcement of the provisions of the certification scheme through dissuasive and proportional penalties for violations; self regulation by the diamond industry that fulfills minimum requirements; and sharing information with all other participants on relevant rules, procedures, and legislation as well as examples of national certificates used to accompany shipments of rough diamonds (Weldon, 2001§). Canada acted as the chair and secretariat of the KPCS for the first 2 years, and in October 2004, Russia assumed these duties. For the KPCS to be fully implemented, all participating countries must pass the necessary laws to carry it out. In 2005, Indonesia and Lebanon joined the list of countries participating in the KPCS, amounting to a total of 45 nations that have signed the agreement; participating nations in the KPCS account for approximately 98% of the global production and trade of rough diamonds (Diamond Registry Bulletin, 2005h; Kimberley Process, 2005§). Discussions about the possible participation of several other countries are ongoing.

Worldwide, the value of production of natural gemstones other than diamond was estimated to have exceeded $2 billion in 2005. Most nondiamond gemstone mines are small, low-cost, and widely dispersed operations in remote regions of developing nations. Foreign countries with major gemstone deposits other than diamond are Afghanistan (aquamarine, beryl, emerald, kunzite, lapis lazuli, ruby, and tourmaline), Australia (beryl, opal, and sapphire), Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline), Burma (beryl, jade, ruby, sapphire, and topaz), Colombia (beryl, emerald, and sapphire), Kenya (beryl, garnet, and sapphire), Madagascar (beryl, rose quartz, sapphire, and tourmaline), Mexico (agate, opal, and topaz), Sri Lanka (beryl, ruby, sapphire, and topaz), Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline), and Zambia (amethyst and beryl). In addition, pearls are cultured throughout the South Pacific and in other equatorial waters; Australia, China, French Polynesia, and Japan are key producers.

World Review

Canada.—The Ekati Diamond Mine, Canada's first operating commercial diamond mine, completed its seventh full year of production. In 2005, Ekati produced 3.23 million carats of diamond from 4.44 Mt of ore (BHP Billiton Ltd., 2006b). BHP Billiton Ltd. has an 80% controlling ownership in Ekati, which is in the Northwest Territories. Ekati has estimated reserves of 60.3 Mt of ore in kimberlite pipes that contain 54.3 million carats of diamond, and BHP Billiton projected the mine life to be 25 years. The Ekati Mine is now producing from the Koala, Panda, and Misery kimberlite pipes. BHP Billiton is using underground mining techniques to recover diamonds from deeper portions of the Panda kimberlite pipe (BHP Billiton Ltd., 2004). Underground mining of the deeper portions of the Koala kimberlite pipe has been approved and is expected to begin in December 2007 (BHP Billiton Ltd., 2006a). The Koala and Panda kimberlite pipes were first open pit mined (Diamond Registry Bulletin, 2002). Approximately one-third of the Ekati diamond production is industrial-grade material (Darren Dyck, senior project geologist, BHP Diamonds, Inc., oral commun., May 27, 2001).

The Diavik Diamond Mine, also in the Northwest Territories, completed its third full year of production. In 2005, Diavik produced 8.3 million carats of diamond from its A154 North ore body and the adjacent A154 South pipe. Both pipes are located within the same pit (Diavik Diamond Mines Inc., 2006). Diavik has estimated the mine's remaining proven and probable reserves to be 29.8 Mt of ore in kimberlite pipes, containing 95.6 million carats of diamond, and projected the mine life to be 16 to 22 years (Diavik Diamond Mines Inc., 2005). The mine is an unincorporated joint venture between Diavik Diamond Mines Inc. (60%) and Aber Diamond Mines Ltd. (40%). The mine is expected to produce a total of about 107 million carats of diamond at a rate of 8 million carats per year worth about $63 per carat during the entire mine life, which began production in December 2002 (Diavik Diamond Mines Inc., 2000, p. 10-12).

Diamond exploration is continuing in Canada, with several other commercial diamond projects and additional discoveries located in Alberta, British Columbia, the Northwest Territories, the Nunavut Territory, Ontario, and Quebec. Canada produced about 7% of the world's combined natural gemstone and industrial diamond production in 2005. Canadian diamond discoveries continue to be made and production continues to increase, and Canada is now fourth ranked in production of gemstone diamond after Botswana, Russia, and Australia.

Guyana.—A report by Partnership Africa Canada (PAC) stated that nearly 20% of diamonds mined in Guyana evade the KPSC by being smuggled to Brazil and cited weak controls in

Brazil and Venezuela as the problem. The situation exposes the entire industry to laundered diamonds from other countries, such as Côte d'Ivoire and Congo (Kinshasa). The report called for the expulsion of Brazil and Venezuela from the KPSC if the situation is not corrected (Diamond Registry Bulletin, 2006a).

Israel.—Polished diamond net exports for the 12-month period through October 2005 increased by 4.2% to $6.33 billion compared with the same period in 2004, and exports of rough diamond increased by 22.2% to $3 billion for the same period. Polished diamond net imports for the first 10 months of 2005 decreased by 18.4% to $264 million compared with those of the first 10 months of 2004, while net imports of rough diamond increased by 2.2% to $4.5 billion for the same 10-month period (Diamond Registry Bulletin, 2005d). The United States remained the leading diamond trading partner for Israel (Diamond Registry Bulletin, 2005e).

Russia.—Diamond production figures were released for the first time in December 2004. Production information had been kept as a state secret since the first diamond discovery in Siberia in 1955 (Diamond Registry Bulletin, 2005g).

Sierra Leone.—During the civil war in Sierra Leone, official diamond exports had plunged to $1.5 million a year. However, since the implementation of the KPSC and the end of the civil war diamond exports for 2005 were reported at $142 million (Diamond Registry Bulletin, 2006d).

Outlook

There are indications that there may be continued growth in the U.S. diamond and jewelry markets in 2006. Historically, diamonds have proven to hold their value despite wars or economic depressions (Schumann, 1998, p. 8).

Independent producers, such as Argyle Diamond Mines in Australia and Ekati and Diavik in Canada, will continue to bring a greater measure of competition to global markets. More competition presumably will bring more supplies and lower prices. Further consolidation of diamond producers and larger amounts of rough diamond being sold outside DTC will continue as the diamond industry adjusts to De Beers' reduced influence on the industry.

More laboratory-created gemstones, simulants, and treated gemstones will enter the marketplace and necessitate more transparent trade industry standards to maintain customer confidence.

During 2005, online sales rose by 25%, representing 3.5% of all retail jewelry sales for the year, and Internet sales of diamonds, gemstones, and jewelry will continue to grow and increase in popularity, as will other forms of e-commerce that emerge to serve the diamond and gemstone industry. This will take place as the gemstone industry and its customers become more comfortable with and learn the applications of new e-commerce tools (Diamond Registry Bulletin, 2004b, c; IDEX Magazine, 2006§).

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TABLE 1
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0-2.5	1.0-1.1	Single	1.54	Synthetic or pressed plastics, kaurigum	Fossil resin, color, low density, soft and trapped insects.
Apatite	Chlorocalcium phosphate	Colorless, pink, yellow, green, blue, violet	Small	Low	5.0	3.16-3.23	Double	1.63-1.65	Amblygonite, andalusite, brazilianite, precious beryl, titanite, topaz, tourmaline	Crystal habit, color, hardness, appearance.
Azurite	Copper carbonate hydroxide	Azure, dark blue, pale blue	Small to medium	do.	3.5-4.0	3.7-3.9	do.	1.72-1.85	Dumortierite, hauynite, lapis lazuli, lazulite, sodalite	Color, softness, crystal habits and associated minerals.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	do.	High	6.0-6.5	3.64-3.68	do.	1.76-1.80	Sapphire, tanzanite, blue diamond, blue tourmaline, cordierite	Strong blue in ultraviolet light.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5-8.0	2.63-2.80	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	Red	Small	Very high	7.5-8.0	2.63-2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald, natural	do.	Green	Medium	do.	7.5	2.63-2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5-8.0	2.63-2.80	do.	1.58	Genuine emerald	Lack of flaws, brilliant fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5-8.0	2.63-2.80	do.	1.58	Citrine, topaz, glass, doublets	Weak-colored.
Goshenite	do.	Colorless	do.	Low	7.5-8.0	2.63-2.80	do.	1.58	Quartz, glass, white sapphire, white topaz	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5-8.0	2.63-2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49-1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.60	do.	Banded, translucent.
Charoite	Hydrated sodium calcium hydroxi-fluoro-silicate	Lilac, violet, or white	Small to medium	do.	5.0-6.0	2.54-2.78	XX	1.55-1.56	Purple marble	Color, locality.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day light, red by artificial light	Small (CIS[3]); medium (Sri Lanka)	High	8.5	3.50-3.84	Double	1.75	Synthetic	Strong dichroism, color varies from red to green, hardness.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Chrysoberyl—Continued:										
Cats-eye	Beryllium aluminate	Greenish to brownish	Small to large	High	8.5	3.50-3.84	Double	1.75	Synthetic, shell	Density, translucence, chatoyance.
Chrysolite	do.	Yellow, green, and/or brown	Medium	Medium	8.5	3.50-3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Chrysocolla	Hydrated copper silicate	Green, blue	Any	Low	2.0-4.0	2.0-2.4	XX	1.46-1.57	Azurite, dyed chalcedony, malachite, turquoise, variscite	Lack of crystals, color, fracture, low density and softness.
Coral	Calcium carbonate	Orange, red, white, black, purple, or green	Branching, medium	do.	3.5-4.0	2.6-2.7	Double	1.49-1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95-4.10	do.	1.78	Synthetics, including spinel, garnet	Inclusions, fluorescence.
Sapphire, blue	do.	Blue	Medium	High	9.0	3.95-4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, colorless, orange, green, or violet	Medium to large	Medium	9.0	3.95-4.10	do.	1.78	Synthetics, glass and doublets, morganite	Inclusions, double refreaction, refractive index.
Sapphire or ruby, stars	do.	Red, pink, violet, blue, or gray	do.	High to low	9.0	3.95-4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.
Sapphire or ruby, synthetic	do.	Yellow, pink, or blue	Up to 20 carats	Low	9.0	3.95-4.10	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Cubic zirconia	Zirconium and yttrium oxides	Colorless, pink, blue, lavender, yellow	Small	do.	8.25-8.5	5.8	Single	2.17	Diamond, zircon, titania, moissanite	Hardness, density, lack of flaws and inclusions, refractive index.
Diamond	Carbon	White, blue-white, yellow, brown, green, red, pink, blue	Any	Very high	10.0	3.516-3.525	do.	2.42	Zircon, titania, cubic zirconia, moissanite	High index, dispersion, hardness, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green-blue	Large	Low	6.0-6.5	2.56	XX	1.52	Jade, turquoise	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play (schiller)	do.	do.	6.0-6.5	2.56	XX	1.56	do.	Do.
Moonstone	do.	Colorless, white, gray, or yellow with white, blue, or bronze schiller	do.	do.	6.0-6.5	2.77	XX	1.52-1.54	Glass, chalcedony, opal	Pale sheen, opalescent.
Sunstone	do.	Orange, red brown, colorless with gold or red glittery schiller	Small to medium	do.	6.0-6.5	2.77	XX	1.53-1.55	Aventurine, glass	Red glittery schiller.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Garnet	Complex silicate	Brown, black, yellow, green, red, or orange	Small to medium	Low to high	6.5-7.5	3.15-4.30	Single strained	1.79-1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Hematite	Iron oxide	Black, black-gray, brown-red	Medium to large	Low	5.5-6.5	5.12-5.28	XX	2.94-3.22	Davidite, cassiterite, magnetite, neptunite, pyrolusite, wolframite	Crystal habit, streak, hardness.
Jade:										
Jadeite	Complex silicate	Green, yellow, black, white, or mauve	Large	Low to very high	6.5-7.0	3.3-3.5	Crypto-crystalline	1.65-1.68	Nephrite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0-6.5	2.96-3.10	do.	1.61-1.63	Jadeite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Do.
Jet (gagate)	Lignite	Deep black, dark brown	do.	Low	2.5-4.0	1.19-1.35	XX	1.64-1.68	Anthracite, asphalt, cannel coal, onyx, schorl, glass, rubber	Luster, color.
Lapis lazuli	Sodium calcium aluminum silicate	Dark azure-blue to bright indigo blue or even a pale sky blue.	do.	do.	5.0-6.0	2.50-3.0	XX	1.50	Azurite, dumortierite, dyed howlite, lazulite, sodalite, glass	Color, crystal habit, associated minerals, luster, and localities.
Malachite	Hydrated copper carbonate	Light to black-green banded	do.	do.	3.5-4.0	3.25-4.10	XX	1.66-1.91	Brochantite, chrysoprase, opaque green gemstones	Color banding, softness, associated minerals.
Moissanite	Silicon carbide	Colorless and pale shades of green, blue, yellow	Small	Low to medium	9.25	3.21	Double	2.65-2.69	Diamond, zircon, titania, cubic zirconia	Hardness, dispersion, lack of flaws and inclusions, refractive index.
Obsidian	Amorphous, variable (usually felsic)	Black, gray, brown, dark green, white, transparent	Large	Low	5.0-5.5	2.35-2.60	XX	1.45-1.55	Aegirine-augite, gadolinite, gagate, hematite, pyrolusite, wolframite	Color, conchoidal fracture, flow bubbles, softness, and lack of crystal faces.
Opal	Hydrated silica	Reddish orange, colors flash in white gray, black, red, or yellow	do.	Low to high	5.5-6.5	1.9-2.3	Single	1.45	Glass, synthetics, triplets, chalcedony	Color play (opalescence).
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5-7.0	3.27-3.37	Double (strong)	1.65-1.69	Tourmaline, chrysoberyl	Strong double refraction, low dichroism.
Quartz:										
Agate	Silicon dioxide	Any	Large	Low	7.0	2.58-2.64	XX	XX	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Quartz—Continued:										
Amethyst	Silicon dioxide	Purple	Large	Medium	7.0	2.65-2.66	Double	1.55	Glass, plastic, fluorite	Macrocrystalline, color, refractive index, transparent, hardness.
Aventurine	do.	Green, red-brown, gold-brown, with metallic iridescent reflection	do.	Low	7.0	2.64-2.69	do.	1.54-1.55	Iridescent analcime, aventurine feldspar, emerald, aventurine glass	Macrocrystalline, color, metallic iridescent flake reflections, hardness.
Cairngorm	do.	Smoky orange or yellow	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Carnelian	do.	Flesh red to brown red	do.	do.	6.5-7.0	2.58-2.64	do.	1.53-1.54	Jasper	Cryptocrystalline, color, hardness.
Chalcedony	do.	Bluish, white, gray	do.	do.	6.5-7.0	2.58-2.64	do.	1.53-1.54	Tanzanite	Do.
Chrysoprase	do.	Green, apple-green	do.	do.	6.5-7.0	2.58-2.64	do.	1.53-1.54	Chrome chalcedony, jade, prase opal, prehnite, smithsonite, variscite, artifically colored green chalcedony	Do.
Citrine	Silica	Yellow	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Crystal:										
Rock	do.	Colorless	do.	do.	7.0	2.65-2.66	do.	1.55	Topaz, colorless sapphire	Do.
Jasper	do.	Any, striped, spotted, or sometimes uniform	do.	do.	7.0	2.58-2.66	XX	XX	do.	Cryptocrystalline, opaque, vitreous luster, hardness.
Onyx	do.	Many colors	do.	do.	7.0	2.58-2.64	XX	XX	do.	Cryptocrystalline, uniformly banded, hardness.
Petrified wood	do.	Brown, gray, red, yellow	do.	do.	6.5-7.0	2.58-2.91	Double	1.54	Agate, jasper	Color, hardness, wood grain.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Tiger's eye	do.	Golden yellow, brown, red, blue-black	do.	do.	6.5-7.0	2.58-2.64	XX	1.53-1.54	XX	Macrocrystalline, color, hardness, hatoyancy.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Rhodochrosite	Manganese carbonate	Rose-red to yellowish, stripped	Large	Low	4.0	3.45-3.7	Double	1.6-1.82	Fire opal, rhodonite, tugtupite, tourmaline	Color, crystal habit, reaction to acid, perfect rhombohedral cleavage.
Rhodonite	Manganese iron calcium silicate	Dark red, flesh red, with dendritic inclusions of black manganese oxide	do.	do.	5.5-6.5	3.40-3.74	do.	1.72-1.75	Rhodochrosite, thulite, hessonite, spinel, pyroxmangite, spessartine, tourmaline	Color, black inclusions, lack of reaction to acid, hardness.
Shell:										
Mother-of-pearl	Calcium carbonate	White, cream, green, blue-green, with iridescent play of color	Small	do.	3.5	2.6-2.85	XX	XX	Glass and plastic imitation	Luster, iridescent play of color.
Pearl	do.	White, cream to black, sometimes with hint of pink, green, purple	do.	Low to high	2.5-4.5	2.6-2.85	XX	XX	Cultured and glass or plastic imitation	Luster, iridescence, x-structure, ray.
Spinel	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5-3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5-3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5-7.0	3.13-3.20	do.	1.66	Synthetic spinel	Refractive index, color, pleochroism.
Kunzite	do.	Pink to lilac	do.	do.	6.5-7.0	3.13-3.20	do.	1.66	Amethyst, morganite	Do.
Tanzanite	Complex silicate	Blue to lavender	Small	High	6.0-7.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism, color.
Topaz	do.	White, blue, green, pink, yellow, gold	Medium	Low to medium	8.0	3.4-3.6	do.	1.62	Beryl, quartz	Color, density, hardness, refractive index, perfect in basal cleavage.
Tourmaline	do.	Any, including mixed	do.	do.	7.0-7.5	2.98-3.20	do.	1.63	Peridot, beryl, garnet corundum, glass	Double refraction, color, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green with black, brown-red inclusions	Large	Low	6.0	2.60-2.83	do.	1.63	Chrysocolla, dyed howlite, dumortierite, glass, plastics, variscite	Difficult if matrix not present, matrix usually limonitic.
Unakite	Granitic rock, feldspar, epidote, quartz	Olive green, pink, and blue-gray	do.	do.	6.0-7.0	2.60-3.20	XX	XX	XX	Olive green, pink, gray-blue colors.
Zircon	Zirconium silicate	White, blue, brown, yellow, or green	Small to medium	Low to medium	6.0-7.5	4.0-4.8	Double (strong)	1.79-1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

XX Not applicable.

[1]Small: up to 5 carats; medium: 5 to 50 carats; large: more than 50 carats.

[2]Low: up to $25 per carat; medium: up to $200 per carat; high: more than $200 per carat.

[3]Commonwealth of Independent States.

TABLE 2
LABORATORY-CREATED GEMSTONE PRODUCTION METHODS

Gemstone	Production method	Company/producer	Date of first production
Alexandrite	Flux	Creative Crystals	1970s.
Do.	Melt pulling	J.O. Crystal	1990s.
Do.	do.	Kyocera	1980s.
Do.	Zone melt	Seiko	1980s.
Cubic zirconia	Skull melt	Various producers	1970s.
Emerald	Flux	Chatham	1930s.
Do.	do.	Gilson	1960s.
Do.	do.	Kyocera	1970s.
Do.	do.	Seiko	1980s.
Do.	do.	Lennix	1980s.
Do.	do.	Russia	1980s.
Do.	Hydrothermal	Lechleitner	1960s.
Do.	do.	Regency	1980s.
Do.	do.	Biron	1980s.
Do.	do.	Russia	1980s.
Ruby	Flux	Chatham	1950s.
Do.	do.	Kashan	1960s.
Do.	do.	J.O. Crystal	1980s.
Do.	do.	Douras	1990s.
Do.	Zone melt	Seiko	1980s.
Do.	Melt pulling	Kyocera	1970s.
Do.	Verneuil	Various producers	1900s.
Sapphire	Flux	Chatham	1970s.
Do.	Zone melt	Seiko	1980s.
Do.	Melt pulling	Kyocera	1980s.
Do.	Verneuil	Various producers	1900s.
Star ruby	do.	Linde	1940s.
Do.	Melt pulling	Kyocera	1980s.
Do.	do.	Nakazumi	1980s.
Star sapphire	Verneuil	Linde	1940s.

TABLE 3
VALUE OF U.S. GEMSTONE PRODUCTION, BY TYPE[1]

(Thousand dollars)

Gem materials	2004	2005
Beryl	18	48
Coral, all types	261	216
Diamond	(2)	(2)
Garnet	207	46
Gem feldspar	659	626
Geode/nodules	212	214
Opal	137	140
Quartz:		
Macrocrystalline[3]	206	196
Cryptocrystalline[4]	383	427
Sapphire/ruby	473	450
Shell	4,000	3,560
Topaz	(2)	(2)
Tourmaline	45	39
Turquoise	699	511
Other	7,170 r	6,960
Total	14,500	13,400

See footnotes at end of table.

TABLE 3—Continued
VALUE OF U.S. GEMSTONE PRODUCTION, BY TYPE[1]

[r]Revised.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Included with "Other."
[3]Macrocrystalline quartz (crystals recognizable with the naked eye) includes amethyst, amethyst quartz, aventurine, blue quartz, citrine, hawk's eye, pasiolite, prase, quartz cat's eye, rock crystal, rose quartz, smoky quartz, and tiger's eye.
[4]Cryptocrystalline (microscopically small crystals) includes agate carnelian, chalcedony, chrysoprase, fossilized wood, heliotrope, jasper, moss agate, onyx, and sard.

TABLE 4
PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY IN 2005[1]

Carat weight	Description, color[2]	Clarity[3] (GIA terms)	Representative prices		
			January[4]	June[5]	December[6]
0.25	G	VS1	$1,200	$1,200	$1,200
do.	G	VS2	1,150	1,150	1,150
do.	G	SI1	975	975	975
do.	H	VS1	1,100	1,100	1,100
do.	H	VS2	1,000	1,000	1,000
do.	H	SI1	925	925	925
0.50	G	VS1	3,200	3,200	3,200
do.	G	VS2	2,800	2,800	2,800
do.	G	SI1	2,400	2,400	2,400
do.	H	VS1	2,800	2,800	2,800
do.	H	VS2	2,400	2,400	2,400
do.	H	SI1	2,200	2,200	2,200
0.75	G	VS1	3,600	3,600	3,600
do.	G	VS2	3,500	3,500	3,500
do.	G	SI1	3,200	3,200	3,200
do.	H	VS1	3,300	3,300	3,300
do.	H	VS2	3,200	3,200	3,200
do.	H	SI1	2,900	2,900	2,900
1.00	G	VS1	5,800	5,800	5,800
do.	G	VS2	5,500	5,500	5,500
do.	G	SI1	4,800	4,800	4,800
do.	H	VS1	5,200	5,200	5,200
do.	H	VS2	4,900	4,900	4,900
do.	H	SI1	4,700	4,700	4,700

[1]Data are rounded to no more than three significant digits.
[2]Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; G, H, I—traces of color.
[3]Clarity: IF—no blemishes; VVS1—very, very slightly included; VS1—very slightly included; VS2—very slightly included, but not visible; SI1—slightly included.
[4]Source: Jewelers' Circular Keystone, v. 174, no. 2, February 2003, p. 44.
[5]Source: Jewelers' Circular Keystone, v. 174, no. 7, July 2003, p. 52.
[6]Source: Jewelers' Circular Keystone, v. 175, no. 1, January 2004, p. 28.

TABLE 5
PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES IN 2005

Gemstone	Price range per carat	
	January[1]	December[2]
Amethyst	$7-15	$7-15
Blue sapphire	625-1,250	625-1,250
Blue topaz	3-5	3-5
Emerald	1,900-3,200	1,900-3,200
Green tourmaline	45-60	45-60
Pearl:[3]		
Cultured saltwater	5	5
Natural	210	210
Pink tourmaline	60-125	60-125
Rhodolite garnet	18-30	18-30
Ruby	900-1,125	900-1,125
Tanzanite	250-375	250-400

[1]Source: The Guide, spring/summer 2005, p. 14, 30, 45, 61, 72, 86, 96, 98, 104, 123, and 135. These figures are approximate current wholesale purchase prices paid by retail jewelers on a per stone basis for fine-quality stones.

[2]Source: The Guide, fall/winter 2005-2006, p. 14, 30, 45, 61, 72, 86, 96, 98, 104, 123, and 135. These figures are approximate current wholesale purchase prices paid by retail jewelers on a per stone basis for fine-quality stones.

[3]Prices are per 4.6-millimeter pearl.

TABLE 6

U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY[1]

Country	2004 Quantity (carats)	2004 Value[2] (millions)	2005 Quantity (carats)	2005 Value[2] (millions)
Exports:				
Australia	7,570	$7	33,700	$7
Belgium	189,000	100 r	1,300,000	538
Canada	68,500	47	84,200	56
Costa Rica	31,800	3	37,200	3
France	16,300	11	90,000	51
Hong Kong	529,000	219	1,030,000	294
India	151,000	31	206,000	57
Israel	352,000 r	208 r	1,890,000	1,090
Japan	22,600	26	52,400	53
Mexico	397,000	124	1,080,000	144
Netherlands	421	3	27,600	8
Netherlands Antilles	47,200	23	35,500	33
Singapore	12,300	5	54,000	19
South Africa	498	(3)	21,100	4
Switzerland	19,000 r	47	108,000	82
Taiwan	11,000	6	16,700	4
Thailand	68,500	15	98,000	28
United Arab Emirates	15,700	4	101,000	43
United Kingdom	26,300	28	78,800	22
Other	52,200 r	29 r	87,200	46
Total	2,020,000 r	936 r	6,430,000	2,580
Reexports:				
Armenia	69,500 r	3	44,300	3
Australia	19,100	7	40,300	8
Belgium	4,780,000 r	1,370 r	3,920,000	1,100
Canada	223,000 r	107 r	247,000	136
Dominican Republic	104,000	23	153,000	33
France	155,000	32 r	88,200	16
Guatemala	91,100	8	107,000	12
Hong Kong	2,690,000 r	490 r	2,500,000	618
India	2,200,000 r	345 r	1,840,000	387
Israel	7,650,000 r	2,690 r	7,670,000	2,640
Japan	207,000 r	47 r	150,000	33
Malaysia	41,100	9	34,900	5
Mexico	37,000	5	57,700	11
Singapore	264,000 r	46	218,000	35
South Africa	78,000 r	48 r	47,600	36
Switzerland	563,000 r	289 r	638,000	303
Thailand	285,000 r	70	290,000	83
United Arab Emirates	477,000 r	108 r	612,000	142
United Kingdom	490,000 r	171	540,000	211
Other	147,000 r	59 r	122,000	87
Total	20,600,000 r	5,930 r	19,300,000	5,890
Grand total	22,600,000 r	6,870 r	25,700,000	8,470

[r]Revised.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY[1]

	2004		2005	
Kind, range, and country of origin	Quantity (carat)	Value[2] (millions)	Quantity (carat)	Value[2] (millions)
Rough or uncut, natural:[3]				
Angola	6,590	$19	19,400	$57
Australia	12,200	8	62,400	8
Botswana	144,000	48	274,000	132
Brazil	9,530	8	24,600	2
Canada	36,500	38	57,600	62
Congo (Kinshasa)	20,900	17	44,300	116
Ghana	1,910	(4)	58,000	3
Guyana	157,000	16	68,400	8
India	34,500	3	29,200	(4)
Namibia	28,700	1	10,700	1
Russia	250,000	20	45,500	13
South Africa	430,000	508	347,000	413
Other	74,400 r	68 r	16,800	49
Total	1,210,000	753	1,060,000	864
Cut but unset, not more than 0.5 carat:				
Belgium	786,000	275	530,000	197
Canada	4,800	4	7,890	9
China	67,100	10	78,900	13
Dominican Republic	37,200	4	57,100	5
Hong Kong	200,000	43	228,000	58
India	9,720,000	1,770	8,780,000	1,820
Israel	969,000	477	843,000	425
Mauritius	1,890	4	10,400	15
Mexico	14,400	(4)	247,000	35
Singapore	9,460	2	6,180	2
South Africa	8,410	3	5,330	2
Switzerland	7,390	2	33,600	18
Thailand	189,000	36	71,500	18
United Arab Emirates	122,000	24	91,600	23
Other	67,700 r	15 r	28,600	13
Total	12,200,000	2,670	11,000,000	2,650
Cut but unset, more than 0.5 carat:				
Belgium	1,230,000	2,450	1,160,000	2,620
Canada	23,600	67	15,200	50
Hong Kong	71,300	111	83,400	162
India	1,530,000	1,080	1,340,000	1,260
Israel	3,080,000	6,660	3,070,000	7,670
Mexico	16	(4)	49,900	37
Russia	62,200	121	57,600	126
South Africa	40,500	242	46,300	336
Switzerland	20,100	155	16,600	138
Thailand	21,300	23	21,200	20
United Arab Emirates	23,800	21	50,300	64
Other	88,200 r	272 r	67,000	235
Total	6,190,000	11,200	5,980,000	12,700

[r]Revised.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Includes some natural advanced diamond.

[4]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 8

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

Kind and country	2004 Quantity (carats)	2004 Value[2] (millions)	2005 Quantity (carats)	2005 Value[2] (millions)
Emerald:				
Argentina	--	--	12,500	(3)
Belgium	25,200	$2	4,230	$1
Brazil	355,000	4	83,600	5
Canada	412	(3)	6,430	(3)
China	227,000	1	17,900	(3)
Colombia	677,000	47	456,000	54
France	745	1	2,360	7
Germany	7,440	1	93,600	1
Hong Kong	57,100	4	86,100	8
India	1,880,000	18	1,340,000	17
Israel	259,000	21	139,000	22
Italy	865	(3)	3,120	2
Namibia	--	--	4,590	(3)
Switzerland	9,450	7	18,500	8
Thailand	424,000	8	348,000	7
United Kingdom	851	2	2,520	2
Other	74,600	6	4,770	2
Total	4,000,000	122	2,620,000	137
Ruby:				
Belgium	6,450	2	11,600	1
China	21,700	(3)	29,700	(3)
Dominican Republic	4,920	(3)	23,600	(3)
France	786	1	2,300	5
Germany	19,400	1	77,600	1
Hong Kong	52,100	4	119,000	7
India	1,300,000	4	935,000	5
Israel	41,300	1	8,840	1
Italy	6,570	(3)	4,340	1
Kenya	526	(3)	33,500	(3)
Sri Lanka	5,260	1	4,080	1
Switzerland	2,230	11	89,300	29
Thailand	2,090,000	43	3,030,000	48
United Arab Emirates	7,700	1	3,340	1
Other	186,000	2	8,630	2
Total	3,750,000	72	4,380,000	102
Sapphire:				
Australia	5,300	(3)	57,900	1
Austria	947	(3)	29,600	1
Belgium	4,480	1	7,120	1
China	120,000	(3)	84,100	(3)
Dominican Republic	3,750	(3)	24,500	(3)
Germany	41,000	2	72,700	5
Hong Kong	138,000	7	272,000	15
India	1,040,000	9	987,000	6
Israel	56,600	3	31,600	3
Italy	4,130	(3)	5,880	(3)
Singapore	379	(3)	5,350	(3)
Sri Lanka	455,000	42	448,000	45
Switzerland	29,900	11	49,000	9
Thailand	5,470,000	78	5,620,000	81

See footnotes at end of table.

TABLE 8—Continued
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

	2004		2005	
Kind and country	Quantity (carats)	Value[2] (millions)	Quantity (carats)	Value[2] (millions)
Sapphire—Continued:				
United Arab Emirates	7,360	(3)	2,490	(3)
United Kingdom	7,820	$3	2,550	(3)
Other	113,000	4	14,700	$5
Total	7,500,000	163	7,710,000	174
Other:				
Rough, uncut:				
Australia	NA	3	NA	2
Brazil	NA	8	NA	10
Canada	NA	3	NA	4
China	NA	3	NA	4
Colombia	NA	1	NA	1
Czech Republic	NA	(3)	NA	2
Germany	NA	2	NA	3
India	NA	1	NA	1
Japan	NA	(3)	NA	1
Mexico	NA	1	NA	1
Netherlands	NA	1	NA	1
Pakistan	NA	1	NA	1
South Africa	NA	7	NA	1
Tanzania	NA	1	NA	3
United Kingdom	NA	(3)	NA	1
Other	NA	5 r	NA	5
Total	NA	39	NA	40
Cut, set and unset:				
Australia	NA	9	NA	9
Austria	NA	3	NA	4
Brazil	NA	13	NA	18
Canada	NA	1	NA	1
China	NA	45	NA	57
France	NA	1	NA	3
Germany	NA	38	NA	33
Hong Kong	NA	35	NA	49
India	NA	82	NA	93
Israel	NA	4	NA	5
Italy	NA	1	NA	1
South Africa	NA	5	NA	3
Sri Lanka	NA	7	NA	7
Switzerland	NA	10	NA	19
Taiwan	NA	2	NA	2
Tanzania	NA	7	NA	7
Thailand	NA	46	NA	40
United Arab Emirates	NA	2	NA	1
United Kingdom	NA	1	NA	1
Other	NA	7 r	NA	7
Total	NA	320	NA	360

[r]Revised. NA Not available. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 9
VALUE OF U.S. IMPORTS OF LABORATORY-CREATED
AND IMITATION GEMSTONES, BY COUNTRY[1,2]

(Thousand dollars)

Country	2004	2005
Laboratory-created, cut but unset:		
Austria	2,410	3,700
Brazil	225	151
Canada	98	133
China	14,100	15,200
Cyprus	246	86
Czech Republic	114	91
France	989	945
Germany	13,800	12,200
Hong Kong	1,500	1,580
India	261	526
Ireland	7	69
Italy	75	131
Japan	112	110
Korea, Republic of	649	468
Netherlands	232	296
South Africa	--	87
Sri Lanka	1,290	1,300
Switzerland	3,340	2,050
Taiwan	197	238
Thailand	1,090	1,420
United Arab Emirates	--	70
Other	158 r	253
Total	40,900	41,100
Imitation:[3]		
Austria	60,800	73,600
Brazil	8	16
China	4,660	3,500
Czech Republic	7,000	11,000
France	16	13
Germany	974	1,160
Hong Kong	700	271
India	207	361
Italy	100	222
Japan	1,110	474
Korea, Republic of	774	619
Philippines	16	15
Russia	53	17
Spain	165	256
Taiwan	220	179
Thailand	31	52
United Kingdom	--	24
Other	227 r	109
Total	77,000	91,900

[r]Revised. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Includes pearls.

Source: U.S. Census Bureau.

TABLE 10

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES[1]

(Thousand carats and thousand dollars)

Stones	2004 Quantity	2004 Value[2]	2005 Quantity	2005 Value[2]
Diamonds:				
Rough or uncut	1,210	753,000	1,060	864,000
Cut but unset	18,400	13,900,000	17,000	15,400,000
Emeralds, cut but unset	4,000	122,000	2,630	137,000
Coral and similar materials, unworked	6,120	11,500	5,520	12,200
Rubies and sapphires, cut but unset	11,200	234,000	12,100	275,000
Pearls:				
Natural	NA	15,500 r	NA	21,800
Cultured	NA	29,500	NA	27,100
Imitation	NA	3,780	NA	4,170
Other precious and semiprecious stones:				
Rough, uncut	1,130,000	25,200	1,630,000	22,900
Cut, set and unset	NA	279,000	NA	319,000
Other	NA	5,680	NA	7,200
Laboratory-created:				
Cut but unset	249,000	40,900	196,000	41,100
Other	NA	8,110	NA	10,300
Imitation gemstone[3]	NA	73,300	NA	87,700
Total	XX	15,500,000 r	XX	17,200,000

[r]Revised. NA Not available. XX Not applicable.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Does not include pearls.

Source: U.S. Census Bureau.

TABLE 11

NATURAL DIAMOND: WORLD PRODUCTION, BY COUNTRY AND TYPE[1, 2, 3]

(Thousand carats)

Country and type[4]	2001	2002	2003	2004	2005
Gemstones:					
Angola[e]	4,643 [r]	4,520	5,130 [r]	5,490 [r]	5,580
Australia	14,397 [r]	15,136 [r]	13,981 [r]	20,602 [r]	20,000 [e]
Botswana[e]	19,812 [r, 5]	21,297 [r, 5]	22,800	23,300	23,900
Brazil[e]	700	500 [5]	400 [r]	300 [r, 5]	300
Canada	3,716	4,937	10,756 [r]	12,618	12,300
Central African Republic[e]	340	312	250	263 [r]	265
China[e]	100 [r]	100 [r]	100 [r]	100 [r]	100
Congo (Kinshasa)	3,638	4,223 [r]	5,381 [r]	6,180 [r]	6,300 [e]
Côte d'Ivoire	207 [e]	205 [r]	154 [r]	201 [r, e]	201 [e]
Ghana	936 [e]	770 [e]	675 [r]	690 [r]	760 [e]
Guinea[e]	273	368	484 [6]	354 [r, 6]	411 [6]
Guyana	179	248	413	455 [r]	357
Liberia[e]	100	48	36	18	18
Namibia	1,487	1,562	1,481	2,004 [r]	1,900 [e]
Russia[e]	17,500	17,400	20,000	21,400	23,000
Sierra Leone	102 [r]	162 [r]	233 [r, e]	318 [r, e]	318 [e]
South Africa	4,465 [r]	4,351 [r]	5,144 [r]	5,780 [e]	5,780 [e]
Tanzania[e]	216 [5]	204	201	258 [r]	175
Venezuela	14	46	11	40 [e]	46 [e]
Other[7]	54 [r]	42 [r]	44 [r]	74 [r]	110
Total	72,900 [r]	76,400 [r]	87,700 [r]	100,000 [r]	102,000
Industrial:					
Angola[e]	516	502	570 [r]	610 [r]	620
Australia	11,779 [r]	18,500	17,087 [r]	22,709 [r]	20,000 [e]
Botswana[e]	6,604 [r, 5]	7,100	7,600	7,800	8,000
Brazil[e]	600	600	600	600	600
Central African Republic[e]	113	104	83	88 [r]	88
China[e]	950	955	955	960	960
Congo (Kinshasa)	14,560	17,456	21,600	24,700 [r]	25,200 [e]
Côte d'Ivoire	102	101 [r]	76 [r]	99 [r, e]	99 [e]
Ghana[e]	234	193	225 [r]	230 [r]	253
Guinea[e]	91	123	161 [6]	118 [r, 6]	137 [6]
Liberia[e]	70	32	24	12	12
Russia[e]	11,700	11,600	13,000	14,200	15,000
Sierra Leone	120 [r]	190 [r]	274 [r, e]	374 [r, e]	374 [e]
South Africa	6,698 [r]	6,526 [r]	7,540 [r]	8,500 [r, e]	9,380 [e]
Tanzania	38	36	36	46 [r]	30
Venezuela	28	61	24	60 [e]	69 [e]
Other[8]	91 [r]	81 [r]	82 [r]	121 [r]	190
Total	54,300 [r]	64,200 [r]	69,900 [r]	81,200 [r]	81,000
Grand total	127,000	141,000 [r]	158,000 [r]	182,000 [r]	183,000

[e]Estimated. [r]Revised.

[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through June 5, 2006.

[3]In addition to the countries listed, Nigeria produces natural diamond, but information is inadequate to formulate reliable estimates of output levels.

[4]Includes near-gem and cheap-gem qualities.

[5]Reported figure.

[6]Exports.

[7]Includes Cameroon, Congo (Brazzaville), Gabon (unspecified), India, Indonesia, and Zimbabwe.

[8]Includes Congo (Brazzaville), India, Indonesia, and Zimbabwe.

2006 Minerals Yearbook

GEMSTONES

U.S. Department of the Interior
U.S. Geological Survey

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Gemstones

By Donald W. Olson

Domestic survey data and tables were prepared by Jackie Arbour and Mahbood Mahdavi, statistical assistants, and the world production table was prepared by Glenn J. Wallace, international data coordinator.

In 2006, the estimated value of natural gemstones produced in the United States was more than $11.3 million, and the estimated value of U.S. laboratory-created gemstone production was more than $52.1 million. The total estimated value of U.S. gemstone production was almost $63.4 million. The value of U.S. gemstone imports was $18.3 billion, and the value of combined U.S. gemstone exports and reexports was estimated to be $9.93 billion.

In this report, the terms “gem” and “gemstone” mean any mineral or organic material (such as amber, pearl, petrified wood, and shell) used for personal adornment, display, or object of art because it possesses beauty, durability, and rarity. Of more than 4,000 mineral species, only about 100 possess all these attributes and are considered to be gemstones. Silicates other than quartz are the largest group of gemstones in terms of chemical composition; oxides and quartz are the second largest (table 1). Gemstones are subdivided into diamond and colored gemstones, which in this report designates all natural nondiamond gems. In addition, laboratory-created gemstones, cultured pearls, and gemstone simulants are discussed but are treated separately from natural gemstones (table 2). Trade data in this report are from the U.S. Census Bureau. All percentages in the report were computed using unrounded data. Current information on industrial-grade diamond and industrial-grade garnet can be found in the U.S. Geological Survey (USGS) Minerals Yearbook, volume I, Metals and Minerals chapters on industrial diamond and industrial garnet, respectively.

Gemstones have fascinated humans since prehistoric times. They have been valued as treasured objects throughout history by all societies in all parts of the world. Amber, amethyst, coral, diamond, emerald, garnet, jade, jasper, lapis lazuli, pearl, rock crystal, ruby, serpentine, and turquoise are some of the first stones known to have been used for making jewelry. These stones served as symbols of wealth and power. Today, gems are worn more for pleasure or in appreciation of their beauty than to demonstrate wealth. In addition to jewelry, gemstones are used for collections, decorative art objects, and exhibits.

Production

U.S. gemstone production data were based on a survey of more than 230 domestic gemstone producers conducted by the USGS. The survey provided a foundation for projecting the scope and level of domestic gemstone production during the year. However, the USGS survey did not represent all gemstone activity in the United States, which includes thousands of professional and amateur collectors. Consequently, the USGS supplemented its survey with estimates of domestic gemstone production from related published data, contacts with gemstone dealers and collectors, and information gathered at gem and mineral shows.

Commercial mining of gemstones has never been extensive in the United States. More than 60 varieties of gemstones have been produced commercially from domestic mines, but most of the deposits have been relatively small compared with other mining operations. In the United States, much of the current gemstone mining is conducted by individual collectors, gem clubs, and hobbyists rather than by businesses.

The commercial gemstone industry in the United States consists of individuals and companies that mine gemstones or harvest shell and pearl, firms that manufacture laboratory-created gemstones, and individuals and companies that cut and polish natural and laboratory-created gemstones. The domestic gemstone industry is focused on the production of colored gemstones and on the cutting and polishing of large diamond stones. Industry employment is estimated to range from 1,000 to 1,500 workers (U.S. International Trade Commission, 1997, p. 1).

Most natural gemstone producers in the United States are small businesses that are widely dispersed and operate independently. The small producers probably have an average of less than three employees, including those who only work part time. The number of gemstone mines operating from year to year fluctuates because the uncertainty associated with the discovery and marketing of gem-quality minerals makes it difficult to obtain financing for developing and sustaining economically viable operations (U.S. International Trade Commission, 1997, p. 23).

The total value of natural gemstones produced in the United States during 2006 was estimated to be more than $11.3 million (table 3). The production value decreased by 16% from that of 2005.

Natural gemstone materials indigenous to the United States are collected, produced, and/or marketed in every State. During 2006, all 50 States produced at least $1,000 worth of gemstone materials. Nine States accounted for 82% of the total value, as reported by survey respondents. These States were, in order of declining value of production, Tennessee, Oregon, Arizona, California, Arkansas, Alabama, Idaho, Montana, and Nevada. Some States were known for the production of a single gemstone material—Tennessee for freshwater pearls, for example. Other States produced a variety of gemstones; for example Arizona’s gemstone deposits included agate, amethyst, azurite, chrysocolla, garnet, jade, jasper, malachite, obsidian, onyx, opal, peridot, petrified wood, smithsonite, and turquoise. There is also a wide variety of gemstones found and produced in California, Idaho, Montana, and North Carolina.

During 2006, the United States had only one operation in known diamond-bearing areas from which diamonds were produced. That diamond operation is in Crater of Diamonds State Park near Murfreesboro in Pike County, AR, where a dig-for-fee operation for tourists and rockhounds is maintained by the State of Arkansas. Crater of Diamonds is the only diamond mine in the world that is open to the public. The diamonds occur in a lamproite breccia tuff associated with a volcanic pipe and in the soil developed from the lamproite breccia tuff. In 2006, 488 diamond stones with an average weight of 0.241 carats were recovered at the Crater of Diamonds State Park. Of the 488 diamond stones recovered, 15 weighed more than 1 carat. Since the diamond-bearing pipe and the adjoining area became a State park in 1972, 25,857 diamond stones with a total carat weight of 5,071.92 have been recovered (Tom Stolarz, Park Superintendent, Crater of Diamonds State Park, written commun., January 31, 2007). Exploration has demonstrated that there is about 78.5 million metric tons (Mt) of diamond-bearing rock in this diamond deposit (Howard, 1999, p. 62). An Arkansas law enacted early in 1999 prohibits commercial diamond mining in the park (Diamond Registry Bulletin, 1999).

There have been no commercially operated diamond mines in the United States since 2002. Diamond was produced at the Kelsey Lake diamond mine, located close to the Colorado-Wyoming State line near Fort Collins, CO, for several years until April 2002. The Kelsey Lake property has now been fully reclaimed.

Studies by the Wyoming Geological Survey have shown that Wyoming has the potential for a $1 billion diamond mining business. Wyoming has many of the same geologic conditions that are found in the diamond-producing areas of Canada, and there is evidence of hundreds of kimberlite pipes in the State. There have been 20 diamondiferous kimberlite pipes and 1 diamondiferous mafic breccia pipe identified in southern Wyoming. The State Line and the Iron Mountain kimberlite fields of Wyoming are two of the largest kimberlite fields in the United States, and the Leucite Hills lamproite field in Wyoming is the largest lamproite field in the United States. Several diamond mining firms have shown interest in the northern Colorado and southern Wyoming area (Associated Press, 2002).

The success of Canadian diamond mines has stimulated some interest in exploring for commercially feasible diamond deposits in the United States outside of Colorado and Wyoming, in Alaska, Minnesota, and Montana. Parts of Alaska have similar geologic terrain to the Northwest Territories; and some diamond indicator minerals, as well as some microscopic diamonds have been found near Anchorage, AK. This has lead to exploratory drilling by two Canadian companies. University of Minnesota geologists teamed with an Australian mining company to conduct a soil sampling program in Minnesota exploring for diamond and other mineral deposits. The samples were being analyzed by Australia's BHP Billiton Plc., and the chances of success were thought to be good owing to similarities between the geology in Canada and Minnesota (Diamond Registry Bulletin, 2005a). Diamond deposit exploration is also being conducted near Lewistown, MT; a diamond-bearing kimberlite was found in a 32.4-hectare site known as the Homestead property. Preliminary tests have shown the presence of microscopic diamonds. Diamonds have been found in the stream beds and glacial valleys of Montana for years (Associated Press, 2004).

In addition to natural gemstones, laboratory-created gemstones and gemstone simulants are produced in the United States. Laboratory-created or synthetic gemstones have the same chemical, optical, and physical properties as the natural gemstones. Simulants have an appearance similar to that of a natural gemstone material, but they have different chemical, optical, and physical properties. Laboratory-created gemstones that have been produced in the United States include alexandrite, diamond, emerald, garnet, moissanite, ruby, sapphire, spinel, turquoise, and zirconia. However, during 2006, only diamond, garnet, moissanite, and turquoise were produced commercially. Simulants of coral, lapis lazuli, malachite, and turquoise also are manufactured in the United States. In addition, certain colors of laboratory-created sapphire and spinel, used to represent other gemstones, are classified as simulants.

Laboratory-created gemstone production in the United States was valued at more than $52.1 million during 2006, which was a slight increase over that of 2005. The value of U.S. simulant gemstone output was estimated to be more than $100 million. Five companies in five States, representing virtually the entire U.S. laboratory-created gemstone industry, reported production to the USGS. The States with reported laboratory-created gemstone production were, in descending order of production value, North Carolina, Florida, Massachusetts, Michigan, and Arizona.

Gemesis Corp. in Sarasota, FL, consistently produced gem-quality laboratory-created diamond and reported a seventh year of production in 2006. The laboratory-created diamonds are produced using equipment, expertise, and technology developed by a team of scientists from Russia and the University of Florida. The weight of the laboratory-created diamond stones range from 1.5 to 2 carats, and most of the stones are yellow, brownish yellow, colorless, and green (Weldon, 1999). Gemesis uses diamond-growing machines, each machine capable of growing 3-carat rough diamonds by generating high-pressure, high-temperature (HPHT) conditions that recreate the conditions in the Earth's mantle where natural diamonds form (Davis, 2003). Gemesis could be producing as much as 30,000 to 40,000 stones each year, and annual revenues may reach $70 million to $80 million (Diamond Registry Bulletin, 2001). Gemesis diamonds are available for retail purchase in jewelry stores and on the Internet, and the prices of the Gemesis laboratory-created diamonds are below those of natural diamond but above the prices of simulated diamond (Weldon, 2003).

Apollo Diamond, Inc., near Boston, MA, developed and patented a method for growing extremely pure, gem-quality diamond with flawless crystal structure by chemical vapor deposition (CVD). The CVD technique transforms carbon into plasma, which is then precipitated onto a substrate as diamond. CVD has been used for more than a decade to cover large surfaces with microscopic diamond crystals, but until this process, no one had discovered the temperature, gas composition, and pressure combination that resulted in the growth of a single diamond crystal. CVD diamond precipitates as nearly 100% pure, almost flawless diamond, and therefore may not be distinguishable from natural diamond by some tests (Davis, 2003). In 2006, Apollo Diamond Inc. produced laboratory-created stones that range from 1 to 2 carats and expected to expand to larger stones in the future. Late in 2006, Apollo started selling jewelry directly to consumers through a jeweler in Boston, MA. In 2007, the company hoped to increase production of large stones, while expanding distribution to other jewelers and selling online through an Apollo Diamond

Web store (O'Connell, 2007). Apollo planned to start selling diamonds in the jewelry market at costs 10% to 30% below those of comparable natural diamonds (Hastings, 2005). Besides its use as a gemstone, CVD diamond's highest value is as a material for high-tech uses, such as in computer technology (Maney, 2005).

The Carnegie Institution of Washington Geophysical Laboratory and the University of Alabama had jointly developed and patented the CVD process and apparatus to produce ½-inch-thick 10-carat single diamond crystals at very rapid growth rates (100 micrometers per hour). This faster CVD method uses microwave plasma technology and allows multiple crystals to be grown simultaneously. This size is about five times that of commercially available laboratory-created diamonds produced by HPHT methods and other CVD techniques. A researcher at the Carnegie Institution stated, "High-quality crystals over 3 carats are very difficult to produce using the conventional approach. Several groups have begun to grow diamond single crystals by CVD, but large, colorless, and flawless ones remain a challenge. Our fabrication of 10-carat, half-inch CVD diamonds is a major breakthrough" (Willis, 2004; Carnegie Institution of Washington, 2005; Science Blog, 2005). Apollo Diamond and the Carnegie Institution have noted that diamonds produced by the CVD method are harder than natural diamonds and diamonds produced by HPHT methods.

In 2006, the North Carolina company Charles & Colvard, Ltd. entered its ninth year of producing and marketing moissanite, a gem-quality laboratory-created silicon carbide. Moissanite is also an excellent diamond simulant, but it is being marketed for its own gem qualities. Moissanite exhibits a higher refractive index (brilliance) and higher luster than diamond. Its hardness is between those of corundum (ruby and sapphire) and diamond, which gives it durability (Charles & Colvard, Ltd., 2007).

U.S. shell production decreased by 8% in 2006 compared with that of 2005. U.S. shell mussels is used as a source of mother-of-pearl and as seed material for culturing pearls. The lower shell production is because of overharvesting in past years, the killing off of U.S. native mussel species by invasive exotic species, and a decline in market demand. Pearl producers in Japan are using manmade seed materials or seed materials from China and other sources in addition to the stockpiled material. There also has been an increase in the popularity of darker and colored pearls that do not use U.S. seed material. In some regions of the United States, shell from mussels is being used more as a gemstone based on its own merit rather than as seed material for pearls. This shell material is being processed into mother-of-pearl and used in beads, jewelry, and watch faces.

Consumption

Although the United States accounted for little of the total global gemstone production, it was the world's leading gemstone market. U.S. gemstone markets accounted for more than an estimated 35% of world gemstone demand in 2006. The U.S. market for unset gem-quality diamond during the year was estimated to be about $17.3 billion. Domestic markets for natural, unset nondiamond gemstones totaled approximately $1.07 billion.

In the United States, about two-thirds of domestic consumers designate diamond as their favorite gemstone when surveyed. In 2006, the top-selling colored gemstones were, in descending order, blue sapphire, blue topaz, emerald, ruby, fancy sapphire, amethyst, pink tourmaline, peridot and citrine (tied for eighth place), rhodolite garnet, and green tourmaline. Aquamarine, opal, and tanzanite from the previous year dropped out of the top 10. During 2006, 42% of the jewelry retailers said their sales were up compared with 50% of retailers in 2005 (Wade, 2006; Zborowski, 2007).

The U.S. colored gemstone market posted an overall increase in sales during 2006 compared with the sales in 2005. The popularity of colored gemstones, colored laboratory-created gemstones, and "fancy" colored diamonds continued to increase in 2006. This was indicated by increased values of U.S. imports for consumption in some colored stone categories (emerald, coral, pearls, other precious and semiprecious stones, and laboratory-created gems) in 2006 compared with the values from 2005 (table 10). Colored stone popularity also was evidenced by their general sales increase in 2006 (Zborowski, 2007).

Prices

Gemstone prices are governed by many factors and qualitative characteristics, including beauty, clarity, defects, demand, durability, and rarity. Diamond pricing, in particular, is complex; values can vary significantly depending on time, place, and the subjective valuations of buyers and sellers. There are more than 14,000 categories used to assess rough diamond and more than 100,000 different combinations of carat, clarity, color, and cut values used to assess polished diamond (Pearson, 1998).

Colored gemstone prices are generally influenced by market supply and demand considerations, and diamond prices are supported by producer controls on the quantity and quality of supply. Values and prices of gemstones produced and/or sold in the United States are listed in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported, exported, or reexported are listed in tables 6 through 10.

De Beers Group companies remain a significant force affecting the price of gem-quality diamond worldwide because they mine about 40% of the gem-quality diamond produced each year (De Beers Group, 2005; Diamond Registry Bulletin, 2007b). De Beers companies also sort and valuate about two-thirds (by value) of the world's annual supply of rough diamond through De Beers' subsidiary Diamond Trading Co. (DTC), which has marketing agreements with other producers (De Beers Group, 2003).

In 2006, there were about 200,000 diamond jewelry retail outlets worldwide. From these retail outlets, about 45% of diamond jewelry was sold in the United States, 33% in Asia, and 11% in Europe. Increase in sales was approximately 6% compared with that of 2005. The value of the entire market was more than $62 billion (De Beers Group, 2006).

The International Diamond and Jewelry Exchange (IDEX) diamond price index showed the following price trends in polished stones from June 2005 to June 2006. Larger polished diamonds and very small diamonds (less than 0.1 carat) rose in price while diamonds in the 0.5- to 1-carat range declined slightly in price; the price of 1.5-carat diamonds increased 2.8%, and the price of 2-carat diamonds increased 5.5%. The decline in prices of diamonds in the 0.5- to 1-carat range had been an ongoing trend for many months. About 30% of the polished diamond market's total dollar value falls into the 0.5- to 2-carat size range. Among very large diamonds, round cut 5-carat polished diamonds had risen a dramatic 17% in price since June 2005. These diamonds represent less than 1% of the market. The IDEX diamond price index measures price changes relative to the baseline of 100 set by the June 2004 price (Diamond News, 2006).

Foreign Trade

During 2006, total U.S. gemstone trade with all countries and territories was valued at more than $27.9 billion, which was an increase of 8.5% from that of 2005. Diamond accounted for about 96% of the 2006 gemstone trade total. In 2006, U.S. exports and reexports of diamond were shipped to 87 countries and territories, and imports of all gemstones were received from 104 countries and territories (tables 6-10). During 2006, U.S. trade in cut diamond and unworked diamond increased slightly and by 13.4%, respectively, compared with that of 2005. The United States remained the world's leading diamond importer and is a significant international diamond transit center as well as the world's leading gem-quality diamond market. The large volume of reexports shipped to other centers reveals the significance that the United States has in the world's diamond supply network (table 6).

Imports of laboratory-created gemstone increased by 2.9% for the United States in 2006 compared with trade in 2005. Laboratory-created gemstone imports from Austria, China, Germany, Hong Kong, India, Sri Lanka, Switzerland, and Thailand, with more than $500,000 in imports from each country, made up about 92% (by value) of the total domestic imports of laboratory-created gemstones during the year. Prices of certain imported laboratory-created gemstones, such as amethyst, were very competitive. The marketing of imported laboratory-created gemstones and enhanced gemstones as natural gemstones and the mixing of laboratory-created materials with natural stones in imported parcels continued to be problems for some domestic producers in 2006. There also were problems with some simulants being marketed as laboratory-created gemstones during the year.

World Review

The gemstone industry worldwide has two distinct sectors—diamond mining and marketing and colored gemstone production and sales. Most diamond supplies are controlled by a few major mining companies; prices are supported by managing the quality and quantity of the gemstones relative to demand, a function performed by De Beers through DTC. Unlike diamond, colored gemstones are primarily produced at relatively small, low-cost operations with few dominant producers; prices are influenced by consumer demand and supply availability.

In 2006, world natural diamond production totaled about 171 million carats—91.3 million carats gem quality and 79.9 million carats industrial grade (table 11). Most production was concentrated in a few regions—Africa [Angola, Botswana, Congo (Kinshasa), Namibia, and South Africa], Asia (northeastern Siberia and Yakutia in Russia), Australia, North America (Northwest Territories in Canada), and South America (Brazil and Venezuela). In 2006, Australia led the world in total diamond output quantity (combined gemstone and industrial). Botswana was the world's leading gemstone diamond producer, followed by Russia, Canada, Australia, Angola, South Africa, Congo (Kinshasa), and Namibia in descending quantity order. These eight countries produced 96.5% (by quantity) of the world's gemstone diamond output in 2006. In 2006, the total estimated value of global gem diamond production was $12.0 billion; this was a 4.3% increase compared with that of 2005 (De Beers Group, 2006).

De Beers reported that its sales of rough diamond for 2006 were $6.15 billion, which was a decrease of 6% from $6.54 billion in 2005 (JCK Online, 2007).

In 2002, the international rough-diamond certification system, the Kimberley Process Certification Scheme (KPCS), was agreed upon by United Nations (UN) member nations, the diamond industry, and involved nongovernmental organizations. The KPCS includes the following key elements: the use of forgery-resistant certificates and tamper-proof containers for shipments of rough diamonds; internal controls and procedures that provide credible assurance that conflict diamonds do not enter the legitimate diamond market; a certification process for all exports of rough diamonds; the gathering, organizing, and sharing of import and export data on rough diamonds with other participants of relevant production; credible monitoring and oversight of the international certification scheme for rough diamonds; effective enforcement of the provisions of the certification scheme through dissuasive and proportional penalties for violations; self regulation by the diamond industry that fulfills minimum requirements; and sharing information with all other participants on relevant rules, procedures, and legislation as well as examples of national certificates used to accompany shipments of rough diamonds (Weldon, 2001). Canada acted as the chair and secretariat of the KPCS for the first 2 years, and in October 2004, Russia assumed these duties. The list of participating countries has expanded to include 42 nations that have met the minimum requirements of the agreement. The rough diamond-trading entity of Chinese Taipei has also met the minimum requirements of the KPCS. The KPCS was implemented to solve the problem of conflict diamonds—rough diamonds used by rebel forces and their allies in several countries to help finance warfare aimed at subverting governments recognized as legitimate by the UN. The participating nations in the KPCS account for approximately 98% of the global production and trade of rough diamonds (Diamond Registry Bulletin, 2005b; Kimberley Process, 2007). Discussions about the possible participation of several other countries are ongoing.

Globally, the value of production of natural gemstones other than diamond was estimated to have exceeded $2 billion in 2006. Most nondiamond gemstone mines are small, low-cost, and widely dispersed operations in remote regions of developing nations. Foreign countries with major gemstone deposits other than diamond are Afghanistan (aquamarine, beryl, emerald, kunzite, lapis lazuli, ruby, and tourmaline), Australia (beryl, opal, and sapphire), Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline), Burma (beryl, jade, ruby, sapphire, and topaz), Colombia (beryl, emerald, and sapphire), Kenya (beryl, garnet, and sapphire), Madagascar (beryl, rose quartz, sapphire, and tourmaline), Mexico (agate, opal, and topaz), Sri Lanka (beryl, ruby, sapphire, and topaz), Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline), and Zambia (amethyst and beryl). In addition, pearls are cultured throughout the South Pacific and in other equatorial waters; Australia, China, French Polynesia, and Japan are key producers.

Canada.—The Ekati Diamond Mine, Canada's first operating commercial diamond mine, completed its eighth full year of production in 2006. Ekati produced 2.52 million carats of diamond from 4.48 Mt of ore (BHP Billiton Ltd., 2007). BHP Billiton Ltd. has an 80% controlling ownership in Ekati, which is in the Northwest Territories in Canada. Ekati has estimated reserves of 60.3 Mt of ore in kimberlite pipes that contain 54.3 million carats of diamond, and BHP Billiton projected the mine life to be 25 years. Approximately one-third of the Ekati diamond production is industrial-grade material (Darren Dyck, Senior Project Geologist, BHP Diamonds, Inc., oral commun., May 27, 2001).

The Diavik Diamond Mine, also in the Northwest Territories, completed its fourth full year of production. In 2006, Diavik produced 9.8 million carats of diamond from two adjacent kimberlite pipes located within the same pit (Diavik Diamond Mines Inc., 2007). The mine will also be producing from a third kimberlite pipe by yearend 2007. Diavik has estimated the mine's remaining proven and probable reserves to be 24.5 Mt of ore in kimberlite pipes, containing 81.7 million carats of diamond, and projected the mine life to be 16 to 22 years (Diavik Diamond Mine Dialogue, 2007). The mine is an unincorporated joint venture between Diavik Diamond Mines Inc. (60%) and Aber Diamond Mines Ltd. (40%). The mine is expected to produce a total of about 110 million carats of diamond at a rate of 8 million carats per year (Diavik Diamond Mines Inc., 2000, p. 10-12; Diavik Diamond Mine Dialogue, 2007).

Canada's third diamond mine, the Jericho Diamond Mine (wholly owned by Tahera Diamond Corp.), began production of rough diamonds during the first quarter of 2006 and declared commercial production on July 1, 2006. The Jericho mine is located in Nunavut. Jericho experienced startup difficulties, which persisted throughout 2006, but 539,000 t of kimberlite ore was processed, resulting in production of 296,000 carats. Tahera estimated the Jericho Diamond Mine's reserves to be 2.6 Mt of ore and 3.11 million carats of diamond (Tahera Diamond Corp., 2007).

Diamond exploration is continuing in Canada, with several other commercial diamond projects and additional discoveries located in Alberta, British Columbia, the Northwest Territories, Nunavut, Ontario, and Quebec. Canada produced about 7% of the world's combined natural gemstone and industrial diamond production in 2006.

Canadian diamond discoveries continue to be made and production continues to increase. Canada ranked third in quantity produced of gemstone diamond in 2006 after Botswana and Russia.

Côte d'Ivoire.—In September, the UN Security Council unanimously upheld resolution 1643 (2005), which requires nations to prevent the import of all rough diamonds from Côte d'Ivoire into their territory. The UN Security Council deemed Côte d'Ivoire to be a threat to international peace and security. The effect of this action is the continued embargo against diamond trade from Côte d'Ivoire (Diamond Registry Bulletin, 2006b).

Ghana.—In late 2006, the Minister of Mines and Energy of Ghana reported that the country had put new "conflict diamond" controls in place and was now in accord with the Kimberley Process. These controls became necessary after it was discovered that rebels in northern Côte d'Ivoire were mining diamonds and selling them in Ghana (Diamond Registry Bulletin, 2007a).

Liberia.—The UN Security Council extended the ban on Liberian diamond exports through the end of 2006. The ban was put into place by the UN in May 2001. Members of the UN Security Council urged the Liberian Government to accelerate the implementation of reform measures so that they could join the Kimberley Process (Diamond Registry Bulletin, 2006a).

Russia.—The historic Malysheva Emerald mine in central Russia officially reopened on October 9. The mine is now owned by Emerite Co. (a wholly owned Russian subsidiary company of the Tsar Emerald Corp). The deposit was first discovered in 1833, and mining began a year later. Over time, the Malysheva became well know for its deposits of high-quality gemstones, which included emerald, alexandrite, topaz, citrine, and a variety of beryl. The mine's production has been curtailed several times throughout its history for various political reasons. The most recent closure was in 1995 following the collapse of the Soviet Union. In 2000, the mine resumed limited production, but full-scale mining could not be achieved. The Tsar Emerald Corp. has now completed a 3-year rehabilitation of the mine, and the Malysheva has been restored to its former status. With the reopening in October, came the first recovery of underground emerald ore in recent years (Co, 2006; Colored Stone, 2007).

Tanzania.—The violet-blue gemstone tanzanite was discovered in 1967 near the village of Merelani in northern Tanzania. From its discovery until the early 1990s, tanzanite was mined by local small-scale miners without the aid of modern technology or investment capital. Then, tanzanite began to increase significantly in mainstream popularity. African Gem Resources Ltd. (a South African company), which later became TanzaniteOne Ltd., moved in and set up a modern mechanized mining operation that was well-funded by international investors on a large central portion of the Merelani tanzanite mining district. The company promoted their operation to the world as an alternative to the existing tanzanite supply chain, with no child labor, no unsafe working conditions, and no illegal smuggling. The local miners saw this as an attempt to force them out, control tanzanite trade, and keep the profits for themselves. Local miners clashed violently and repeatedly with the TanzaniteOne workers. In February 2006, TanzaniteOne announced an international promotional campaign and the establishment of a brand for tanzanite. The campaign would promote tanzanite to customers worldwide, especially in the United States, Europe, and South Africa. The branding proposal included certificates of authenticity, which signified that the tanzanite was purchased from TanzaniteOne or one of its partners. The certifications are managed by the Tanzanite Foundation (a nonprofit organization funded by TanzaniteOne and its customers). The Tanzanite Foundation recommends that tanzanite consumers insist on receiving a "Certificate of Authenticity." The announcement reportedly was well received by most of the local miners of the Merelani gem community because, in promoting tanzanite to the world, local miners would also benefit, and local companies could create brands of their own. TanzaniteOne started regular purchases from local small-scale miners and won their respect by offering prices much higher than most foreign dealers pay (Kondo, 2007; Tanzanite Foundation, The, 2007).

Outlook

There are indications of possible continued growth in the U.S. diamond and jewelry markets in 2007. Historically, diamonds have proven to hold their value despite wars or economic depressions (Schumann, 1998, p. 8).

Independent producers, such as Argyle Diamond in Australia and Ekati and Diavik in Canada, will continue to bring a greater measure of competition to global markets. More competition presumably will bring more supplies and lower prices. Further consolidation of diamond producers and larger amounts of rough diamond being sold outside DTC will continue as the diamond industry adjusts to De Beers' reduced influence on the industry.

More laboratory-created gemstones, simulants, and treated gemstones will enter the marketplace and necessitate more transparent trade industry standards to maintain customer confidence.

During 2006, online sales rose by 25%, representing 3.5% of all retail jewelry sales for the year, and Internet sales of diamonds, gemstones, and jewelry are expected to continue to grow and increase in popularity, as will other forms of e-commerce that emerge to serve the diamond and gemstone industry. This is likely to take place as the gemstone industry and its customers become more comfortable with and learn the applications of new e-commerce tools (IDEX Magazine, 2006).

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TABLE 1
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0-2.5	1.0-1.1	Single	1.54	Synthetic or pressed plastics, kaurigum	Fossil resin, color, low density, soft and trapped insects.
Apatite	Chlorocalcium phosphate	Colorless, pink, yellow, green, blue, violet	Small	Low	5.0	3.16-3.23	Double	1.63-1.65	Amblygonite, andalusite, brazilianite, precious beryl, titanite, topaz, tourmaline	Crystal habit, color, hardness, appearance.
Azurite	Copper carbonate hydroxide	Azure, dark blue, pale blue	Small to medium	do.	3.5-4.0	3.7-3.9	do.	1.72-1.85	Dumortierite, hauynite, lapis lazuli, lazulite, sodalite	Color, softness, crystal habits and associated minerals.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	do.	High	6.0-6.5	3.64-3.68	do.	1.76-1.80	Sapphire, tanzanite, blue diamond, blue tourmaline, cordierite	Strong blue in ultraviolet light.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5-8.0	2.63-2.80	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	Red	Small	Very high	7.5-8.0	2.63-2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald, natural	do.	Green	Medium	do.	7.5	2.63-2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5-8.0	2.63-2.80	do.	1.58	Genuine emerald	Lack of flaws, brilliant fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5-8.0	2.63-2.80	do.	1.58	Citrine, topaz, glass, doublets	Weak-colored.
Goshenite	do.	Colorless	do.	Low	7.5-8.0	2.63-2.80	do.	1.58	Quartz, glass, white sapphire, white topaz	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5-8.0	2.63-2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49-1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.60	do.	Banded, translucent.
Charoite	Hydrated sodium calcium hydroxi-fluoro-silicate	Lilac, violet, or white	Small to medium	do.	5.0-6.0	2.54-2.78	XX	1.55-1.56	Purple marble	Color, locality.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day light, red by artificial light	Small to medium	High	8.5	3.50-3.84	Double	1.75	Synthetic	Strong dichroism, color varies from red to green, hardness.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Chrysoberyl—Continued:										
Cats-eye	Beryllium aluminate	Greenish to brownish	Small to large	High	8.5	3.50-3.84	Double	1.75	Synthetic, shell	Density, translucence, chatoyance.
Chrysolite	do.	Yellow, green, and/or brown	Medium	Medium	8.5	3.50-3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Chrysocolla	Hydrated copper silicate	Green, blue	Any	Low	2.0-4.0	2.0-2.4	XX	1.46-1.57	Azurite, dyed chalcedony, malachite, turquoise, variscite	Lack of crystals, color, fracture, low density and softness.
Coral	Calcium carbonate	Orange, red, white, black, purple, or green	Branching, medium	do.	3.5-4.0	2.6-2.7	Double	1.49-1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95-4.10	do.	1.78	Synthetics, including spinel, garnet	Inclusions, fluorescence.
Sapphire, blue	do.	Blue	Medium	High	9.0	3.95-4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, colorless, orange, green, or violet	Medium to large	Medium	9.0	3.95-4.10	do.	1.78	Synthetics, glass and doublets, morganite	Inclusions, double refreaction, refractive index.
Sapphire or ruby, stars	do.	Red, pink, violet, blue, or gray	do.	High to low	9.0	3.95-4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.
Sapphire or ruby, synthetic	do.	Yellow, pink, or blue	Up to 20 carats	Low	9.0	3.95-4.10	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Cubic zirconia	Zirconium and yttrium oxides	Colorless, pink, blue, lavender, yellow	Small	do.	8.25-8.5	5.8	Single	2.17	Diamond, zircon, titania, moissanite	Hardness, density, lack of flaws and inclusions, refractive index.
Diamond	Carbon	White, blue-white, yellow, brown, green, red, pink, blue	Any	Very high	10.0	3.516-3.525	do.	2.42	Zircon, titania, cubic zirconia, moissanite	High index, dispersion, hardness, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green-blue	Large	Low	6.0-6.5	2.56	XX	1.52	Jade, turquoise	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play (schiller)	do.	do.	6.0-6.5	2.56	XX	1.56	do.	Do.
Moonstone	do.	Colorless, white, gray, or yellow with white, blue, or bronze schiller	do.	do.	6.0-6.5	2.77	XX	1.52-1.54	Glass, chalcedony, opal	Pale sheen, opalescent.
Sunstone	do.	Orange, red brown, colorless with gold or red glittery schiller	Small to medium	do.	6.0-6.5	2.77	XX	1.53-1.55	Aventurine, glass	Red glittery schiller.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Garnet	Complex silicate	Brown, black, yellow, green, red, or orange	Small to medium	Low to high	6.5-7.5	3.15-4.30	Single strained	1.79-1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Hematite	Iron oxide	Black, black-gray, brown-red	Medium to large	Low	5.5-6.5	5.12-5.28	XX	2.94-3.22	Davidite, cassiterite, magnetite, neptunite, pyrolusite, wolframite	Crystal habit, streak, hardness.
Jade:										
Jadeite	Complex silicate	Green, yellow, black, white, or mauve	Large	Low to very high	6.5-7.0	3.3-3.5	Crypto-crystalline	1.65-1.68	Nephrite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0-6.5	2.96-3.10	do.	1.61-1.63	Jadeite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Do.
Jet (gagate)	Lignite	Deep black, dark brown	do.	Low	2.5-4.0	1.19-1.35	XX	1.64-1.68	Anthracite, asphalt, cannel coal, onyx, schorl, glass, rubber	Luster, color.
Lapis lazuli	Sodium calcium aluminum silicate	Dark azure-blue to bright indigo blue or even a pale sky blue.	do.	do.	5.0-6.0	2.50-3.0	XX	1.50	Azurite, dumortierite, dyed howlite, lazulite, sodalite, glass	Color, crystal habit, associated minerals, luster, and localities.
Malachite	Hydrated copper carbonate	Light to black-green banded	do.	do.	3.5-4.0	3.25-4.10	XX	1.66-1.91	Brochantite, chrysoprase, opaque green gemstones	Color banding, softness, associated minerals.
Moissanite	Silicon carbide	Colorless and pale shades of green, blue, yellow	Small	Low to medium	9.25	3.21	Double	2.65-2.69	Diamond, zircon, titania, cubic zirconia	Hardness, dispersion, lack of flaws and inclusions, refractive index.
Obsidian	Amorphous, variable (usually felsic)	Black, gray, brown, dark green, white, transparent	Large	Low	5.0-5.5	2.35-2.60	XX	1.45-1.55	Aegirine-augite, gadolinite, gagate, hematite, pyrolusite, wolframite	Color, conchoidal fracture, flow bubbles, softness, and lack of crystal faces.
Opal	Hydrated silica	Reddish orange, colors flash in white gray, black, red, or yellow	do.	Low to high	5.5-6.5	1.9-2.3	Single	1.45	Glass, synthetics, triplets, chalcedony	Color play (opalescence).
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5-7.0	3.27-3.37	Double (strong)	1.65-1.69	Tourmaline, chrysoberyl	Strong double refraction, low dichroism.
Quartz:										
Agate	Silicon dioxide	Any	Large	Low	7.0	2.58-2.64	XX	XX	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Quartz—Continued:										
Amethyst	Silicon dioxide	Purple	Large	Medium	7.0	2.65-2.66	Double	1.55	Glass, plastic, fluorite	Macrocrystalline, color, refractive index, transparent, hardness.
Aventurine	do.	Green, red-brown, gold-brown, with metallic iridescent reflection	do.	Low	7.0	2.64-2.69	do.	1.54-1.55	Iridescent analcime, aventurine feldspar, emerald, aventurine glass	Macrocrystalline, color, metallic iridescent flake reflections, hardness.
Cairngorm	do.	Smoky orange or yellow	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Carnelian	do.	Flesh red to brown red	do.	do.	6.5-7.0	2.58-2.64	do.	1.53-1.54	Jasper	Cryptocrystalline, color, hardness.
Chalcedony	do.	Bluish, white, gray	do.	do.	6.5-7.0	2.58-2.64	do.	1.53-1.54	Tanzanite	Do.
Chrysoprase	do.	Green, apple-green	do.	do.	6.5-7.0	2.58-2.64	do.	1.53-1.54	Chrome chalcedony, jade, prase opal, prehnite, smithsonite, variscite, artifically colored green chalcedony	Do.
Citrine	Silica	Yellow	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Crystal:										
Rock	do.	Colorless	do.	do.	7.0	2.65-2.66	do.	1.55	Topaz, colorless sapphire	Do.
Jasper	do.	Any, striped, spotted, or sometimes uniform	do.	do.	7.0	2.58-2.66	XX	XX	do.	Cryptocrystalline, opaque, vitreous luster, hardness.
Onyx	do.	Many colors	do.	do.	7.0	2.58-2.64	XX	XX	do.	Cryptocrystalline, uniformly banded, hardness.
Petrified wood	do.	Brown, gray, red, yellow	do.	do.	6.5-7.0	2.58-2.91	Double	1.54	Agate, jasper	Color, hardness, wood grain.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Tiger's eye	do.	Golden yellow, brown, red, blue-black	do.	do.	6.5-7.0	2.58-2.64	XX	1.53-1.54	XX	Macrocrystalline, color, hardness, hatoyancy.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Rhodochrosite	Manganese carbonate	Rose-red to yellowish, stripped	Large	Low	4.0	3.45-3.7	Double	1.6-1.82	Fire opal, rhodonite, tugtupite, tourmaline	Color, crystal habit, reaction to acid, perfect rhombohedral cleavage.
Rhodonite	Manganese iron calcium silicate	Dark red, flesh red, with dendritic inclusions of black manganese oxide	do.	do.	5.5-6.5	3.40-3.74	do.	1.72-1.75	Rhodochrosite, thulite, hessonite, spinel, pyroxmangite, spessartine, tourmaline	Color, black inclusions, lack of reaction to acid, hardness.
Shell:										
Mother-of-pearl	Calcium carbonate	White, cream, green, blue-green, with iridescent play of color	Small	do.	3.5	2.6-2.85	XX	XX	Glass and plastic imitation	Luster, iridescent play of color.
Pearl	do.	White, cream to black, sometimes with hint of pink, green, purple	do.	Low to high	2.5-4.5	2.6-2.85	XX	XX	Cultured and glass or plastic imitation	Luster, iridescence, x-structure, ray.
Spinel, natural	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5-3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5-3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5-7.0	3.13-3.20	do.	1.66	Synthetic spinel	Refractive index, color, pleochroism.
Kunzite	do.	Pink to lilac	do.	do.	6.5-7.0	3.13-3.20	do.	1.66	Amethyst, morganite	Do.
Tanzanite	Complex silicate	Blue to lavender	Small	High	6.0-7.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism, color.
Topaz	do.	White, blue, green, pink, yellow, gold	Medium	Low to medium	8.0	3.4-3.6	do.	1.62	Beryl, quartz	Color, density, hardness, refractive index, perfect in basal cleavage.
Tourmaline	do.	Any, including mixed	do.	do.	7.0-7.5	2.98-3.20	do.	1.63	Peridot, beryl, garnet corundum, glass	Double refraction, color, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green with black, brown-red inclusions	Large	Low	6.0	2.60-2.83	do.	1.63	Chrysocolla, dyed howlite, dumortierite, glass, plastics, variscite	Difficult if matrix not present, matrix usually limonitic.
Unakite	Granitic rock, feldspar, epidote, quartz	Olive green, pink, and blue-gray	do.	do.	6.0-7.0	2.60-3.20	XX	XX	XX	Olive green, pink, gray-blue colors.
Zircon	Zirconium silicate	White, blue, brown, yellow, or green	Small to medium	Low to medium	6.0-7.5	4.0-4.8	Double (strong)	1.79-1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

XX Not applicable.

[1]Small: up to 5 carats; medium: 5 to 50 carats; large: more than 50 carats.

[2]Low: up to $25 per carat; medium: up to $200 per carat; high: more than $200 per carat.

[3]Commonwealth of Independent States.

TABLE 2
LABORATORY-CREATED GEMSTONE PRODUCTION METHODS

Gemstone	Production method	Company/producer	Date of first production
Alexandrite	Flux	Creative Crystals Inc.	1970s.
Do.	Melt pulling	J.O. Crystal Co., Inc.	1990s.
Do.	do.	Kyocera Corp.	1980s.
Do.	Zone melt	Seiko Corp.	1980s.
Cubic zirconia	Skull melt	Various producers	1970s.
Emerald	Flux	Chatham Created Gems	1930s.
Do.	do.	Gilson	1960s.
Do.	do.	Kyocera Corp.	1970s.
Do.	do.	Seiko Corp.	1980s.
Do.	do.	Lennix	1980s.
Do.	do.	Russia	1980s.
Do.	Hydrothermal	Lechleitner	1960s.
Do.	do.	Regency	1980s.
Do.	do.	Biron Corp.	1980s.
Do.	do.	Russia	1980s.
Ruby	Flux	Chatham Created Gems	1950s.
Do.	do.	Kashan Created Ruby	1960s.
Do.	do.	J.O. Crystal Co., Inc.	1980s.
Do.	do.	Douras	1990s.
Do.	Zone melt	Seiko Corp.	1980s.
Do.	Melt pulling	Kyocera Corp.	1970s.
Do.	Verneuil	Various producers	1900s.
Sapphire	Flux	Chatham Created Gems	1970s.
Do.	Zone melt	Seiko Corp.	1980s.
Do.	Melt pulling	Kyocera Corp.	1980s.
Do.	Verneuil	Various producers	1900s.
Star ruby	do.	Linde Air Products Co.	1940s.
Do.	Melt pulling	Kyocera Corp.	1980s.
Do.	do.	Nakazumi Earth Crystals Co.	1980s.
Star sapphire	Verneuil	Linde Air Products Co.	1940s.

TABLE 3

VALUE OF U.S. GEMSTONE PRODUCTION, BY TYPE[1]

(Thousand dollars)

Gem materials	2005	2006
Beryl	48	21
Coral, all types	216	106
Diamond	(2)	(2)
Garnet	46	44
Gem feldspar	626	1,190
Geode/nodules	214	47
Opal	140	380
Quartz:		
Macrocrystalline[3]	196	228
Cryptocrystalline[4]	427	147
Sapphire/ruby	450	198
Shell	3,560	3,270
Topaz	(2)	(2)
Tourmaline	39	55
Turquoise	511	202
Other	6,960	5,440
Total	13,400	11,300

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Included with "Other."

[3]Macrocrystalline quartz (crystals recognizable with the naked eye) includes amethyst, amethyst quartz, aventurine, blue quartz, citrine, hawk's eye, pasiolite, prase, quartz cat's eye, rock crystal, rose quartz, smoky quartz, and tiger's eye.

[4]Cryptocrystalline (microscopically small crystals) includes agate, carnelian, chalcedony, chrysoprase, fossilized wood, heliotrope, jasper, moss agate, onyx, and sard.

TABLE 4

PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY IN 2006[1]

Carat weight	Description, color[2]	Clarity[3] (GIA terms)	Representative prices		
			January[4]	June[5]	December[6]
0.25	G	VS1	$1,300	$1,300	$1,300
do.	G	VS2	1,200	1,200	1,200
do.	G	SI1	1,100	1,100	1,100
do.	H	VS1	1,150	1,150	1,150
do.	H	VS2	1,050	1,050	1,050
do.	H	SI1	1,000	1,000	1,000
0.50	G	VS1	3,200	3,200	3,200
do.	G	VS2	2,800	2,800	2,800
do.	G	SI1	2,400	2,400	2,400
do.	H	VS1	2,800	2,800	2,800
do.	H	VS2	2,400	2,400	2,400
do.	H	SI1	2,200	2,200	2,200
0.75	G	VS1	3,800	3,800	3,800
do.	G	VS2	3,600	3,600	3,600
do.	G	SI1	3,300	3,300	3,300
do.	H	VS1	3,500	3,500	3,500
do.	H	VS2	3,300	3,300	3,300
do.	H	SI1	3,000	3,000	3,000
1.00	G	VS1	6,500	6,500	6,500
do.	G	VS2	6,100	6,100	6,100
do.	G	SI1	5,000	5,000	5,000
do.	H	VS1	5,500	5,500	5,500
do.	H	VS2	5,300	5,300	5,300
do.	H	SI1	4,600	4,600	4,600

[1]Data are rounded to no more than three significant digits.

[2]Gemological Institute of America (GIA) color grades: D-colorless; E-rare white; G, H, I-traces of color.

[3]Clarity: IF—no blemishes; VVS1—very, very slightly included; VS1—very slightly included; VS2—very slightly included, but not visible; SI1—slightly included.

[4]Source: Jewelers' Circular Keystone, v. 177, no. 2, February 2006, p. 136.

[5]Source: Jewelers' Circular Keystone, v. 177, no. 7, July 2006, p. 169.

[6]Source: Jewelers' Circular Keystone, v. 178, no. 1, January 2007, p. 137.

TABLE 5

PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES IN 2006

Gemstone	Price range per carat	
	January[1]	December[2]
Amethyst	$7-15	$7-15
Blue sapphire	675-1,250	700-1,375
Blue topaz	5-10	5-10
Emerald	2,400-3,500	2,400-4,000
Green tourmaline	45-60	45-60
Cultured saltwater pearl[3]	5	5
Pink tourmaline	60-125	60-125
Rhodolite garnet	18-30	18-30
Ruby	900-1,125	1,725-2,000
Tanzanite	275-425	300-450

[1]Source: The Guide, spring/summer 2006, p. 14, 31, 45, 61, 72, 86, 96, 98, 104, and 123. These figures are approximate current wholesale purchase prices paid by retail jewelers on a per stone basis for 1 to <2 carat, fine-quality stones.

[2]Source: The Guide, fall/winter 2006-2007, p. 22, 37, 51, 65, 74, 85, 95, 98, 104, and 119. These figures are approximate current wholesale purchase prices paid by retail jewelers on a per stone basis for 1 to <2 carat, fine-quality stones.

[3]Prices are per 4.6-millimeter pearl.

TABLE 6
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY[1]

Country	2005 Quantity (carats)	2005 Value[2] (millions)	2006 Quantity (carats)	2006 Value[2] (millions)
Exports:				
Australia	33,700	$7	50,100	$19
Belgium	1,300,000	538	2,480,000	725
Canada	84,200	56	82,900	90
Costa Rica	37,200	3	67,700	7
France	90,000	51	189,000	64
Hong Kong	1,030,000	294	1,620,000	419
India	206,000	57	706,000	232
Israel	1,890,000	1,090	3,820,000	1,700
Japan	52,400	53	74,900	43
Mexico	1,080,000	144	864,000	129
Netherlands	27,600	8	27,600	6
Netherlands Antilles	35,500	33	15,500	51
Singapore	54,000	19	83,300	14
South Africa	21,100	4	32,000	13
Switzerland	108,000	82	142,000	129
Taiwan	16,700	4	21,800	4
Thailand	98,000	28	121,000	34
United Arab Emirates	101,000	43	226,000	61
United Kingdom	78,800	22	88,600	66
Other	87,200	46	220,000	74
Total	6,430,000	2,580	10,900,000	3,890
Reexports:				
Armenia	44,300	3	54,300	5
Australia	40,300	8	16,500	6
Belgium	3,920,000	1,100	4,340,000	1,070
Canada	247,000	136	260,000	162
Dominican Republic	153,000	33	107,000	15
France	88,200	16	11,500	1
Guatemala	107,000	12	96,800	10
Hong Kong	2,500,000	618	3,470,000	771
India	1,840,000	387	1,910,000	369
Israel	7,670,000	2,640	8,770,000	2,310
Japan	150,000	33	91,700	23
Malaysia	34,900	5	28,100	6
Mexico	57,700	11	31,500	7
Singapore	218,000	35	173,000	37
South Africa	47,600	36	396,000	55
Switzerland	638,000	303	453,000	345
Thailand	290,000	83	243,000	62
United Arab Emirates	612,000	142	513,000	131
United Kingdom	540,000	211	525,000	213
Other	122,000	87	176,000	58
Total	19,300,000	5,890	21,700,000	5,660
Grand total	25,700,000	8,470	32,600,000	9,540

[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.

Source: U.S. Census Bureau.

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY[1]

Kind, range, and country of origin	2005 Quantity (carats)	2005 Value[2] (millions)	2006 Quantity (carats)	2006 Value[2] (millions)
Rough or uncut, natural:[3]				
Angola	19,400	$57	42,600	$34
Australia	62,400	8	1,350	1
Botswana	274,000	132	172,000	162
Brazil	24,600	2	5,840	5
Canada	57,600	62	45,300	41
Congo (Kinshasa)	44,300	116	45,800	66
Ghana	58,000	3	38,700	1
Guyana	68,400	8	24,500	3
India	29,200	(4)	12,300	1
Namibia	10,700	1	4,050	2
Russia	45,500	13	443,000	27
South Africa	347,000	413	332,000	384
Other	16,800	49	31,900	74
Total	1,060,000	864	1,200,000	801
Cut but unset, not more than 0.5 carat:				
Belgium	530,000	197	526,000	203
Canada	7,890	9	10,500	14
China	78,900	13	62,600	16
Dominican Republic	57,100	5	64,200	6
Hong Kong	228,000	58	390,000	70
India	8,780,000	1,820	8,560,000	1,780
Israel	843,000	425	843,000	426
Mauritius	10,400	15	5,370	11
Mexico	247,000	35	453,000	58
Singapore	6,180	2	979	1
South Africa	5,330	2	3,350	2
Switzerland	33,600	18	53,800	25
Thailand	71,500	18	102,000	21
United Arab Emirates	91,600	23	131,000	35
Other	28,600	13	65,000	26
Total	11,000,000	2,650	11,300,000	2,690
Cut but unset, more than 0.5 carat:				
Belgium	1,160,000	2,620	1,120,000	2,600
Canada	15,200	50	18,800	66
Hong Kong	83,400	162	65,600	154
India	1,340,000	1,260	1,390,000	1,480
Israel	3,070,000	7,670	2,870,000	8,140
Mexico	49,900	37	9,480	1
Russia	57,600	126	53,600	132
South Africa	46,300	336	78,200	559
Switzerland	16,600	138	11,000	191
Thailand	21,200	20	16,900	24
United Arab Emirates	50,300	64	82,500	111
Other	67,000	235	83,000	298
Total	5,980,000	12,700	5,790,000	13,800

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Includes some natural advanced diamond.

Source: U.S. Census Bureau.

TABLE 8

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

Kind and country	2005 Quantity (carats)	2005 Value[2] (millions)	2006 Quantity (carats)	2006 Value[2] (millions)
Emerald:				
Argentina	12,500	(3)	--	--
Belgium	4,230	$1	137,000	$1
Brazil	83,600	5	206,000	8
Canada	6,430	(3)	993	(3)
China	17,900	(3)	5,000	(3)
Colombia	456,000	54	1,020,000	86
France	2,360	7	1,020	2
Germany	93,600	1	12,400	2
Hong Kong	86,100	8	439,000	5
India	1,340,000	17	1,450,000	19
Israel	139,000	22	138,000	22
Italy	3,120	2	7,590	3
Namibia	4,590	(3)	--	--
Switzerland	18,500	8	28,200	19
Thailand	348,000	7	420,000	7
United Kingdom	2,520	2	1,320	1
Other	4,770	2	37,400	(3)
Total	2,620,000	137	3,910,000	175
Ruby:				
Belgium	11,600	1	1,760	1
China	29,700	(3)	17,000	(3)
Dominican Republic	23,600	(3)	15,700	(3)
France	2,300	5	2,840	4
Germany	77,600	1	9,590	2
Hong Kong	119,000	7	129,000	6
India	935,000	5	1,930,000	3
Israel	8,840	1	4,810	1
Italy	4,340	1	3,280	1
Kenya	33,500	(3)	2,000	(3)
Sri Lanka	4,080	1	2,120	1
Switzerland	89,300	29	15,000	12
Thailand	3,030,000	48	1,510,000	53
United Arab Emirates	3,340	1	2,220	(3)
Other	8,630	2	24,600	3
Total	4,380,000	102	3,680,000	87
Sapphire:				
Australia	57,900	1	2,100	(3)
Austria	29,600	1	3,060	(3)
Belgium	7,120	1	2,860	1
China	84,100	(3)	35,000	(3)
Dominican Republic	24,500	(3)	44,300	(3)
Germany	72,700	5	119,000	3
Hong Kong	272,000	15	336,000	9
India	987,000	6	1,680,000	5
Israel	31,600	3	26,700	2
Italy	5,880	(3)	2,860	(3)
Singapore	5,350	(3)	2,840	(3)
Sri Lanka	448,000	45	363,000	49
Switzerland	49,000	9	43,200	10
Thailand	5,620,000	81	4,150,000	75

See footnotes at end of table.

TABLE 8—Continued
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

	2005		2006	
Kind and country	Quantity (carats)	Value[2] (millions)	Quantity (carats)	Value[2] (millions)
Sapphire—Continued:				
United Arab Emirates	2,490	(3)	6,130	$1
United Kingdom	2,550	(3)	4,220	1
Other	14,700	$5	39,500	6
Total	7,710,000	174	6,860,000	162
Other:				
Rough, uncut:				
Australia	NA	2	NA	5
Brazil	NA	10	NA	11
Canada	NA	4	NA	4
China	NA	4	NA	4
Colombia	NA	1	NA	2
Czech Republic	NA	2	NA	2
Germany	NA	3	NA	1
India	NA	1	NA	7
Japan	NA	1	NA	1
Mexico	NA	1	NA	(3)
Netherlands	NA	1	NA	(3)
Pakistan	NA	1	NA	2
South Africa	NA	1	NA	(3)
Tanzania	NA	3	NA	1
United Kingdom	NA	1	NA	(3)
Other	NA	5	NA	13
Total	NA	40	NA	52
Cut, set and unset:				
Australia	NA	9	NA	13
Austria	NA	4	NA	2
Brazil	NA	18	NA	18
Canada	NA	1	NA	1
China	NA	57	NA	71
France	NA	3	NA	4
Germany	NA	33	NA	44
Hong Kong	NA	49	NA	50
India	NA	93	NA	86
Israel	NA	5	NA	6
Italy	NA	1	NA	1
South Africa	NA	3	NA	3
Sri Lanka	NA	7	NA	11
Switzerland	NA	19	NA	13
Taiwan	NA	2	NA	2
Tanzania	NA	7	NA	6
Thailand	NA	40	NA	57
United Arab Emirates	NA	1	NA	1
United Kingdom	NA	1	NA	2
Other	NA	7	NA	14
Total	NA	360	NA	405

NA Not available. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 9
VALUE OF U.S. IMPORTS OF LABORATORY-CREATED
AND IMITATION GEMSTONES, BY COUNTRY[1, 2]

(Thousand dollars)

Country	2005	2006
Laboratory-created, cut but unset:		
Austria	3,700	882
Brazil	151	361
Canada	133	124
China	15,200	14,900
Cyprus	86	(3)
Czech Republic	91	112
France	945	354
Germany	12,200	12,700
Hong Kong	1,580	1,830
India	526	1,000
Ireland	69	(3)
Italy	131	51
Japan	110	75
Korea, Republic of	468	468
Netherlands	296	436
South Africa	87	(3)
Sri Lanka	1,300	2,210
Switzerland	2,050	4,550
Taiwan	238	197
Thailand	1,420	778
United Arab Emirates	70	60
Other	253	1,170
Total	41,100	42,300
Imitation:[4]		
Austria	73,600	72,600
Brazil	16	12
China	3,500	3,850
Czech Republic	11,000	9,250
France	13	118
Germany	1,160	1,760
Hong Kong	271	250
India	361	434
Italy	222	214
Japan	474	269
Korea, Republic of	619	689
Philippines	15	(3)
Russia	17	7
Spain	256	170
Taiwan	179	66
Thailand	52	49
United Kingdom	24	139
Other	109	135
Total	91,900	90,100

[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Less than ½ unit.
[4]Includes pearls.

Source: U.S. Census Bureau.

TABLE 10

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES[1]

(Thousand carats and thousand dollars)

Stones	2005 Quantity	2005 Value[2]	2006 Quantity	2006 Value[2]
Diamonds:				
Rough or uncut	1,060	$864,000	1,200	$801,000
Cut but unset	17,000	15,400,000	17,100	16,400,000
Emeralds, cut but unset	2,630	137,000	3,910	175,000
Coral and similar materials, unworked	5,520	12,200	5,600	24,900
Rubies and sapphires, cut but unset	12,100	275,000	10,500	249,000
Pearls:				
Natural	NA	21,800	NA	23,600
Cultured	NA	27,100	NA	44,300
Imitation	NA	4,170	NA	4,100
Other precious and semiprecious stones:				
Rough, uncut	1,630,000	22,900	2,270,000	31,400
Cut, set and unset	NA	319,000	NA	363,000
Other	NA	7,200	NA	9,250
Laboratory-created:				
Cut but unset	196,000	41,100	194,000	42,300
Other	NA	10,300	NA	11,400
Imitation gemstone[3]	NA	87,700	NA	86,000
Total	XX	17,200,000	XX	18,300,000

NA Not available. XX Not applicable.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Does not include pearls.

Source: U.S. Census Bureau.

TABLE 11

NATURAL DIAMOND: WORLD PRODUCTION, BY COUNTRY AND TYPE[1, 2, 3]

(Thousand carats)

Country and type[4]	2002	2003	2004	2005	2006
Gemstones:					
Angola[e]	4,520	5,130	5,490	6,300 [r]	7,000
Australia	15,136	13,981	6,058	8,577 [r]	7,305
Botswana[e]	21,297	22,800	23,300	23,900	24,000
Brazil[e]	500 [5]	400	300 [5]	300	300
Canada	4,937	10,756	12,618	12,300 [e]	12,350
Central African Republic[e]	312	250	263	285 [r]	315
China[e]	100	100	100	100	100
Congo (Kinshasa)	4,223	5,381	6,180	6,100 [r, e]	5,600
Côte d'Ivoire	205	154	201 [e]	201 [e]	200
Ghana	770	724 [r]	725 [r]	850 [r]	780
Guinea	368	500 [r]	555 [r]	413 [r]	355
Guyana	248	413	445 [r]	340 [r, e]	300
Liberia[e]	52 [r]	26 [r]	7 [r]	7 [r]	7
Namibia	1,562	1,481	2,004	1,902 [r]	2,200
Russia[e]	17,400	20,000	21,400	23,000	23,400
Sierra Leone[e]	162 [5]	233	318	395	360
South Africa	4,351	5,144	5,800 [r, e]	6,400 [r, e]	6,240 [e]
Tanzania[e]	204 [5]	201	258	185 [r]	195
Venezuela	46	11	40 [e]	46 [e]	45 [e]
Other[6]	42	131 [r]	186 [r]	241 [r]	236
Total	76,400	87,800 [r]	86,200 [r]	91,800 [r]	91,300
Industrial:					
Angola[e]	502	570	610	700 [r]	800
Australia	18,500	17,087	18,172 [r]	25,730 [r]	21,915
Botswana[e]	7,100	7,600	7,800	8,000	8,000
Brazil[e]	600	600	600	600	600
Central African Republic[e]	104	83	88	95 [r]	105
China[e]	955	955	960	960	965
Congo (Kinshasa)	17,456	21,600	24,700	24,200 [r, e]	22,400 [e]
Côte d'Ivoire	101	76	99 [e]	99 [e]	99 [e]
Ghana[e]	193	180 [r]	180 [r]	213 [r]	190
Guinea[e]	123	167 [r]	185 [r]	138 [r]	118
Liberia[e]	28	14 [r]	4 [r]	4 [r]	4
Russia[e]	11,600	13,000	14,200	15,000	15,000
Sierra Leone	190	274 [e]	374 [e]	274 [r]	252
South Africa	6,526	7,540	8,500 [e]	9,400 [r, e]	9,130
Tanzania[e]	36	36	46	35 [r]	35
Venezuela	61	24	60 [e]	69 [e]	70 [e]
Other[7]	81	82	121	190	189
Total	64,200	69,900	76,700 [r]	85,700 [r]	79,900
Grand total	141,000	158,000	163,000 [r]	178,000 [r]	171,000

[e]Estimated. [r]Revised.

[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through June 5, 2007.

[3]In addition to the countries listed, Nigeria and the Republic of Korea produce natural diamond and synthetic diamond, respectively, but information is inadequate to formulate reliable estimates of output levels.

[4]Includes near-gem and cheap-gem qualities.

[5]Reported figure.

[6]Includes Cameroon, Congo (Brazzaville), Gabon (unspecified), India, Indonesia, Togo (unspecified), and Zimbabwe.

[7]Includes Congo (Brazzaville), India, Indonesia, and Zimbabwe.

science for a changing world

2007 Minerals Yearbook

GEMSTONES [ADVANCE RELEASE]

U.S. Department of the Interior
U.S. Geological Survey

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GEMSTONES

By Donald W. Olson

Domestic survey data and tables were prepared by Connie Lopez, statistical assistant, and the world production table was prepared by Glenn J. Wallace, international data coordinator.

In 2007, the estimated value of natural gemstones produced in the United States was more than $11.9 million, and the estimated value of U.S. laboratory-created gemstone production was more than $73.5 million. The total estimated value of U.S. gemstone production was almost $85.4 million. The value of U.S. gemstone imports was $20.1 billion, and the value of combined U.S. gemstone exports and reexports was estimated to be $12.3 billion.

In this report, the terms "gem" and "gemstone" mean any mineral or organic material (such as amber, pearl, petrified wood, and shell) used for personal adornment, display, or object of art because it possesses beauty, durability, and rarity. Of more than 4,000 mineral species, only about 100 possess all these attributes and are considered to be gemstones. Silicates other than quartz are the largest group of gemstones in terms of chemical composition; oxides and quartz are the second largest (table 1). Gemstones are subdivided into diamond and colored gemstones, which in this report designates all natural nondiamond gems. In addition, laboratory-created gemstones, cultured pearls, and gemstone simulants are discussed but are treated separately from natural gemstones (table 2). Trade data in this report are from the U.S. Census Bureau. All percentages in the report were computed using unrounded data. Current information on industrial-grade diamond and industrial-grade garnet can be found in the U.S. Geological Survey (USGS) Minerals Yearbook, volume I, Metals and Minerals chapters on industrial diamond and industrial garnet, respectively.

Gemstones have fascinated humans since prehistoric times. They have been valued as treasured objects throughout history by all societies in all parts of the world. Amber, amethyst, coral, diamond, emerald, garnet, jade, jasper, lapis lazuli, pearl, rock crystal, ruby, serpentine, and turquoise are some of the first stones known to have been used for making jewelry. These stones served as symbols of wealth and power. Today, gems are worn more for pleasure or in appreciation of their beauty than to demonstrate wealth. In addition to jewelry, gemstones are used for collections, decorative art objects, and exhibits.

Production

U.S. gemstone production data were based on a survey of more than 230 domestic gemstone producers conducted by the USGS. The survey provided a foundation for projecting the scope and level of domestic gemstone production during the year. However, the USGS survey did not represent all gemstone activity in the United States, which includes thousands of professional and amateur collectors. Consequently, the USGS supplemented its survey with estimates of domestic gemstone production from related published data, contacts with gemstone dealers and collectors, and information gathered at gem and mineral shows.

Commercial mining of gemstones has never been extensive in the United States. More than 60 varieties of gemstones have been produced commercially from domestic mines, but most of the deposits are relatively small compared with those of other mining operations. In the United States, much of the current gemstone mining is conducted by individual collectors, gem clubs, and hobbyists rather than by businesses.

The commercial gemstone industry in the United States consists of individuals and companies that mine gemstones or harvest shell and pearl, firms that manufacture laboratory-created gemstones, and individuals and companies that cut and polish natural and laboratory-created gemstones. The domestic gemstone industry is focused on the production of colored gemstones and on the cutting and polishing of large diamond stones. Industry employment is estimated to range from 1,000 to 1,500 workers (U.S. International Trade Commission, 1997, p. 1).

Most natural gemstone producers in the United States are small businesses that are widely dispersed and operate independently. The small producers probably have an average of less than three employees, including those who only work part time. The number of gemstone mines operating from year to year fluctuates because the uncertainty associated with the discovery and marketing of gem-quality minerals makes it difficult to obtain financing for developing and sustaining economically viable operations (U.S. International Trade Commission, 1997, p. 23).

The total value of natural gemstones produced in the United States during 2007 was estimated to be more than $11.9 million (table 3). This production value was a 5% increase from that of 2006.

Natural gemstone materials indigenous to the United States are collected, produced, and/or marketed in every State. During 2007, all 50 States produced at least $1,000 worth of gemstone materials. Nine States accounted for 84% of the total value, as reported by survey respondents. These States were, in order of declining value of production, Tennessee, Oregon, Arizona, California, Arkansas, Alabama, Montana, North Carolina, and Idaho. Some States were known for the production of a single gemstone material—Tennessee for freshwater pearls, for example. Other States produced a variety of gemstones; for example Arizona's gemstone deposits included agate, amethyst, azurite, chrysocolla, garnet, jade, jasper, malachite, obsidian, onyx, opal, peridot, petrified wood, smithsonite, and turquoise. There is also a wide variety of gemstones found and produced in California, Idaho, Montana, and North Carolina.

During 2007, the United States had only one operation in known diamond-bearing areas from which diamonds were produced. That diamond operation is in Crater of Diamonds State Park near Murfreesboro in Pike County, AR, where a dig-for-fee operation for tourists and rockhounds is maintained by the State of Arkansas. Crater of Diamonds is the only diamond mine in the world that is open to the public. The diamonds occur in a lamproite breccia tuff associated with a volcanic pipe and in the soil developed from the lamproite breccia tuff. In 2007, 1,024 diamond stones with an average weight of 0.247 carats were recovered at the Crater of Diamonds State Park. Of the 1,024 diamond stones recovered, 44 weighed more than 1 carat. Since the diamond-bearing pipe and the adjoining area became a State park in 1972, 26,881 diamond stones with a total carat weight of 5,324.65 have been recovered (Kimberly Garland, interpreter, Crater of Diamonds State Park, written commun., January 16, 2008). Exploration has demonstrated that there is about 78.5 million metric tons (Mt) of diamond-bearing rock in this diamond deposit (Howard, 1999, p. 62). An Arkansas law enacted early in 1999 prohibits commercial diamond mining in the park (Diamond Registry Bulletin, 1999).

There have been no commercially operated diamond mines in the United States since 2002. Diamond was produced at the Kelsey Lake diamond mine, located close to the Colorado-Wyoming State line near Fort Collins, CO, for several years until April 2002. The Kelsey Lake property has now been fully reclaimed.

The success of the Canadian diamond industry has stimulated interest in exploration for commercially feasible diamond deposits in the United States in Alaska, Colorado, Minnesota, Montana, and Wyoming. Microscopic and larger diamonds and some diamond indicator minerals have been found in all of these States. Parts of Alaska have similar geologic terrain to the diamond producing areas of Canada's Northwest Territories, and there are similarities between the geology in other Canadian areas where diamond deposits have been found and the geology in Minnesota (Diamond Registry Bulletin, 2005a). A diamond-bearing kimberlite was found in a 32.4-hectare site known as the Homestead property near Lewistown, MT; and diamonds have been found in the stream beds and glacial valleys of Montana for years (Associated Press, 2004). Studies by the Wyoming Geological Survey have shown that Wyoming has the potential for a large diamond-mining business. Wyoming has many of the same geologic conditions that are found in the Canadian diamond-producing areas, and there is good evidence of hundreds of kimberlite pipes in the State. More than 20 diamondiferous kimberlite pipes and 1 diamondiferous mafic breccia pipe have been identified in southern Wyoming. The State Line and the Iron Mountain kimberlite fields of Wyoming are two of the largest kimberlite fields in the United States, and the Leucite Hills lamproite field in Wyoming is the largest lamproite field in the United States (Associated Press, 2002).

In addition to natural gemstones, laboratory-created gemstones and gemstone simulants are produced in the United States. Laboratory-created or synthetic gemstones have the same chemical, optical, and physical properties as the natural gemstones. Simulants have an appearance similar to that of a natural gemstone material, but they have different chemical, optical, and physical properties. Laboratory-created gemstones that have been produced in the United States include alexandrite, diamond, emerald, garnet, moissanite, ruby, sapphire, spinel, turquoise, and zirconia. However, during 2007, only diamond, moissanite, and turquoise were produced commercially. Simulants of coral, lapis lazuli, malachite, and turquoise also are manufactured in the United States. In addition, certain colors of laboratory-created sapphire and spinel, used to represent other gemstones, are classified as simulants.

Laboratory-created gemstone production in the United States was valued at more than $73.5 million during 2007, which was a 41% increase compared with that of 2006. This was owing to very large increases in the production of laboratory-created diamonds combined with a large increase in laboratory-created moissanite production. The value of U.S. simulant gemstone output was estimated to be more than $100 million. Four companies in four States, representing virtually the entire U.S. laboratory-created gemstone industry, reported production to the USGS. The States with reported laboratory-created gemstone production were, in descending order of production value, North Carolina, Florida, Massachusetts, and Arizona.

Since the 1950s, when scientists manufactured the first laboratory-created bits of diamond grit using a high-pressure, high-temperature (HPHT) method, this method of growing diamonds has become relatively commonplace in the world as a technology for laboratory-created diamonds, so much so that thousands of small plants all over China are now using the HPHT method and producing laboratory-created diamonds suitable for cutting as gemstones. Gem-quality diamonds of one carat or more are harder to manufacture because at that size it is difficult to consistently produce diamonds of high quality, even in the controlled environment of a lab using the HPHT method. But after 50 years of development, that situation is changing and several laboratory-created diamond companies are producing high-quality diamonds that equal those produced from mines (Park, 2007).

Gemesis Corp. in Sarasota, FL, consistently produced gem-quality laboratory-created diamond and reported an eighth year of production in 2007. The laboratory-created diamonds are produced using equipment, expertise, and technology developed by a team of scientists from Russia and the University of Florida. The weight of the laboratory-created diamond stones range from 1.5 to 2 carats, and most of the stones are yellow, brownish yellow, colorless, and green (Weldon, 1999). Gemesis uses diamond-growing machines, each machine capable of growing 3-carat rough diamonds by generating HPHT conditions that recreate the conditions in the Earth's mantle where natural diamonds form (Davis, 2003). Gemesis could be producing as much as 30,000 to 40,000 stones each year, and annual revenues may reach $70 million to $80 million (Diamond Registry Bulletin, 2001). Gemesis diamonds are available for retail purchase in jewelry stores and on the Internet, and the prices of the Gemesis laboratory-created diamonds are below those of natural diamond but above the prices of simulated diamond (Weldon, 2003).

Apollo Diamond, Inc., near Boston, MA, developed and patented a method for growing extremely pure, gem-quality diamond with flawless crystal structure by chemical vapor deposition (CVD). The CVD technique transforms carbon into plasma, which is then precipitated onto a substrate as diamond. CVD has been used for more than a decade to cover large surfaces with microscopic diamond crystals, but until this process, no one had discovered the temperature, gas composition, and pressure combination that resulted in the growth of a single diamond crystal. CVD diamond precipitates as nearly 100% pure, almost flawless diamond, and therefore may not be distinguishable from natural diamond by some tests (Davis, 2003). In 2006, Apollo Diamond Inc. produced laboratory-created stones that range from 1 to 2 carats and expected to expand to larger stones in the future. Growth of CVD diamonds is limited only by the size of the seed placed in the diamond growing chamber. Late in 2006, Apollo started selling jewelry directly to consumers through a jeweler in Boston, MA. In 2007, the company increased its production of large stones and is now selling online through an Apollo Diamond Web store (O'Connell, 2007). Apollo planned to start selling diamonds in the jewelry market at costs 10% to 30% below those of comparable natural diamonds (Hastings, 2005). CVD diamond's highest value, besides its use as gemstones, is as a material for high-tech uses. CVD diamond could be used to make extremely powerful lasers; to create cellular telephones that fit into a watch, and storage devices for MP3 players that could store 10,000 movies, not just 10,000 songs; to create frictionless medical replacement joints; to create windows on spacecraft; to create surgical diamond blades and scalpels; to create tweeters for audio equipment; or to create coatings for cars that would not scratch or wear out. The greatest potential use for CVD diamond is in computers and other electronic devices that utilize processors (Maney, 2005; Park, 2007).

The Carnegie Institution of Washington Geophysical Laboratory and the University of Alabama jointly developed and patented the CVD process and apparatus to produce ½-inch-thick 10-carat single diamond crystals at very rapid growth rates (100 micrometers per hour). This faster CVD method uses microwave plasma technology and allows multiple crystals to be grown simultaneously. This size is about five times that of commercially available laboratory-created diamonds produced by HPHT methods and other CVD techniques. A researcher at the Carnegie Institution stated, "High-quality crystals over 3 carats are very difficult to produce using the conventional approach. Several groups have begun to grow diamond single crystals by CVD, but large, colorless, and flawless ones remain a challenge. Our fabrication of 10-carat, half-inch CVD diamonds is a major breakthrough" (Willis, 2004; Carnegie Institution of Washington, 2005; Science Blog, 2005). Apollo Diamond and the Carnegie Institution have noted that diamonds produced by the CVD method are harder than natural diamonds and diamonds produced by HPHT methods.

In 2007, Charles & Colvard, Ltd., in North Carolina, entered its 10th year of producing and marketing moissanite, a gem-quality laboratory-created silicon carbide. Moissanite is also an excellent diamond simulant, but it is being marketed for its own gem qualities. Moissanite exhibits a higher refractive index (brilliance) and higher luster than diamond. Its hardness is between those of corundum (ruby and sapphire) and diamond, which gives it durability (Charles & Colvard, Ltd., 2007).

U.S. shell production increased by 3% in 2007 compared with that of 2006. U.S. mussel shells are used as a source of mother-of-pearl and as seed material for culturing pearls. Pearl producers in Japan are using manmade seed materials or seed materials from China and other sources in addition to the stockpiled material. There also has been an increase in the popularity of darker and colored pearls and freshwater pearls that do not use U.S. seed material. In some regions of the United States, shell from mussels is being used more as a gemstone based on its own merit rather than as seed material for pearls. This shell material is being processed into mother-of-pearl and used in beads, jewelry, and watch faces.

Consumption

Although the United States accounted for little of the total global gemstone production, it was the world's leading gemstone market. It is estimated that U.S. gemstone markets accounted for more than 35% of world gemstone demand in 2007. The U.S. market for unset gem-quality diamond during the year was estimated to be about $19.0 billion, an increase of 10% compared with that of the previous year. Domestic markets for natural, unset nondiamond gemstones totaled approximately $1.22 billion in 2007, which was an increase of 9% from that of 2006.

In the United States, about two-thirds of domestic consumers designate diamond as their favorite gemstone when surveyed (Wade, 2006). The U.S. colored gemstone market posted an overall increase in sales during 2007 compared with the sales in 2006. The popularity of colored gemstones, colored laboratory-created gemstones, and "fancy" colored diamonds continued to increase in 2007. This was indicated by increased values of U.S. imports for consumption in some colored stone categories (emerald, rubies and sapphires, and cultured pearls) in 2007 compared with the values from 2006 (table 10). Colored stone popularity also was evidenced by their general sales increase in 2007 (Zborowski, 2007). Another indication reported by the Natural Color Diamond Association, was that demand for colored diamonds rose sharply during the first half of 2007, and the trend was expected to continue. This increased demand pushed prices up for colored diamond stones. The largest demand for colored stones was in the Asian and United States markets with increased sales of champagne, cognac, grey, black, pink, orange and yellow stones (Diamond Registry Bulletin, 2007a).

Prices

Gemstone prices are governed by many factors and qualitative characteristics, including beauty, clarity, defects, demand, durability, and rarity. Diamond pricing, in particular, is complex; values can vary significantly depending on time, place, and the subjective valuations of buyers and sellers. There are more than 14,000 categories used to assess rough diamond and more than 100,000 different combinations of carat, clarity, color, and cut values used to assess polished diamond (Pearson, 1998).

Colored gemstone prices are generally influenced by market supply and demand considerations, and diamond prices are supported by producer controls on the quantity and quality of supply. Values and prices of gemstones produced and/or sold in the United States are listed in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported, exported, or reexported are listed in tables 6 through 10.

De Beers Group companies remain a significant force affecting the price of gem-quality diamond worldwide because they mine a significant portion of the world's gem-quality diamond produced each year, and they also purchase diamonds from Russia. In 2007, De Beers companies produced 51.1 million carats, which maintained the record production of 2006. De Beers companies also sort and valuate a large portion (by value) of the world's annual supply of rough diamond through De Beers' subsidiary Diamond Trading Co. (DTC), which has marketing agreements with other producers. In 2007, DTC had diamond sales of $5.92 billion, which were down about 4% from those of 2006 (De Beers Group, 2007, 2008). In 2007, there were about 200,000 diamond jewelry retail outlets worldwide. From these retail outlets, about 45% of diamond jewelry was sold in the United States, 33% in Asia, and 11% in Europe. Increase in sales was approximately 6% compared with that of 2006. There were an estimated 32,000 retail outlets specializing in fine jewelry in the United States. Of these jewelry-only retailers, 79% are small, independent businesses that are highly competitive in their local markets. The remaining 21% are major national and regional chains and online retailers. The estimated U.S. retail jewelry market was $65.3 billion during 2007. The market shares by type of outlet were (in decreasing value order): local independents, 21%; national and regional chains, 15%; department stores, 13%; television shopping networks, 11%; Internet auction sites, 11%; discount chains, 8%; Internet jewelry sites, 6%; and others (catalogs, boutiques, and other outlets), 15% (Profile America, Inc., 2008).

Foreign Trade

During 2007, total U.S. gemstone trade with all countries and territories was valued at about $32.4 billion, which was an increase of 16% from that of 2006. Diamond accounted for about 95% of the 2007 gemstone trade total. In 2007, U.S. exports and reexports of diamond were shipped to 85 countries and territories, and imports of all gemstones were received from 98 countries and territories (tables 6–10). During 2007, U.S. trade in cut diamond and unworked diamond increased by 10% and by 6%, respectively, compared with that of 2006. The United States remained the world's leading diamond importer and is a significant international diamond transit center as well as the world's leading gem-quality diamond market. The large volume of reexports shipped to other centers reveals the significance that the United States has in the world's diamond supply network (table 6).

Imports of laboratory-created gemstone decreased by 2% for the United States in 2007 compared with trade in 2006. Laboratory-created gemstone imports from Austria, China, Germany, Hong Kong, India, Sri Lanka, Switzerland, and Thailand, with more than $500,000 in imports from each country, made up about 89% (by value) of the total domestic imports of laboratory-created gemstones during the year. Prices of certain imported laboratory-created gemstones, such as amethyst, were very competitive. The marketing of imported laboratory-created gemstones and enhanced gemstones as natural gemstones, and the mixing of laboratory-created materials with natural stones in imported parcels, continued to be problems for some domestic producers in 2007. There also were problems with some simulants being marketed as laboratory-created gemstones during the year.

World Review

The gemstone industry worldwide has two distinct sectors—diamond mining and marketing and colored gemstone production and sales. Most diamond supplies are controlled by a few major mining companies; prices are supported by managing the quality and quantity of the gemstones relative to demand, a function performed by De Beers through DTC. Unlike diamond, colored gemstones are primarily produced at relatively small, low-cost operations with few dominant producers; prices are influenced by consumer demand and supply availability.

In 2007, world natural diamond production totaled about 169 million carats—92.6 million carats gem quality and 76.7 million carats industrial grade (table 11). Most production was concentrated in a few regions—Africa [Angola, Botswana, Congo (Kinshasa), Namibia, and South Africa], Asia (northeastern Siberia and Yakutia in Russia), Australia, North America (Northwest Territories in Canada), and South America (Brazil and Venezuela). In 2007, Russia led the world in total diamond output quantity (combined gemstone and industrial). Botswana was the world's leading gemstone diamond producer, followed by Russia, Canada, Angola, South Africa, Congo (Kinshasa), and Namibia in descending quantity order. These seven countries produced 96% (by quantity) of the world's gemstone diamond output in 2007.

In 2002, the international rough-diamond certification system, the Kimberley Process Certification Scheme (KPCS), was agreed upon by United Nations (UN) member nations, the diamond industry, and involved nongovernmental organizations. The KPCS includes the following key elements: the use of forgery-resistant certificates and tamper-proof containers for shipments of rough diamonds; internal controls and procedures that provide credible assurance that conflict diamonds do not enter the legitimate diamond market; a certification process for all exports of rough diamonds; the gathering, organizing, and sharing of import and export data on rough diamonds with other participants of relevant production; credible monitoring and oversight of the international certification scheme for rough diamonds; effective enforcement of the provisions of the certification scheme through dissuasive and proportional penalties for violations; self regulation by the diamond industry that fulfills minimum requirements; and sharing information with all other participants on relevant rules, procedures, and legislation as well as examples of national certificates used to accompany shipments of rough diamonds (Weldon, 2001). Canada acted as the chair and secretariat of the KPCS for the first 2 years, and in October 2004, Russia assumed these duties. The list of participating countries has expanded to include 47 nations that have met the minimum requirements of the agreement. The rough diamond-trading entity of Chinese Taipei has also met the minimum requirements of the KPCS. The KPCS was implemented to solve the problem of conflict diamonds—rough diamonds used by rebel forces and their allies in several countries to help finance warfare aimed at subverting governments recognized as legitimate by the UN. The participating nations in the KPCS account for approximately 98% of the global production and trade of rough diamonds (Diamond Registry Bulletin, 2005b; Kimberley Process, 2008). Discussions about the possible participation of several other countries are ongoing.

Globally, the value of production of natural gemstones other than diamond was estimated to have exceeded $2 billion in 2007. Most nondiamond gemstone mines are small, low-cost, and widely dispersed operations in remote regions of developing nations. Foreign countries with major gemstone deposits other than diamond are Afghanistan (aquamarine, beryl, emerald, kunzite, lapis lazuli, ruby, and tourmaline), Australia (beryl, opal, and sapphire), Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline), Burma (beryl, jade, ruby, sapphire, and topaz), Colombia (beryl, emerald, and sapphire), Kenya (beryl, garnet, and sapphire), Madagascar (beryl, rose quartz, sapphire, and tourmaline), Mexico (agate, opal, and topaz), Sri Lanka (beryl, ruby, sapphire, and topaz), Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline), and Zambia (amethyst and beryl). In addition, pearls are cultured throughout the South Pacific and in other equatorial waters; Australia, China, French Polynesia, and Japan are key producers.

Canada.—Canadian diamond production continued increasing in 2007 to about 18 million carats. Diamond exploration continued in many parts of Canada, and many new deposits have been found and are being developed. In 2007, Canada produced about 11% of the world's combined natural gemstone and industrial diamonds.

The Ekati Diamond Mine, Canada's first operating commercial diamond mine, completed its ninth full year of production in 2007. Ekati produced 3.67 million carats of diamond from 4.33 million metric tons (Mt) of ore (BHP Billiton Ltd., 2008). BHP Billiton Ltd. has an 80% controlling ownership in Ekati, which is in the Northwest Territories in Canada. Ekati has estimated reserves of 60.3 Mt of ore in kimberlite pipes that contain 54.3 million carats of diamond, and BHP Billiton projected the mine life to be 25 years. Approximately one-third of the Ekati diamond production is industrial-grade material (Darren Dyck, senior project geologist, BHP Diamonds, Inc., oral commun., May 27, 2001).

The Diavik Diamond Mine, also in the Northwest Territories, completed its fifth full year of production. In 2007, Diavik produced 11.9 million carats of diamond (Diavik Diamond Mines Inc., 2008). At yearend 2006, Diavik estimated the mine's remaining proven and probable reserves to be 24.5 Mt of ore in kimberlite pipes, containing 81.7 million carats of diamond, and projected the mine life to be 16 to 22 years (Diavik Diamond Mine Dialogue, 2007). The mine is an unincorporated joint venture between Diavik Diamond Mines Inc. (60%) and Harry Winston Diamond Mines Ltd. (40%). In November, Diavik announced approval of its investment in the underground mining phase of the Diavik Diamond Mine. Underground diamond production will begin in 2009 and continue beyond 2020. Open pit mining is expected to cease in 2012, at which time Diavik will become an all-underground mine (Diavik Diamond Mine Dialogue, 2008). The mine is expected to produce a total of about 110 million carats of diamond at a rate of 8 million carats per year (Diavik Diamond Mines Inc., 2000, p. 10–12; Diavik Diamond Mine Dialogue, 2007).

Canada's third diamond mine, the Jericho Diamond Mine wholly owned by Tahera Diamond Corp., completed its first full year of production. The Jericho mine is located in Nunavut. In 2007, Jericho produced 375,000 carats (Abazias Diamonds, 2008). Tahera estimated the Jericho Diamond Mine's reserves at 2.6 Mt of ore and 3.11 million carats of diamond (Tahera Diamond Corp., 2007).

Diamond exploration continued in Canada, with several other commercial diamond projects and additional discoveries located in Alberta, British Columbia, the Northwest Territories, the Nunavut Territory, Ontario, and Quebec. Canada produced about 11% of the world's combined natural gemstone and industrial diamond production in 2007.

Côte d'Ivoire.—In 2007, the UN Security Council continued the ban on rough diamond trade with the Côte d'Ivoire. The ban was originally implemented in 2004 and continued in 2006 under resolution 1643 (2005). The UN Security Council deemed Côte d'Ivoire to be a threat to international peace and security because the profits from its trade of rough diamonds were used to arm civil conflict within Côte d'Ivoire. The sanctions were aimed at stemming civil conflict in Côte d'Ivoire. According to the World Diamond Council, Côte d'Ivoire is the only remaining source of conflict diamonds (Diamond Registry Bulletin, 2006, 2007c).

Liberia.—The UN removed diamond sanctions against Liberia. The move was followed by the European Union also lifting its embargo on rough diamond trade from Liberia. Liberia was accepted as a member state to the Kimberley Process Certification Scheme in May 2007. The United States added Liberia to its list of diamond trading partners in June (Diamond Registry Bulletin, 2007b).

Namibia.—Mining began in January 2007 at the marine project of Bonaparte Diamond Mines NL, located off the coast of Namibia. During the first quarter, 21,942 diamonds weighing more than 9,000 carats were recovered (Diamond Registry Bulletin, 2007d).

Outlook

There are indications of possible continued growth in the U.S. diamond and jewelry markets in 2008. Historically, diamonds have proven to hold their value despite wars or economic depressions (Schumann, 1998, p. 8).

Independent producers, such as Ekati and Diavik in Canada, will continue to bring a greater measure of competition to global markets. More competition presumably will bring more supplies and lower prices. Further consolidation of diamond producers and larger amounts of rough diamond being sold outside DTC will continue as the diamond industry adjusts to De Beers' reduced influence on the industry.

More laboratory-created gemstones, simulants, and treated gemstones will enter the marketplace and necessitate more transparent trade industry standards to maintain customer confidence.

During 2007, online sales rose to 6% of all retail jewelry sales, compared with 3.5% in 2006. Internet sales of diamonds, gemstones, and jewelry are expected to continue to grow and increase in popularity, as will other forms of e-commerce that emerge to serve the diamond and gemstone industry. This is likely to take place as the gemstone industry and its customers become more comfortable with and learn the applications of new e-commerce tools (IDEX Magazine, 2006; Profile America, Inc., 2008).

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TABLE 1
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0–2.5	1.0–1.1	Single	1.54	Synthetic or pressed plastics, kaurigum	Fossil resin, color, low density, soft and trapped insects.
Apatite	Chlorocalcium phosphate	Colorless, pink, yellow, green, blue, violet	Small	Low	5.0	3.16–3.23	Double	1.63–1.65	Amblygonite, andalusite, brazilianite, precious beryl, titanite, topaz, tourmaline	Crystal habit, color, hardness, appearance.
Azurite	Copper carbonate hydroxide	Azure, dark blue, pale blue	Small to medium	do.	3.5–4.0	3.7–3.9	do.	1.72–1.85	Dumortierite, hauynite, lapis lazuli, lazulite, sodalite	Color, softness, crystal habits and associated minerals.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	do.	High	6.0–6.5	3.64–3.68	do.	1.76–1.80	Sapphire, tanzanite, blue diamond, blue tourmaline, cordierite	Strong blue in ultraviolet light.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5–8.0	2.63–2.80	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	Red	Small	Very high	7.5–8.0	2.63–2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald, natural	do.	Green	Medium	do.	7.5	2.63–2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5–8.0	2.63–2.80	do.	1.58	Genuine emerald	Lack of flaws, brilliant fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5–8.0	2.63–2.80	do.	1.58	Citrine, topaz, glass, doublets	Weak-colored.
Goshenite	do.	Colorless	do.	Low	7.5–8.0	2.63–2.80	do.	1.58	Quartz, glass, white sapphire, white topaz	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5–8.0	2.63–2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49–1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.60	do.	Banded, translucent.
Charoite	Hydrated sodium calcium hydroxi-fluoro-silicate	Lilac, violet, or white	Small to medium	do.	5.0–6.0	2.54–2.78	XX	1.55–1.56	Purple marble	Color, locality.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day light, red by artificial light	Small to medium	High	8.5	3.50–3.84	Double	1.75	Synthetic	Strong dichroism, color varies from red to green, hardness.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Chrysoberyl—Continued:										
Cats-eye	Beryllium aluminate	Greenish to brownish	Small to large	High	8.5	3.50–3.84	Double	1.75	Synthetic, shell	Density, translucence, chatoyance.
Chrysolite	do.	Yellow, green, and/or brown	Medium	Medium	8.5	3.50–3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Chrysocolla	Hydrated copper silicate	Green, blue	Any	Low	2.0–4.0	2.0–2.4	XX	1.46–1.57	Azurite, dyed chalcedony, malachite, turquoise, variscite	Lack of crystals, color, fracture, low density and softness.
Coral	Calcium carbonate	Orange, red, white, black, purple, or green	Branching, medium	do.	3.5–4.0	2.6–2.7	Double	1.49–1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95–4.10	do.	1.78	Synthetics, including spinel, garnet	Inclusions, fluorescence.
Sapphire, blue	do.	Blue	Medium	High	9.0	3.95–4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, colorless, orange, green, or violet	Medium to large	Medium	9.0	3.95–4.10	do.	1.78	Synthetics, glass and doublets, morganite	Inclusions, double refreaction, refractive index.
Sapphire or ruby, stars	do.	Red, pink, violet, blue, or gray	do.	High to low	9.0	3.95–4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.
Sapphire or ruby, synthetic	do.	Yellow, pink, or blue	Up to 20 carats	Low	9.0	3.95–4.10	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Cubic zirconia	Zirconium and yttrium oxides	Colorless, pink, blue, lavender, yellow	Small	do.	8.25–8.5	5.8	Single	2.17	Diamond, zircon, titania, moissanite	Hardness, density, lack of flaws and inclusions, refractive index.
Diamond	Carbon	White, blue-white, yellow, brown, green, red, pink, blue	Any	Very high	10.0	3.516–3.525	do.	2.42	Zircon, titania, cubic zirconia, moissanite	High index, dispersion, hardness, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green-blue	Large	Low	6.0–6.5	2.56	XX	1.52	Jade, turquoise	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play (schiller)	do.	do.	6.0–6.5	2.56	XX	1.56	do.	Do.
Moonstone	do.	Colorless, white, gray, or yellow with white, blue, or bronze schiller	do.	do.	6.0–6.5	2.77	XX	1.52–1.54	Glass, chalcedony, opal	Pale sheen, opalescent.
Sunstone	do.	Orange, red brown, colorless with gold or red glittery schiller	Small to medium	do.	6.0–6.5	2.77	XX	1.53–1.55	Aventurine, glass	Red glittery schiller.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Garnet	Complex silicate	Brown, black, yellow, green, red, or orange	Small to medium	Low to high	6.5–7.5	3.15–4.30	Single strained	1.79–1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Hematite	Iron oxide	Black, black-gray, brown-red	Medium to large	Low	5.5–6.5	5.12–5.28	XX	2.94–3.22	Davidite, cassiterite, magnetite, neptunite, pyrolusite, wolframite	Crystal habit, streak, hardness.
Jade:										
Jadeite	Complex silicate	Green, yellow, black, white, or mauve	Large	Low to very high	6.5–7.0	3.3–3.5	Crypto-crystalline	1.65–1.68	Nephrite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0–6.5	2.96–3.10	do.	1.61–1.63	Jadeite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Do.
Jet (gagate)	Lignite	Deep black, dark brown	do.	Low	2.5–4.0	1.19–1.35	XX	1.64–1.68	Anthracite, asphalt, cannel coal, onyx, schorl, glass, rubber	Luster, color.
Lapis lazuli	Sodium calcium aluminum silicate	Dark azure-blue to bright indigo blue or even a pale sky blue.	do.	do.	5.0–6.0	2.50–3.0	XX	1.50	Azurite, dumortierite, dyed howlite, lazulite, sodalite, glass	Color, crystal habit, associated minerals, luster, and localities.
Malachite	Hydrated copper carbonate	Light to black-green banded	do.	do.	3.5–4.0	3.25–4.10	XX	1.66–1.91	Brochantite, chrysoprase, opaque green gemstones	Color banding, softness, associated minerals.
Moissanite	Silicon carbide	Colorless and pale shades of green, blue, yellow	Small	Low to medium	9.25	3.21	Double	2.65–2.69	Diamond, zircon, titania, cubic zirconia	Hardness, dispersion, lack of flaws and inclusions, refractive index.
Obsidian	Amorphous, variable (usually felsic)	Black, gray, brown, dark green, white, transparent	Large	Low	5.0–5.5	2.35–2.60	XX	1.45–1.55	Aegirine-augite, gadolinite, gagate, hematite, pyrolusite, wolframite	Color, conchoidal fracture, flow bubbles, softness, and lack of crystal faces.
Opal	Hydrated silica	Reddish orange, colors flash in white gray, black, red, or yellow	do.	Low to high	5.5–6.5	1.9–2.3	Single	1.45	Glass, synthetics, triplets, chalcedony	Color play (opalescence).
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5–7.0	3.27–3.37	Double (strong)	1.65–1.69	Tourmaline, chrysoberyl	Strong double refraction, low dichroism.
Quartz:										
Agate	Silicon dioxide	Any	Large	Low	7.0	2.58–2.64	XX	XX	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Quartz—Continued:										
Amethyst	Silicon dioxide	Purple	Large	Medium	7.0	2.65–2.66	Double	1.55	Glass, plastic, fluorite	Macrocrystalline, color, refractive index, transparent, hardness.
Aventurine	do.	Green, red-brown, gold-brown, with metallic iridescent reflection	do.	Low	7.0	2.64–2.69	do.	1.54–1.55	Iridescent analcime, aventurine feldspar, emerald, aventurine glass	Macrocrystalline, color, metallic iridescent flake reflections, hardness.
Cairngorm	do.	Smoky orange or yellow	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Carnelian	do.	Flesh red to brown red	do.	do.	6.5–7.0	2.58–2.64	do.	1.53–1.54	Jasper	Cryptocrystalline, color, hardness.
Chalcedony	do.	Bluish, white, gray	do.	do.	6.5–7.0	2.58–2.64	do.	1.53–1.54	Tanzanite	Do.
Chrysoprase	do.	Green, apple-green	do.	do.	6.5–7.0	2.58–2.64	do.	1.53–1.54	Chrome chalcedony, jade, prase opal, prehnite, smithsonite, variscite, artifically colored green chalcedony	Do.
Citrine	Silica	Yellow	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Crystal:										
Rock	do.	Colorless	do.	do.	7.0	2.65–2.66	do.	1.55	Topaz, colorless sapphire	Do.
Jasper	do.	Any, striped, spotted, or sometimes uniform	do.	do.	7.0	2.58–2.66	XX	XX	do.	Cryptocrystalline, opaque, vitreous luster, hardness.
Onyx	do.	Many colors	do.	do.	7.0	2.58–2.64	XX	XX	do.	Cryptocrystalline, uniformly banded, hardness.
Petrified wood	do.	Brown, gray, red, yellow	do.	do.	6.5–7.0	2.58–2.91	Double	1.54	Agate, jasper	Color, hardness, wood grain.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Tiger's eye	do.	Golden yellow, brown, red, blue-black	do.	do.	6.5–7.0	2.58–2.64	XX	1.53–1.54	XX	Macrocrystalline, color, hardness, hatoyancy.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Rhodochrosite	Manganese carbonate	Rose-red to yellowish, stripped	Large	Low	4.0	3.45–3.7	Double	1.6–1.82	Fire opal, rhodonite, tugtupite, tourmaline	Color, crystal habit, reaction to acid, perfect rhombohedral cleavage.
Rhodonite	Manganese iron calcium silicate	Dark red, flesh red, with dendritic inclusions of black manganese oxide	do.	do.	5.5–6.5	3.40–3.74	do.	1.72–1.75	Rhodochrosite, thulite, hessonite, spinel, pyroxmangite, spessartine, tourmaline	Color, black inclusions, lack of reaction to acid, hardness.
Shell:										
Mother-of-pearl	Calcium carbonate	White, cream, green, blue-green, with iridescent play of color	Small	do.	3.5	2.6–2.85	XX	XX	Glass and plastic imitation	Luster, iridescent play of color.
Pearl	do.	White, cream to black, sometimes with hint of pink, green, purple	do.	Low to high	2.5–4.5	2.6–2.85	XX	XX	Cultured and glass or plastic imitation	Luster, iridescence, x-structure, ray.
Spinel, natural	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5–3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5–3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5–7.0	3.13–3.20	do.	1.66	Synthetic spinel	Refractive index, color, pleochroism.
Kunzite	do.	Pink to lilac	do.	do.	6.5–7.0	3.13–3.20	do.	1.66	Amethyst, morganite	Do.
Tanzanite	Complex silicate	Blue to lavender	Small	High	6.0–7.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism, color.
Topaz	do.	White, blue, green, pink, yellow, gold	Medium	Low to medium	8.0	3.4–3.6	do.	1.62	Beryl, quartz	Color, density, hardness, refractive index, perfect in basal cleavage.
Tourmaline	do.	Any, including mixed	do.	do.	7.0–7.5	2.98–3.20	do.	1.63	Peridot, beryl, garnet corundum, glass	Double refraction, color, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green with black, brown-red inclusions	Large	Low	6.0	2.60–2.83	do.	1.63	Chrysocolla, dyed howlite, dumortierite, glass, plastics, variscite	Difficult if matrix not present, matrix usually limonitic.
Unakite	Granitic rock, feldspar, epidote, quartz	Olive green, pink, and blue-gray	do.	do.	6.0–7.0	2.60–3.20	XX	XX	XX	Olive green, pink, gray-blue colors.
Zircon	Zirconium silicate	White, blue, brown, yellow, or green	Small to medium	Low to medium	6.0–7.5	4.0–4.8	Double (strong)	1.79–1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

Do., do. Ditto. XX Not applicable.

[1]Small: up to 5 carats; medium: 5 to 50 carats; large: more than 50 carats.

[2]Low: up to $25 per carat; medium: up to $200 per carat; high: more than $200 per carat.

TABLE 2
LABORATORY-CREATED GEMSTONE PRODUCTION METHODS

Gemstone	Production method	Company/producer	Date of first production
Alexandrite	Flux	Creative Crystals Inc.	1970s.
Do.	Melt pulling	J.O. Crystal Co., Inc.	1990s.
Do.	do.	Kyocera Corp.	1980s.
Do.	Zone melt	Seiko Corp.	1980s.
Cubic zirconia	Skull melt	Various producers	1970s.
Emerald	Flux	Chatham Created Gems	1930s.
Do.	do.	Gilson	1960s.
Do.	do.	Kyocera Corp.	1970s.
Do.	do.	Lennix	1980s.
Do.	do.	Russia	1980s.
Do.	do.	Seiko Corp.	1980s.
Do.	Hydrothermal	Biron Corp.	1980s.
Do.	do.	Lechleitner	1960s.
Do.	do.	Regency	1980s.
Do.	do.	Russia	1980s.
Ruby	Flux	Chatham Created Gems	1950s.
Do.	do.	Douras	1990s.
Do.	do.	J.O. Crystal Co., Inc.	1980s.
Do.	do.	Kashan Created Ruby	1960s.
Do.	Melt pulling	Kyocera Corp.	1970s.
Do.	Verneuil	Various producers	1900s.
Do.	Zone melt	Seiko Corp.	1980s.
Sapphire	Flux	Chatham Created Gems	1970s.
Do.	Melt pulling	Kyocera Corp.	1980s.
Do.	Verneuil	Various producers	1900s.
Do.	Zone melt	Seiko Corp.	1980s.
Star ruby	Melt pulling	Kyocera Corp.	1980s.
Do.	do.	Nakazumi Earth Crystals Co.	1980s.
Do.	Verneuil	Linde Air Products Co.	1940s.
Star sapphire	do.	Linde Air Products Co.	1940s.

Do., do. Ditto.

TABLE 3

VALUE OF U.S. GEMSTONE PRODUCTION, BY TYPE[1]

(Thousand dollars)

Gem materials	2006	2007
Beryl	21	18
Coral, all types	106	150
Diamond	(2)	(2)
Garnet	44	67
Gem feldspar	1,190	1,330
Geode/nodules	47	53
Opal	380	328
Quartz:		
Macrocrystalline[3]	228	215
Cryptocrystalline[4]	147	300
Sapphire/ruby	198	283
Shell	3,270	3,370
Topaz	(2)	(2)
Tourmaline	55	59
Turquoise	202	475
Other	5,450 r	5,260
Total	11,300	11,900

[r]Revised.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Included with "Other."

[3]Macrocrystalline quartz (crystals recognizable with the naked eye) includes amethyst, amethyst quartz, aventurine, blue quartz, citrine, hawk's eye, pasiolite, prase, quartz cat's eye, rock crystal, rose quartz, smoky quartz, and tiger's eye.

[4]Cryptocrystalline (microscopically small crystals) includes agate, carnelian, chalcedony, chrysoprase, fossilized wood, heliotrope, jasper, moss agate, onyx, and sard.

TABLE 4

PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY IN 2007[1]

Carat weight	Description, color[2]	Clarity[3] (GIA terms)	Representative prices		
			January[4]	June[5]	December[6]
0.25	G	VS1	$1,300	$1,300	$1,495
Do.	G	VS2	1,200	1,200	1,350
Do.	G	SI1	1,100	1,100	1,200
Do.	H	VS1	1,150	1,150	1,400
Do.	H	VS2	1,050	1,050	1,300
Do.	H	SI1	1,000	1,000	1,070
0.50	G	VS1	3,200	3,200	3,200
Do.	G	VS2	2,800	2,800	2,800
Do.	G	SI1	2,400	2,400	2,400
Do.	H	VS1	2,800	2,800	2,800
Do.	H	VS2	2,400	2,400	2,400
Do.	H	SI1	2,200	2,200	2,200
0.75	G	VS1	3,800	3,800	3,800
Do.	G	VS2	3,600	3,600	3,600
Do.	G	SI1	3,300	3,300	3,300
Do.	H	VS1	3,500	3,500	3,500
Do.	H	VS2	3,300	3,300	3,300
Do.	H	SI1	3,000	3,000	3,000
1.00	G	VS1	6,500	6,500	6,500
Do.	G	VS2	6,100	6,100	6,100
Do.	G	SI1	5,000	5,000	5,000
Do.	H	VS1	5,500	5,500	5,500
Do.	H	VS2	5,300	5,300	5,300
Do.	H	SI1	4,600	4,600	4,600

Do.Ditto.

[1]Data are rounded to no more than three significant digits.

[2]Gemological Institute of America (GIA) color grades: D-colorless; E-rare white; G, H, I-traces of color.

[3]Clarity: IF—no blemishes; VVS1—very, very slightly included; VS1—very slightly included; VS2—very slightly included, but not visible; SI1—slightly included.

[4]Source: Jewelers' Circular Keystone, v. 178, no. 2, February 2007, p. 127.

[5]Source: Jewelers' Circular Keystone, v. 178, no. 7, July 2007, p. 157.

[6]Source: Jewelers' Circular Keystone, v. 179, no. 1, January 2008, p. 139.

TABLE 5
PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES IN 2007

Gemstone	Price range per carat	
	January[1]	December[2]
Amethyst	$7–$15	$7–$15
Blue sapphire	700–1,375	700–1,375
Blue topaz	5–10	5–10
Emerald	2,400–4,000	2,400–4,000
Green tourmaline	45–60	45–60
Cultured saltwater pearl[3]	5	5
Pink tourmaline	60–125	60–125
Rhodolite garnet	18–30	18–30
Ruby	1,725–2,000	1,725–2,000
Tanzanite	300–450	300–450

[1]Source: The Guide, spring/summer 2007, p. 22, 37, 51, 65, 74, 85, 96, 98, 104, and 119. These figures are approximate current wholesale purchase prices paid by retail jewelers on a per stone basis for 1 to <2 carat, fine-quality stones.

[2]Source: The Guide, fall/winter 2007-2008, p. 22, 37, 51, 65, 74, 85, 96, 98, 104, and 119. These figures are approximate current wholesale purchase prices paid by retail jewelers on a per stone basis for 1 to <2 carat, fine-quality stones.

[3]Prices are per 4.5 to 5-millimeter pearl.

TABLE 6

U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY[1]

	2006		2007	
Country	Quantity (carats)	Value[2] (millions)	Quantity (carats)	Value[2] (millions)
Exports:				
Australia	50,100	$19	65,000	$18
Belgium	2,480,000	725	3,510,000	891
Canada	82,900	90	82,400	81
Costa Rica	67,700	7	82,200	7
France	189,000	64	192,000	168
Hong Kong	1,620,000	419	1,460,000	529
India	706,000	232	714,000	502
Israel	3,820,000	1,700	4,500,000	2,390
Japan	74,900	43	131,000	46
Mexico	864,000	129	907,000	128
Netherlands	27,600	6	9,790	2
Netherlands Antilles	15,500	51	14,900	43
Singapore	83,300	14	125,000	18
South Africa	32,000	13	48,400	12
Switzerland	142,000	129	203,000	149
Taiwan	21,800	4	34,400	6
Thailand	121,000	34	177,000	49
United Arab Emirates	226,000	61	287,000	107
United Kingdom	88,600	66	146,000	52
Other	220,000	74	225,000	105
Total	10,900,000	3,890	12,900,000	5,310
Reexports:				
Armenia	54,300	5	4,760	(3)
Australia	16,500	6	30,200	9
Belgium	4,340,000	1,070	4,540,000	1,260
Canada	260,000	162	241,000	155
Dominican Republic	107,000	15	48,700	6
France	11,500	1	11,200	2
Guatemala	96,800	10	89,000	9
Hong Kong	3,470,000	771	3,900,000	1,030
India	1,910,000	369	2,080,000	511
Israel	8,770,000	2,310	9,700,000	2,470
Japan	91,700	23	125,000	37
Malaysia	28,100	6	37,000	3
Mexico	31,500	7	33,700	5
Singapore	173,000	37	199,000	26
South Africa	396,000	55	86,400	62
Switzerland	453,000	345	519,000	523
Thailand	243,000	62	205,000	39
United Arab Emirates	513,000	131	671,000	112
United Kingdom	525,000	213	513,000	186
Other	176,000	58	184,000	70
Total	21,700,000	5,660	23,200,000	6,510
Grand total	32,600,000	9,540	36,100,000	11,800

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY[1]

Kind, range, and country of origin	2006 Quantity (carats)	2006 Value[2] (millions)	2007 Quantity (carats)	2007 Value[2] (millions)
Rough or uncut, natural:[3]				
Angola	42,600	$34	8,850	$43
Australia	1,350	1	228	1
Botswana	172,000	162	207,000	126
Brazil	5,840	5	31,100	5
Canada	45,300	41	45,200	56
Congo (Kinshasa)	45,800	66	37,400	147
Ghana	38,700	1	7,480	1
Guyana	24,500	3	3,890	1
India	12,300	1	228,000	1
Namibia	4,050	2	6,530	1
Russia	443,000	27	551,000	31
South Africa	332,000	384	213,000	360
Other	31,900	74	26,000	75
Total	1,200,000	801	1,370,000	848
Cut but unset, not more than 0.5 carat:				
Belgium	526,000	203	494,000	203
Canada	10,500	14	8,350	9
China	62,600	16	68,300	35
Dominican Republic	64,200	6	60,500	5
Hong Kong	390,000	70	132,000	33
India	8,560,000	1,780	7,390,000	1,660
Israel	843,000	426	696,000	380
Mauritius	5,370	11	6,540	13
Mexico	453,000	58	407,000	57
Singapore	979	1	631	1
South Africa	3,350	2	4,350	2
Switzerland	53,800	25	1,750	1
Thailand	102,000	21	105,000	25
United Arab Emirates	131,000	35	122,000	25
Other	65,000	26	39,900	16
Total	11,300,000	2,690	9,540,000	2,460
Cut but unset, more than 0.5 carat:				
Belgium	1,120,000	2,600	982,000	2,800
Canada	18,800	66	14,700	51
Hong Kong	65,600	154	31,000	87
India	1,390,000	1,480	1,690,000	2,030
Israel	2,870,000	8,140	2,850,000	9,100
Mexico	9,480	1	39,900	6
Russia	53,600	132	73,200	184
South Africa	78,200	559	84,900	712
Switzerland	11,000	191	12,800	238
Thailand	16,900	24	15,800	19
United Arab Emirates	82,500	111	53,600	78
Other	83,000	298	100	352
Total	5,790,000	13,800	5,840,000	15,700

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Includes some natural advanced diamond.

Source: U.S. Census Bureau.

TABLE 8

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

Kind and country	2006 Quantity (carats)	2006 Value[2] (millions)	2007 Quantity (carats)	2007 Value[2] (millions)
Emerald:				
Argentina	--	--	--	--
Belgium	137,000	$1	1,310	$1
Brazil	206,000	8	1,090,000	6
Canada	993	(3)	2,200	1.0
China	5,000	(3)	25,900	1.0
Colombia	1,020,000	86	918,000	120
France	1,020	2	1,020	1
Germany	12,400	2	49,300	2
Hong Kong	439,000	5	161,000	8
India	1,450,000	19	1,210,000	22
Israel	138,000	22	135,000	32
Italy	7,590	3	3,870	2
Namibia	--	--	--	--
Switzerland	28,200	19	6,690	8
Thailand	420,000	7	612,000	14
United Kingdom	1,320	1	771	2
Other	37,400	(3)	66	4
Total	3,910,000	175	4,220,000	218
Ruby:				
Belgium	1,760	1	6,640	1
China	17,000	(3)	2,930	1
Dominican Republic	15,700	(3)	2,340	(3)
France	2,840	4	2,580	1
Germany	9,590	2	21,100	2
Hong Kong	129,000	6	181,000	3
India	1,930,000	3	2,100,000	6
Israel	4,810	1	7,760	1
Italy	3,280	1	1,010	3
Kenya	2,000	(3)	9,550	1
Sri Lanka	2,120	1	4,300	1
Switzerland	15,000	12	9,710	23
Thailand	1,510,000	53	2,380,000	70
United Arab Emirates	2,220	(3)	157,000	1
Other	24,600	3	66,400	3
Total	3,680,000	87	4,960,000	114
Sapphire:				
Australia	2,100	(3)	4,460	2
Austria	3,060	(3)	32,800	1
Belgium	2,860	1	3,910	1
China	35,000	(3)	311,000	1
Dominican Republic	44,300	(3)	3,670	(3)
Germany	119,000	3	65,100	3
Hong Kong	336,000	9	255,000	7
India	1,680,000	5	1,740,000	7
Israel	26,700	2	23,800	3
Italy	2,860	(3)	3,650	1
Singapore	2,840	(3)	3,630	(3)
Sri Lanka	363,000	49	378,000	50
Switzerland	43,200	10	21,800	21
Thailand	4,150,000	75	3,740,000	76
United Arab Emirates	6,130	$1	4,460	$1

See footnotes at end of table.

TABLE 8—Continued

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

	2006		2007	
Kind and country	Quantity (carats)	Value[2] (millions)	Quantity (carats)	Value[2] (millions)
Sapphire—Continued:				
United Kingdom	4,220	1	9,310	2
Other	39,500	6	63,500	6
Total	6,860,000	162	6,670,000	177
Other:				
Rough, uncut:				
Australia	NA	5	NA	4
Brazil	NA	11	NA	11
Canada	NA	4	NA	3
China	NA	4	NA	4
Colombia	NA	2	NA	3
Czech Republic	NA	2	NA	2
Germany	NA	1	NA	1
India	NA	7	NA	3
Japan	NA	1	NA	1
Mexico	NA	(3)	NA	(3)
Netherlands	NA	(3)	NA	(3)
Pakistan	NA	2	NA	(3)
South Africa	NA	(3)	NA	(3)
Tanzania	NA	1	NA	2
United Kingdom	NA	(3)	NA	(3)
Other	NA	13	NA	5
Total	NA	52	NA	39
Cut, set and unset:				
Australia	NA	13	NA	14
Austria	NA	2	NA	4
Brazil	NA	18	NA	18
Canada	NA	1	NA	1
China	NA	71	NA	55
France	NA	4	NA	2
Germany	NA	44	NA	40
Hong Kong	NA	50	NA	48
India	NA	86	NA	97
Israel	NA	6	NA	5
Italy	NA	1	NA	1
South Africa	NA	3	NA	7
Sri Lanka	NA	11	NA	10
Switzerland	NA	13	NA	4
Taiwan	NA	2	NA	2
Tanzania	NA	6	NA	7
Thailand	NA	57	NA	74
United Arab Emirates	NA	1	NA	1
United Kingdom	NA	2	NA	1
Other	NA	14	NA	11
Total	NA	405	NA	402

See footnotes at end of table.

TABLE 8—Continued

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

NA Not available. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 9
VALUE OF U.S. IMPORTS OF LABORATORY-CREATED
AND IMITATION GEMSTONES, BY COUNTRY[1, 2]

(Thousand dollars)

Country	2006	2007
Laboratory-created, cut but unset:		
Austria	882	3,420
Brazil	361	353
Canada	124	158
China	14,900	12,800
Cyprus	(3)	--
Czech Republic	112	107
France	354	272
Germany	12,700	12,800
Hong Kong	1,830	1,530
India	1,000	1,190
Ireland	(3)	--
Italy	51	35
Japan	75	176
Korea, Republic of	468	368
Netherlands	436	119
South Africa	(3)	7
Sri Lanka	2,210	3,260
Switzerland	4,550	989
Taiwan	197	187
Thailand	778	885
United Arab Emirates	60	83
Other	1,170	2,530
Total	42,300	41,300
Imitation:[4]		
Austria	72,600	72,400
Brazil	12	18
China	3,850	3,090
Czech Republic	9,250	8,510
France	118	8
Germany	1,760	1,260
Hong Kong	250	104
India	434	142
Italy	214	262
Japan	269	10
Korea, Republic of	689	439
Philippines	(3)	--
Russia	7	5
Spain	170	--
Taiwan	66	7
Thailand	49	15
United Kingdom	139	4
Other	135	305
Total	90,100	86,600

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Less than ½ unit.

[4]Includes pearls.

Source: U.S. Census Bureau.

TABLE 10

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES[1]

(Thousand carats and thousand dollars)

Stones	2006		2007	
	Quantity	Value[2]	Quantity	Value[2]
Diamonds:				
Rough or uncut	1,200	801,000	1,370,000	848,000
Cut but unset	17,100	16,400,000	15,400	18,100,000
Emeralds, cut but unset	3,910	175,000	4,220	218,000
Coral and similar materials, unworked	5,600	24,900	6,300	16,800
Rubies and sapphires, cut but unset	10,500	249,000	11,600	291,000
Pearls:				
Natural	NA	23,600	NA	23,100
Cultured	NA	44,300	NA	55,200
Imitation	NA	4,100	NA	4,280
Other precious and semiprecious stones:				
Rough, uncut	2,270,000	31,400	1,260,000	26,400
Cut, set and unset	NA	363,000	NA	361,000
Other	NA	9,250	NA	9,510
Laboratory-created:				
Cut but unset	194,000	42,300	163,000	41,300
Other	NA	11,400	NA	11,400
Imitation gemstone[3]	NA	90,100	NA	86,600
Total	XX	18,300,000	XX	20,100,000

NA Not available. XX Not applicable.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Does not include pearls.

Source: U.S. Census Bureau.

TABLE 11

NATURAL DIAMOND: WORLD PRODUCTION, BY COUNTRY AND TYPE[1, 2, 3]

(Thousand carats)

Country and type[4]	2003	2004	2005	2006	2007
Gemstones:					
Angola[e]	5,130	5,490	6,400 r	8,300 r	8,700
Australia	13,981	6,058	8,577	7,305	231
Botswana[e]	22,800	23,300	23,900	24,000	25,000
Brazil[e]	400	300 [5]	300	300	300
Canada	10,756	12,618	12,314 r	13,278 r	17,998
Central African Republic[e]	250	263	300 r	340 r	370
China[e]	100	100	100	100	100
Congo (Kinshasa)	5,400 r	5,900 r	7,000 r	5,700 e	5,400
Côte d'Ivoire[e]	154 [5]	201	210 r	210 r	210
Ghana	724	725	810 r	780	720
Guinea	500	555	440 r	380 r	815 e
Guyana	413	445	357 e	341 e	350
Liberia[e]	26	7	7	7	13
Namibia	1,481	2,004	1,902	2,400 e	2,200
Russia[e]	20,000	23,700 r	23,000	23,400	23,300
Sierra Leone[e]	233	318	395	360 e	360
South Africa[e]	5,144 [5]	5,800	6,400	6,100 r	6,100
Tanzania[e]	201 [5]	258	185	230 r	230
Venezuela[e]	11 [5]	40	46	45	45
Other[6]	145	335 r	262 r	223 r	152
Total	87,800	88,400 r	92,900 r	93,800 r	92,600
Industrial:					
Angola[e]	570	610	680 r	880 r	970
Australia	17,087	18,172	25,730	21,915	18,960
Botswana[e]	7,600	7,800	8,000	8,000	8,000
Brazil[e]	600	600	600	600	600
Central African Republic[e]	83	88	80 r	85 r	47
China[e]	955	960	960	965	970
Congo (Kinshasa)	21,600	23,600 r	28,200 r	22,800 r	21,800
Côte d'Ivoire[e]	76 [5]	99	90 r	90 r	90
Ghana[e]	180	180	200 r	190	180
Guinea	167	185	100 r	95 r	200 e
Liberia[e]	14	4	4	4	9
Russia[e]	13,000	15,200 r	15,000	15,000	15,000
Sierra Leone	274 e	374 e	274	252	240
South Africa[e]	7,540 [5]	8,500	9,400	9,100 r	9,100
Tanzania[e]	36	46	35	42 r	40
Venezuela[e]	24 [5]	60	69	70	70
Other[7]	112 r	191 r	990 r	163 r	463
Total	69,900	76,700	90,400 r	80,300 r	76,700
Grand total	158,000	165,000 r	183,000 r	174,000 r	169,000

[e]Estimated. [r]Revised.

[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through May 22, 2008.

[3]In addition to the countries listed, Nigeria and the Republic of Korea produce natural diamond and synthetic diamond, respectively, but information is inadequate to formulate reliable estimates of output levels.

[4]Includes near-gem and cheap-gem qualities.

[5]Reported figure.

[6]Includes Cameroon, Congo (Brazzaville), Gabon (unspecified), India, Indonesia, Togo (unspecified), and Zimbabwe.

[7]Includes Congo (Brazzaville), India, Indonesia, and Zimbabwe.

2008 Minerals Yearbook

GEMSTONES [ADVANCE RELEASE]

U.S. Department of the Interior
U.S. Geological Survey

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Gemstones

By Donald W. Olson

Domestic survey data and tables were prepared by Connie Lopez, statistical assistant, and the world production table was prepared by Glenn J. Wallace, international data coordinator.

In 2008, the estimated value of natural gemstones produced in the United States was more than $11.5 million, and the estimated value of U.S. laboratory-created gemstone production was more than $51.4 million. The total estimated value of U.S. gemstone production was almost $62.9 million. The value of U.S. gemstone imports was $20.9 billion, and the value of combined U.S. gemstone exports and reexports was estimated to be $15.3 billion.

In this report, the terms "gem" and "gemstone" mean any mineral or organic material (such as amber, pearl, petrified wood, and shell) used for personal adornment, display, or object of art because it possesses beauty, durability, and rarity. Of more than 4,000 mineral species, only about 100 possess all these attributes and are considered to be gemstones. Silicates other than quartz are the largest group of gemstones in terms of chemical composition; oxides and quartz are the second largest (table 1). Gemstones are subdivided into diamond and colored gemstones, which in this report designates all natural nondiamond gems. In addition, laboratory-created gemstones, cultured pearls, and gemstone simulants are discussed but are treated separately from natural gemstones (table 2). Trade data in this report are from the U.S. Census Bureau. All percentages in the report were computed using unrounded data. Current information on industrial-grade diamond and industrial-grade garnet can be found in the U.S. Geological Survey (USGS) Minerals Yearbook, volume I, Metals and Minerals chapters on industrial diamond and industrial garnet, respectively.

Gemstones have fascinated humans since prehistoric times. They have been valued as treasured objects throughout history by all societies in all parts of the world. Amber, amethyst, coral, diamond, emerald, garnet, jade, jasper, lapis lazuli, pearl, rock crystal, ruby, serpentine, and turquoise are some of the first stones known to have been used for making jewelry. These stones served as symbols of wealth and power. Today, gems are worn more for pleasure or in appreciation of their beauty than to demonstrate wealth. In addition to jewelry, gemstones are used for collections, decorative art objects, and exhibits.

Legislation and Government Programs

Congress has authorized the sale of all diamond in the National Defense Stockpile (NDS), which is managed by the Defense National Stockpile Center (DNSC), Defense Logistics Agency. Many of the industrial diamond stones in the NDS were determined to be lower gemstone quality diamonds during an evaluation of the stockpiled diamonds that was conducted in the mid-1990s. The entire remaining inventory of the stockpiled diamond stones was authorized for sale in the NDS's fiscal year 2008 annual plan. This was accomplished in one sale that was held in July in which 473,000 carats of diamond were sold for $8.22 million (Lough, 2008). At yearend 2008, the DNSC reported no remaining inventory of industrial diamond stone in the NDS.

Most U.S. producers of laboratory-created or synthetic gemstones prefer calling their gems "cultured" rather than laboratory-created, referring to the fact that the gems are grown much like a cultured pearl is grown. The Jewelers Vigilance Committee along with 10 other jewelry industry trade associations filed a petition with the Federal Trade Commission (FTC) in December 2006, requesting the Guides for the Jewelry, Precious Metals, and Pewter Industries be amended to prohibit the use of the term "cultured" to describe these laboratory-created gemstones. It was the position of the trade associations that the term was deceptive, misleading, and unfair. However, the FTC denied the petition by unanimous vote in July 2008 (Federal Trade Commission, 2008).

In December 2007, both houses of the U.S. Congress passed the Burma Jade Act of 2008, and it was signed into law by the President on July 29, 2008. The Act became Public Law 110–286 (122 Stat. 2632), which imposes sanctions to prohibit the U.S. importation of gemstones (specifically rubies and jadeite) and hardwoods from Burma (Myanmar). This Act was to promote a coordinated international effort to restore civilian democratic rule to Burma. The Act did not prevent the export of Burmese gems from the United States nor did it prevent U.S. sales of Burmese gems already in the United States (JCK Online, 2008; U.S. Congress, 2008).

Production

U.S. gemstone production data were based on a survey of more than 230 domestic gemstone producers conducted by the USGS. The survey provided a foundation for projecting the scope and level of domestic gemstone production during the year. However, the USGS survey did not represent all gemstone activity in the United States, which includes thousands of professional and amateur collectors. Consequently, the USGS supplemented its survey with estimates of domestic gemstone production from related published data, contacts with gemstone dealers and collectors, and information gathered at gem and mineral shows.

Commercial mining of gemstones has never been extensive in the United States. More than 60 varieties of gemstones have been produced commercially from domestic mines, but most of the deposits are relatively small compared with those of other mining operations. In the United States, much of the current gemstone mining is conducted by individual collectors, gem clubs, and hobbyists rather than by businesses.

The commercial gemstone industry in the United States consists of individuals and companies that mine gemstones or harvest shell and pearl, firms that manufacture laboratory-created gemstones, and individuals and companies that cut and polish natural and laboratory-created gemstones. The domestic gemstone industry is focused on the production of colored gemstones and on the cutting and polishing of large diamond stones. Industry employment is estimated to range from 1,000 to 1,500 workers (U.S. International Trade Commission, 1997, p. 1).

Most natural gemstone producers in the United States are small businesses that are widely dispersed and operate independently. The small producers probably have an average of less than three employees, including those who only work part time. The number of gemstone mines operating from year to year fluctuates because the uncertainty associated with the discovery and marketing of gem-quality minerals makes it difficult to obtain financing for developing and sustaining economically viable operations (U.S. International Trade Commission, 1997, p. 23).

The total value of natural gemstones produced in the United States during 2008 was estimated to be about $11.5 million (table 3). This production value was a 4% decrease from that of 2007, owing to a 32% decrease in shell production.

Natural gemstone materials indigenous to the United States are collected, produced, and/or marketed in every State. During 2008, all 50 States produced at least $1,300 worth of gemstone materials. Nine States accounted for 80% of the total value, as reported by survey respondents. These States were, in descending order of production value, Tennessee, Arizona, Oregon, Utah, California, North Carolina, Arkansas, Idaho, and Colorado. Some States were known for the production of a single gemstone material—Tennessee for freshwater pearls, for example. Other States produced a variety of gemstones; for example, Arizona's gemstone deposits included agate, amethyst, azurite, chrysocolla, garnet, jade, jasper, malachite, obsidian, onyx, opal, peridot, petrified wood, smithsonite, and turquoise. There is also a wide variety of gemstones found and produced in California, Idaho, Montana, and North Carolina.

In 2008, the United States had only one active operation in a known diamond-bearing area in Crater of Diamonds State Park near Murfreesboro in Pike County, AR. The State of Arkansas maintains a dig-for-fee operation for tourists and rockhounds at the park; Crater of Diamonds is the only diamond mine in the world that is open to the public. The diamonds occur in a lamproite breccia tuff associated with a volcanic pipe and in the soil developed from the lamproite breccia tuff. In 2008, 946 diamond stones with an average weight of 0.204 carats were recovered at the Crater of Diamonds State Park. Of the 946 diamond stones recovered, 27 weighed more than 1 carat. Since the diamond-bearing pipe and the adjoining area became a State park in 1972, 27,827 diamond stones with a total carat weight of 5,517.25 have been recovered (Waymon Cox, park interpreter, Crater of Diamonds State Park, written commun., January 22, 2009). Exploration has demonstrated that there is about 78.5 million metric tons (Mt) of diamond-bearing rock in this diamond deposit (Howard, 1999, p. 62). An Arkansas law enacted early in 1999 prohibits commercial diamond mining in the park (Diamond Registry Bulletin, 1999).

There have been no commercially operated diamond mines in the United States since 2002. Diamond was produced at the Kelsey Lake diamond mine, located close to the Colorado-Wyoming State line near Fort Collins, CO, for several years until April 2002. The Kelsey Lake property has now been fully reclaimed.

Canadian diamond mining industry success stimulated some interest in exploration for diamond deposits in areas of the United States with similar geologic settings and terrain. The States where these areas are located are Alaska, Colorado, Minnesota, Montana, and Wyoming (Associated Press, 2002, 2004; Diamond Registry Bulletin, 2005a). Although exploration and field studies have found a number of large diamond deposits, thus far none have attracted long-term investors and have been able to open a commercially feasible mine.

In addition to natural gemstones, laboratory-created gemstones and gemstone simulants are produced in the United States. Laboratory-created or synthetic gemstones have the same chemical, optical, and physical properties as the natural gemstones. Simulants have an appearance similar to that of a natural gemstone material, but they have different chemical, optical, and physical properties. Laboratory-created gemstones that have been produced in the United States include alexandrite, diamond, emerald, garnet, moissanite, ruby, sapphire, spinel, turquoise, and zirconia. However, during 2008, only cubic zirconia, diamond, moissanite, and turquoise were produced commercially. Simulants of coral, lapis lazuli, malachite, and turquoise also are manufactured in the United States. In addition, certain colors of laboratory-created sapphire and spinel, used to represent other gemstones, are classified as simulants.

Laboratory-created gemstone production in the United States was valued at more than $51.4 million during 2008, which was a 30% decrease compared with that of 2007. This was owing to a very large decrease in laboratory-created moissanite production. The value of U.S. simulant gemstone output was estimated to be more than $100 million. Five companies in five States, representing virtually the entire U.S. laboratory-created gemstone industry, reported production to the USGS. The States with reported laboratory-created gemstone production were, in descending order of production value, North Carolina, Florida, New York, Massachusetts, and Arizona.

Since the 1950s, when scientists manufactured the first laboratory-created bits of diamond grit using a high-pressure, high-temperature (HPHT) method, this method of growing diamonds has become relatively commonplace in the world as a technology for laboratory-created diamonds, so much so that thousands of small plants throughout China were using the HPHT method and producing laboratory-created diamonds suitable for cutting as gemstones. Gem-quality diamonds of one carat or more are harder to manufacture because at that size it is difficult to consistently produce diamonds of high quality, even in the controlled environment of a lab using the HPHT method. But after 50 years of development, that situation is changing, and several laboratory-created diamond companies are producing high-quality diamonds that equal those produced from mines (Park, 2007).

Gemesis Corp. in Sarasota, FL, consistently produced gem-quality laboratory-created diamond and reported a ninth year of production in 2008. The laboratory-created diamonds are produced using equipment, expertise, and technology developed by a team of scientists from Russia and the University of Florida. The weight of the laboratory-created diamond stones ranges from 1½ to 2 carats, and most of the stones are yellow, brownish yellow, colorless, and green. Gemesis uses diamond-growing machines, each machine capable of growing 3-carat rough diamonds by generating HPHT conditions that recreate the conditions in the Earth's mantle where natural diamonds form (Davis, 2003). Gemesis could be producing as much as 30,000 to 40,000 stones each year, and annual revenues may reach $70 million to $80 million. Gemesis diamonds are available for retail purchase in jewelry stores and on the Internet, and the prices of the Gemesis laboratory-created diamonds are 30% to 50% less than those of comparable natural diamond but above the prices of simulated diamond (Gemesis Corp., 2010).

Apollo Diamond, Inc. near Boston, MA, developed and patented a method for growing extremely pure, gem-quality diamond with flawless crystal structure by chemical vapor deposition (CVD). The CVD technique transforms carbon into plasma, which is then precipitated onto a substrate as diamond. CVD has been used for more than a decade to cover large surfaces with microscopic diamond crystals, but until this process, no one had discovered the temperature, gas composition, and pressure combination that resulted in the growth of a single diamond crystal. CVD diamond precipitates as nearly 100% pure, almost flawless diamond and therefore may not be distinguishable from natural diamond by some tests (Davis, 2003). In 2007, Apollo Diamond produced laboratory-created stones that ranged from 1 to 2 carats and expected to expand to larger stones in the future. Growth of CVD diamonds is limited only by the size of the seed placed in the diamond growing chamber. Late in 2006, Apollo started selling jewelry directly to consumers through a jeweler in Boston. In 2008, the company increased its production of large stones and was selling online through an Apollo Diamond Web store. Apollo diamonds sell at costs that average 15% less than those of comparable natural diamonds (Apollo Diamond, Inc., 2008). Besides when used as gemstones, CVD diamond is most highly valued as a material for high-tech uses. CVD diamond could be used to make extremely powerful lasers; to create cellular telephones that fit into a watch and storage devices for MP3 players that could store 10,000 movies, not just 10,000 songs; to create frictionless medical replacement joints; to create windows on spacecraft; to create surgical diamond blades and scalpels; to create tweeters for audio equipment; or as coatings for cars that would not scratch or wear out. The greatest potential use for CVD diamond is in computers and other electronic devices that utilize processors (Maney, 2005; Park, 2007).

Both Apollo and Gemesis prefer to call their diamonds "cultured" rather than laboratory-created, referring to the fact that the diamonds are grown much like a cultured pearl is grown.

The Carnegie Institution of Washington Geophysical Laboratory and the University of Alabama jointly developed and patented the CVD process and apparatus to produce ½-inch-thick 10-carat single diamond crystals at very rapid growth rates (100 micrometers per hour). This faster CVD method uses microwave plasma technology and allows multiple crystals to be grown simultaneously. This size is about five times that of commercially available laboratory-created diamonds produced by HPHT methods and other CVD techniques. A researcher at the Carnegie Institution stated, "High-quality crystals over 3 carats are very difficult to produce using the conventional approach. Several groups have begun to grow diamond single crystals by CVD, but large, colorless, and flawless ones remain a challenge. Our fabrication of 10-carat, half-inch CVD diamonds is a major breakthrough" (Willis, 2004; Carnegie Institution of Washington, 2005; Science Blog, 2005). Apollo and the Carnegie Institution have noted that diamonds produced by the CVD method are harder than natural diamonds and diamonds produced by HPHT methods.

In 2008, Charles & Colvard, Ltd. in North Carolina entered its 11th year of producing and marketing moissanite, a gem-quality laboratory-created silicon carbide. Moissanite is also an excellent diamond simulant, but it is being marketed for its own gem qualities. Moissanite exhibits a higher refractive index (brilliance) and higher luster than diamond. Its hardness is between those of corundum (ruby and sapphire) and diamond, which gives it durability (Charles & Colvard, Ltd., 2007).

U.S. shell production decreased by 32% in 2008 compared with that of 2007. U.S. mussel shells are used as a source of mother-of-pearl and as seed material for culturing pearls. Pearl producers in Japan have begun using manmade seed materials or seed materials from China and other sources in addition to the stockpiled material. There also has been an increase in the popularity of darker and colored pearls and freshwater pearls that do not use U.S. seed material. In some regions of the United States, shell from mussels was being used more as a gemstone based on its own merit rather than as seed material for pearls. This shell material was being processed into mother-of-pearl and used in beads, jewelry, and watch faces.

Consumption

Although the United States accounted for little of the total global gemstone production, it was the world's leading gemstone market. It was estimated that U.S. gemstone markets accounted for more than 35% of world gemstone demand in 2008. The U.S. market for unset gem-quality diamond during the year was estimated to be about $19.7 billion, an increase of 4% compared with that of the previous year. Domestic markets for natural, unset nondiamond gemstones totaled approximately $1.12 billion in 2008, which was an 8% decrease from that of 2007.

In the United States, about two-thirds of domestic consumers designate diamond as their favorite gemstone when surveyed (Wade, 2006). The popularity of colored gemstones, colored laboratory-created gemstones, and "fancy" colored diamonds remained high in 2008, but the values of the domestic markets for almost all types of colored natural, unset nondiamond gemstones decreased from 2007 values (table 10) owing to the impact of the recession on luxury spending. Colored stone popularity also was evidenced by their share of overall gemstone sales remaining constant in 2008 (Yonick, 2008). The largest demand for colored stones was in the American and Asian colored diamond markets with strong sales of champagne, cognac, grey, black, pink, orange, and yellow stones (Diamond Registry Bulletin, 2007).

Prices

Gemstone prices are governed by many factors and qualitative characteristics, including beauty, clarity, defects, demand, durability, and rarity. Diamond pricing, in particular, is complex; values can vary significantly depending on time, place, and the subjective valuations of buyers and sellers. There are more than 14,000 categories used to assess rough diamond and more than 100,000 different combinations of carat, clarity, color, and cut values used to assess polished diamond (Pearson, 1998).

Colored gemstone prices are generally influenced by market supply and demand considerations, and diamond prices are supported by producer controls on the quantity and quality of supply. Values and prices of gemstones produced and/or sold in the United States are listed in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported, exported, or reexported are listed in tables 6 through 10.

De Beers Group companies remain a significant force affecting the price of gem-quality diamond worldwide because they mine a significant portion of the world's gem-quality diamond produced each year, and they also purchase diamonds from Russia. In 2008, De Beers companies produced 48.1 million carats, down from 2007 production of 51.1 million carats. De Beers companies also sorted and valuated a large portion (by value) of the world's annual supply of rough diamond through De Beers' subsidiary Diamond Trading Co. (DTC), which had marketing agreements with other producers. In 2008, DTC had diamond sales of $5.93 billion, which was a slight increase from diamond sales of $5.92 billion in 2007 (De Beers Group, 2008, p. 27; 2009, p. 17). There were about 200,000 diamond jewelry retail outlets worldwide. From these retail outlets, about 45% of diamond jewelry was sold in the United States, 33% in Asia, and 11% in Europe. There were an estimated 32,000 retail outlets specializing in fine jewelry in the United States. Of these jewelry-only retailers, 79% are small, independent businesses that are highly competitive in their local markets. The remaining 21% are major national and regional chains and online retailers. The estimated U.S. retail jewelry sales were $60 billion in 2008, down slightly from the prior year's sales (IDEX Magazine, 2009). The market shares by type of outlet, in descending order of value, were local independents, 21%; national and regional chains, 15%; department stores, 13%; television shopping networks, 11%; Internet auction sites, 11%; discount chains, 8%; Internet jewelry sites, 6%; and others (catalogs, boutiques, and other outlets), 15% (Profile America, Inc., 2008).

Foreign Trade

During 2008, total U.S. gemstone trade with all countries and territories was valued at about $36.2 billion, which was an increase of 11% from that of 2007. Diamond accounted for about 97% of the 2008 gemstone trade total. In 2008, U.S. exports and reexports of diamond were shipped to 76 countries and territories, and imports of all gemstones were received from 95 countries and territories (tables 6–10). In 2008, U.S. import quantities in cut diamond decreased by 16%, compared with those of 2007. U.S. imports in rough and unworked diamond decreased by 47%, owing to decreases of 45% or more in the quantities imported from Botswana, Brazil, Canada, Ghana, India, Russia, and South Africa (table 7). The United States remained the world's leading diamond importer and was a significant international diamond transit center as well as the world's leading gem-quality diamond market. In 2008, U.S. export quantities of gem-grade diamond decreased by 29% compared with those of 2007. The large volume of reexports shipped to other centers revealed the significance that the United States had in the world's diamond supply network (table 6).

Imports of laboratory-created gemstone decreased by 17% for the United States in 2008 compared with trade in 2007. Laboratory-created gemstone imports from Austria, Brazil, China, Germany, Hong Kong, India, Sri Lanka, Switzerland, and Thailand, with more than $500,000 in imports each, made up about 90% (by value) of the total domestic imports of laboratory-created gemstones during the year (table 9). Prices of certain imported laboratory-created gemstones, such as amethyst, were very competitive. The marketing of imported laboratory-created gemstones and enhanced gemstones as natural gemstones and the mixing of laboratory-created materials with natural stones in imported parcels continued to be problems for some domestic producers in 2008. There also were continuing problems with some simulants being marketed as laboratory-created gemstones during the year.

World Review

The gemstone industry worldwide has two distinct sectors—diamond mining and marketing and colored gemstone production and sales. Most diamond supplies are controlled by a few major mining companies; prices are supported by managing the quality and quantity of the gemstones relative to demand, a function performed by De Beers through DTC. Unlike diamond, colored gemstones are primarily produced at relatively small, low-cost operations with few dominant producers; prices are influenced by consumer demand and supply availability.

In 2008, world natural diamond production totaled about 159 million carats—87.0 million carats gem quality and 71.8 million carats industrial grade (table 11). Most production was concentrated in a few regions—Africa [Angola, Botswana, Congo (Kinshasa), Namibia, and South Africa], Asia (northeastern Siberia and Yakutia in Russia), Australia, North America (Northwest Territories in Canada), and South America (Brazil and Venezuela). In 2008, Russia led the world in total natural diamond output quantity (combined gemstone and industrial) with 23% of the world estimated production. Botswana was the world's leading gemstone diamond producer, followed by Russia, Canada, Angola, Congo (Kinshasa), South Africa, Guinea, and Namibia in descending order of quantity. These eight countries produced 97% (by quantity) of the world's gemstone diamond output in 2008.

In 2002, the international rough-diamond certification system, the Kimberley Process Certification Scheme (KPCS), was agreed upon by United Nations (UN) member nations, the diamond industry, and involved nongovernmental organizations. The KPCS includes the following key elements: the use of forgery-resistant certificates and tamper-proof containers for shipments of rough diamonds; internal controls and procedures that provide credible assurance that conflict diamonds do not enter the legitimate diamond market; a certification process for all exports of rough diamonds; the gathering, organizing, and sharing of import and export data on rough diamonds with other participants of relevant production; credible monitoring and oversight of the international certification scheme for rough diamonds; effective enforcement of the provisions of the certification scheme through dissuasive and proportional penalties for violations; self regulation by the diamond industry that fulfills minimum requirements; and sharing information with all other participants on relevant rules, procedures, and legislation as well as examples of national certificates used to accompany shipments of rough diamonds (Weldon, 2001). In 2008, India assumed the chair of KPCS for the period from January 1 through December 31, 2008. India was one of the founding members of the KPCS and was the sixth in succession to hold the chair after South Africa, Canada, Russia, Botswana, and the European Commission (Kimberley Process, 2008). The list of participating countries expanded to include 50 nations plus the rough diamond-trading entity of Taipei. Out of these 50 countries, Cote d' Ivoire was under UN sanctions and was not trading in rough diamonds, and Venezula had voluntarily suspended exports and imports of rough diamonds until further notice. The KPCS was implemented to solve the problem of conflict diamonds. The participating nations in the KPCS account for approximately 98% of the global production and trade of rough diamonds (Diamond Registry Bulletin, 2005b; Kimberley Process, 2009).

Globally, the value of production of natural gemstones other than diamond was estimated to be about $2 billion in 2008. Most nondiamond gemstone mines are small, low-cost, and widely dispersed operations in remote regions of developing nations. Foreign countries with major gemstone deposits other than diamond are Afghanistan (aquamarine, beryl, emerald, kunzite, lapis lazuli, ruby, and tourmaline), Australia (beryl, opal, and sapphire), Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline), Burma (beryl, jade, ruby, sapphire, and topaz), Colombia (beryl, emerald, and sapphire), Kenya (beryl, garnet, and sapphire), Madagascar (beryl, rose quartz, sapphire, and tourmaline), Mexico (agate, opal, and topaz), Sri Lanka (beryl, ruby, sapphire, and topaz), Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline), and Zambia (amethyst and beryl). In addition, pearls are cultured throughout the South Pacific and in other equatorial waters; Australia, China, French Polynesia, and Japan are key producers.

Worldwide in 2008, 18 diamond projects containing at least 1 million carats in resources were explored and developed. However, because of global economic turmoil in late 2008 and into 2009, almost all of these were undergoing review as the mining companies attempted to conserve funds and survive until the market improved (Metals Economics Group, 2009).

Botswana.—The Lerala Mine owned by DiamonEx Ltd. started mine production in October. The mine was expected to produce 330,000 carats per year. In early November, the company held its first sale of 10,600 carats. However, in January 2009, DiamonEx placed the Lerala Mine on care-and-maintenance status owing to difficult market conditions (Metals Economics Group, 2009).

Brazil.—The Duas Barras Mine, a placer mine located in Minas Gerais and wholly owned by Vaaldiam Resources Ltd., had reached commercial production level in September 2007 and completed its first diamond sale in January 2008. In 2008, Vaaldiam's production increased to 50,000 carats per year from 25,000 carats per year (Metals Economics Group, 2008).

Canada.—Canadian diamond production was 14.8 million carats during 2008, a decrease of about 14% compared with that of the previous year. Diamond exploration continued in Canada, with several commercial diamond projects and additional discoveries in Alberta, British Columbia, the Northwest Territories, Nunavut, Ontario, and Quebec. In 2008, Canadian production accounted for 9.3% of the world's combined natural gemstone and industrial diamonds.

The Ekati Diamond Mine, Canada's first operating commercial diamond mine, completed its 10th full year of production in 2008. Ekati produced 3.6 million carats of diamond from 4.43 million metric tons (Mt) of ore. BHP Billiton Ltd. has an 80% controlling ownership in Ekati, which is in the Northwest Territories. Ekati has estimated remaining reserves of 44.1 Mt of ore in kimberlite pipes that contain 23.3 million carats of diamond. BHP Billiton projected the remaining mine life to be 14 years (BHP Billiton Ltd., 2009, p. 10; Perron, 2009, p. 17.1).

The Diavik Diamond Mine, Canada's second diamond mine, also located in the Northwest Territories, completed its sixth full year of production. In 2008, Diavik produced 9.2 million carats of diamond, a decrease of 23% from the previous year's production. At yearend 2008, Diavik Diamond Mine Inc. estimated the mine's remaining proven and probable reserves to be 20 Mt of ore in kimberlite pipes containing 62 million carats of diamond and projected the total mine life to be 16 to 22 years (Diavik Diamond Mine Dialogue, 2007; Perron, 2009, p. 17.2). The mine is an unincorporated joint venture between Diavik Diamond (60%) and Harry Winston Diamond Mines Ltd. (40%). In response to the downturn in the economy in the last quarter of 2008, Diavik announced that the mine would cease production between July 14 and August 24, 2009, and be placed on a care-and-maintenance schedule (Perron, 2009, p. 17.2).

Canada's third diamond mine, the Jericho Diamond Mine, is located in Nunavut and is a wholly owned by Tahera Diamond Corp. Tahera estimated Jericho's reserves to be 2.6 Mt of ore and 3.11 million carats of diamond (Tahera Diamond Corp., 2007). The mine experienced startup problems related to ore mining and processing, and suffered financial problems owing to the cost of transporting supplies to the mine site, higher than anticipated operational costs, higher than expected oil prices, and appreciation of the Canadian dollar versus the American dollar. All these problems combined to force the company to enter into protection under Canada's Companies' Creditors Arrangement Act on January 16, 2008, and the mine suspended production on February 6. At yearend, the company was still trying to reach an agreement with its creditors. As a result, the mine's 2008 production was only 118,000 carats (Perron, 2009, p. 17.3).

The Snap Lake Mine, which is wholly owned by De Beers Canada Inc., is located in the Northwest Territories. The Snap Lake deposit is a tabular-shaped kimberlite dyke rather than the typical kimberlite pipe. The dyke is 2.7 meters thick and dips at a 15 degree angle. It is being mined using a modified room-and-pillar underground mining method. The mine started mining operations in October 2007, reached commercial production levels in the first quarter of 2008, and officially opened on June 25. The mine was expected to produce 1.4 million carats per year, and the mine life was expected to be about 20 years. De Beers announced plans to suspend production for 6 weeks in July and August 2009 to align production with market demand (Perron, 2009, p. 17.3).

The Victor Mine, which also is wholly owned by De Beers Canada, is in northern Ontario on the James Bay coast. The Victor kimberlite consists of two pipes with surface area of 15 hectares (37.1 acres). The mine initiated mining operations at the end of December 2007 and was officially opened on July 26, 2008. In 2008, the mine produced 730,000 carats valued at $307 million. The mine has 27.4 Mt of ore with average ore grade of 0.23 carat per metric ton estimated minable reserves. The open pit mine was expected to produce 600,000 carats per year, and the mine life was expected to be about 12 years. De Beers announced that the mine would suspend production for 6 weeks in July and August 2009 to align production with market demand (Perron, 2009, p. 17.3).

South Africa.—The Savanna Mine, a placer mine located in North-West, started production during the last quarter of 2008. The mine was expected to reach a production level of 18,000 carats per year. The mine is owned by Bonaparte Diamond Mines Ltd. (Metals Economics Group, 2009).

The Voorspoed Mine, located near Kroonstad, officially opened in November. The mine is 74% owned by De Beers Consolidated and 26% by Ponahalo Capital Ltd. and was expected to produce 800,000 carats per year for 12 to 16 years (Metals Economics Group, 2009).

Outlook

Historically, diamond gemstones have proven to hold their value despite wars or economic depressions (Schumann, 1998, p. 8), but this did not hold true for the worldwide economic downturn in 2008. Gemstone production, trade, market trends, and consumption demonstrated significant decreases during 2008, mostly concentrated in the last third of the year. There were no indications that this was likely to change during 2009. In 2008, total online sales rose by 7% compared with those of 2007. However, online retail jewelry sales decreased by 12% from levels of the previous year, making jewelry one of the poorer performing categories (JCK Online, 2009). These trends in U.S. gemstone markets were a reflection of the impact of the global recession on luxury spending.

Once the economy improves, Internet sales of diamonds, gemstones, and jewelry were expected to continue to grow and increase in popularity, as were other forms of e-commerce that emerge to serve the diamond and gemstone industry. This is likely to take place as the gemstone industry and its customers become more comfortable with and learn the applications of new e-commerce tools (Profile America, Inc., 2008).

Independent producers, such as Ekati and Diavik in Canada, will likely continue to bring a greater measure of competition to global markets. More competition presumably will bring more supplies and lower prices. Further consolidation of diamond producers and larger amounts of rough diamond being sold outside DTC is expected to continue as the diamond industry adjusts to De Beers' reduced influence on the industry.

More laboratory-created gemstones, simulants, and treated gemstones are likely to enter the marketplace and necessitate more transparent trade industry standards to maintain customer confidence.

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TABLE 1

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0–2.5	1.0–1.1	Single	1.54	Synthetic or pressed plastics, kaurigum	Fossil resin, color, low density, soft and trapped insects.
Apatite	Chlorocalcium phosphate	Colorless, pink, yellow, green, blue, violet	Small	Low	5.0	3.16–3.23	Double	1.63–1.65	Amblygonite, andalusite, brazilianite, precious beryl, titanite, topaz, tourmaline	Crystal habit, color, hardness, appearance.
Azurite	Copper carbonate hydroxide	Azure, dark blue, pale blue	Small to medium	do.	3.5–4.0	3.7–3.9	do.	1.72–1.85	Dumortierite, hauynite, lapis lazuli, lazulite, sodalite	Color, softness, crystal habits and associated minerals.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	do.	High	6.0–6.5	3.64–3.68	do.	1.76–1.80	Sapphire, tanzanite, blue diamond, blue tourmaline, cordierite	Strong blue in ultraviolet light.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5–8.0	2.63–2.80	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	Red	Small	Very high	7.5–8.0	2.63–2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald, natural	do.	Green	Medium	do.	7.5	2.63–2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5–8.0	2.63–2.80	do.	1.58	Genuine emerald	Lack of flaws, brilliant fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5–8.0	2.63–2.80	do.	1.58	Citrine, topaz, glass, doublets	Weak-colored.
Goshenite	do.	Colorless	do.	Low	7.5–8.0	2.63–2.80	do.	1.58	Quartz, glass, white sapphire, white topaz	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5–8.0	2.63–2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49–1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.60	do.	Banded, translucent.
Charoite	Hydrated sodium calcium hydroxi-fluoro-silicate	Lilac, violet, or white	Small to medium	do.	5.0–6.0	2.54–2.78	XX	1.55–1.56	Purple marble	Color, locality.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day light, red by artificial light	Small to medium	High	8.5	3.50–3.84	Double	1.75	Synthetic	Strong dichroism, color varies from red to green, hardness.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Chrysoberyl—Continued:										
Cat's-eye	Beryllium aluminate	Greenish to brownish	Small to large	High	8.5	3.50–3.84	Double	1.75	Synthetic, shell	Density, translucence, chatoyance.
Chrysolite	do.	Yellow, green, and/or brown	Medium	Medium	8.5	3.50–3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Chrysocolla	Hydrated copper silicate	Green, blue	Any	Low	2.0–4.0	2.0–2.4	XX	1.46–1.57	Azurite, dyed chalcedony, malachite, turquoise, variscite	Lack of crystals, color, fracture, low density and softness.
Coral	Calcium carbonate	Orange, red, white, black, purple, or green	Branching, medium	do.	3.5–4.0	2.6–2.7	Double	1.49–1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95–4.10	do.	1.78	Synthetics, including spinel, garnet	Inclusions, fluorescence.
Sapphire, blue	do.	Blue	Medium	High	9.0	3.95–4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, colorless, orange, green, or violet	Medium to large	Medium	9.0	3.95–4.10	do.	1.78	Synthetics, glass and doublets, morganite	Inclusions, double refraction, refractive index.
Sapphire or ruby, stars	do.	Red, pink, violet, blue, or gray	do.	High to low	9.0	3.95–4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.
Sapphire or ruby, synthetic	do.	Yellow, pink, or blue	Up to 20 carats	Low	9.0	3.95–4.10	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Cubic zirconia	Zirconium and yttrium oxides	Colorless, pink, blue, lavender, yellow	Small	do.	8.25–8.5	5.8	Single	2.17	Diamond, zircon, titania, moissanite	Hardness, density, lack of flaws and inclusions, refractive index.
Diamond	Carbon	White, blue-white, yellow, brown, green, red, pink, blue	Any	Very high	10.0	3.516–3.525	do.	2.42	Zircon, titania, cubic zirconia, moissanite	High index, dispersion, hardness, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green-blue	Large	Low	6.0–6.5	2.56	XX	1.52	Jade, turquoise	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play (schiller)	do.	do.	6.0–6.5	2.56	XX	1.56	do.	Do.
Moonstone	do.	Colorless, white, gray, or yellow with white, blue, or bronze schiller	do.	do.	6.0–6.5	2.77	XX	1.52–1.54	Glass, chalcedony, opal	Pale sheen, opalescent.
Sunstone	do.	Orange, red brown, colorless with gold or red glittery schiller	Small to medium	do.	6.0–6.5	2.77	XX	1.53–1.55	Aventurine, glass	Red glittery schiller.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Garnet	Complex silicate	Brown, black, yellow, green, red, or orange	Small to medium	Low to high	6.5–7.5	3.15–4.30	Single strained	1.79–1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Hematite	Iron oxide	Black, black-gray, brown-red	Medium to large	Low	5.5–6.5	5.12–5.28	XX	2.94–3.22	Davidite, cassiterite, magnetite, neptunite, pyrolusite, wolframite	Crystal habit, streak, hardness.
Jade:										
Jadeite	Complex silicate	Green, yellow, black, white, or mauve	Large	Low to very high	6.5–7.0	3.3–3.5	Crypto-crystalline	1.65–1.68	Nephrite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0–6.5	2.96–3.10	do.	1.61–1.63	Jadeite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Do.
Jet (gagate)	Lignite	Deep black, dark brown	do.	Low	2.5–4.0	1.19–1.35	XX	1.64–1.68	Anthracite, asphalt, cannel coal, onyx, schorl, glass, rubber	Luster, color.
Lapis lazuli	Sodium calcium aluminum silicate	Dark azure-blue to bright indigo blue or even a pale sky blue.	do.	do.	5.0–6.0	2.50–3.0	XX	1.50	Azurite, dumortierite, dyed howlite, lazulite, sodalite, glass	Color, crystal habit, associated minerals, luster, and localities.
Malachite	Hydrated copper carbonate	Light to black-green banded	do.	do.	3.5–4.0	3.25–4.10	XX	1.66–1.91	Brochantite, chrysoprase, opaque green gemstones	Color banding, softness, associated minerals.
Moissanite	Silicon carbide	Colorless and pale shades of green, blue, yellow	Small	Low to medium	9.25	3.21	Double	2.65–2.69	Diamond, zircon, titania, cubic zirconia	Hardness, dispersion, lack of flaws and inclusions, refractive index.
Obsidian	Amorphous, variable (usually felsic)	Black, gray, brown, dark green, white, transparent	Large	Low	5.0–5.5	2.35–2.60	XX	1.45–1.55	Aegirine-augite, gadolinite, gagate, hematite, pyrolusite, wolframite	Color, conchoidal fracture, flow bubbles, softness, and lack of crystal faces.
Opal	Hydrated silica	Reddish orange, colors flash in white gray, black, red, or yellow	do.	Low to high	5.5–6.5	1.9–2.3	Single	1.45	Glass, synthetics, triplets, chalcedony	Color play (opalescence).
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5–7.0	3.27–3.37	Double (strong)	1.65–1.69	Tourmaline, chrysoberyl	Strong double refraction, low dichroism.
Quartz:										
Agate	Silicon dioxide	Any	Large	Low	7.0	2.58–2.64	XX	XX	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Quartz—Continued:										
Amethyst	Silicon dioxide	Purple	Large	Medium	7.0	2.65–2.66	Double	1.55	Glass, plastic, fluorite	Macrocrystalline, color, refractive index, transparent, hardness.
Aventurine	do.	Green, red-brown, gold-brown, with metallic iridescent reflection	do.	Low	7.0	2.64–2.69	do.	1.54–1.55	Iridescent analcime, aventurine feldspar, emerald, aventurine glass	Macrocrystalline, color, metallic iridescent flake reflections, hardness.
Cairngorm	do.	Smoky orange or yellow	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Carnelian	do.	Flesh red to brown red	do.	do.	6.5–7.0	2.58–2.64	do.	1.53–1.54	Jasper	Cryptocrystalline, color, hardness.
Chalcedony	do.	Bluish, white, gray	do.	do.	6.5–7.0	2.58–2.64	do.	1.53–1.54	Tanzanite	Do.
Chrysoprase	do.	Green, apple-green	do.	do.	6.5–7.0	2.58–2.64	do.	1.53–1.54	Chrome chalcedony, jade, prase opal, prehnite, smithsonite, variscite, artificially colored green chalcedony	Do.
Citrine	Silica	Yellow	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Crystal:										
Rock	do.	Colorless	do.	do.	7.0	2.65–2.66	do.	1.55	Topaz, colorless sapphire	Do.
Jasper	do.	Any, striped, spotted, or sometimes uniform	do.	do.	7.0	2.58–2.66	XX	XX	do.	Cryptocrystalline, opaque, vitreous luster, hardness.
Onyx	do.	Many colors	do.	do.	7.0	2.58–2.64	XX	XX	do.	Cryptocrystalline, uniformly banded, hardness.
Petrified wood	do.	Brown, gray, red, yellow	do.	do.	6.5–7.0	2.58–2.91	Double	1.54	Agate, jasper	Color, hardness, wood grain.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Tiger's eye	do.	Golden yellow, brown, red, blue-black	do.	do.	6.5–7.0	2.58–2.64	XX	1.53–1.54	XX	Macrocrystalline, color, hardness, hatoyancy.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Rhodochrosite	Manganese carbonate	Rose-red to yellowish, stripped	Large	Low	4.0	3.45–3.7	Double	1.6–1.82	Fire opal, rhodonite, tugtupite, tourmaline	Color, crystal habit, reaction to acid, perfect rhombohedral cleavage.
Rhodonite	Manganese iron calcium silicate	Dark red, flesh red, with dendritic inclusions of black manganese oxide	do.	do.	5.5–6.5	3.40–3.74	do.	1.72–1.75	Rhodochrosite, thulite, hessonite, spinel, pyroxmangite, spessartine, tourmaline	Color, black inclusions, lack of reaction to acid, hardness.
Shell:										
Mother-of-pearl	Calcium carbonate	White, cream, green, blue-green, with iridescent play of color	Small	do.	3.5	2.6–2.85	XX	XX	Glass and plastic imitation	Luster, iridescent play of color.
Pearl	do.	White, cream to black, sometimes with hint of pink, green, purple	do.	Low to high	2.5–4.5	2.6–2.85	XX	XX	Cultured and glass or plastic imitation	Luster, iridescence, x-structure, ray.
Spinel, natural	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5–3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5–3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5–7.0	3.13–3.20	do.	1.66	Synthetic spinel	Refractive index, color, pleochroism.
Kunzite	do.	Pink to lilac	do.	do.	6.5–7.0	3.13–3.20	do.	1.66	Amethyst, morganite	Do.
Tanzanite	Complex silicate	Blue to lavender	Small	High	6.0–7.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism, color.
Topaz	do.	White, blue, green, pink, yellow, gold	Medium	Low to medium	8.0	3.4–3.6	do.	1.62	Beryl, quartz	Color, density, hardness, refractive index, perfect in basal cleavage.
Tourmaline	do.	Any, including mixed	do.	do.	7.0–7.5	2.98–3.20	do.	1.63	Peridot, beryl, garnet corundum, glass	Double refraction, color, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green with black, brown-red inclusions	Large	Low	6.0	2.60–2.83	do.	1.63	Chrysocolla, dyed howlite, dumortierite, glass, plastics, variscite	Difficult if matrix not present, matrix usually limonitic.
Unakite	Granitic rock, feldspar, epidote, quartz	Olive green, pink, and blue-gray	do.	do.	6.0–7.0	2.60–3.20	XX	XX	XX	Olive green, pink, gray-blue colors.
Zircon	Zirconium silicate	White, blue, brown, yellow, or green	Small to medium	Low to medium	6.0–7.5	4.0–4.8	Double (strong)	1.79–1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

Do., do. Ditto. XX Not applicable.

[1]Small: up to 5 carats; medium: 5 to 50 carats; large: more than 50 carats.

[2]Low: up to $25 per carat; medium: up to $200 per carat; high: more than $200 per carat.

TABLE 2

LABORATORY-CREATED GEMSTONE PRODUCTION METHODS

Gemstone	Production method	Company/producer	Date of first production
Alexandrite	Flux	Creative Crystals Inc.	1970s.
Do.	Melt pulling	J.O. Crystal Co., Inc.	1990s.
Do.	do.	Kyocera Corp.	1980s.
Do.	Zone melt	Seiko Corp.	Do.
Cubic zirconia	Skull melt	Various producers	1970s.
Emerald	Flux	Chatham Created Gems	1930s.
Do.	do.	Gilson	1960s.
Do.	do.	Kyocera Corp.	1970s.
Do.	do.	Lennix	1980s.
Do.	do.	Russia	Do.
Do.	do.	Seiko Corp.	Do.
Do.	Hydrothermal	Biron Corp.	Do.
Do.	do.	Lechleitner	1960s.
Do.	do.	Regency	1980s.
Do.	do.	Russia	Do.
Ruby	Flux	Chatham Created Gems	1950s.
Do.	do.	Douras	1990s.
Do.	do.	J.O. Crystal Co., Inc.	1980s.
Do.	do.	Kashan Created Ruby	1960s.
Do.	Melt pulling	Kyocera Corp.	1970s.
Do.	Verneuil	Various producers	1900s.
Do.	Zone melt	Seiko Corp.	1980s.
Sapphire	Flux	Chatham Created Gems	1970s.
Do.	Melt pulling	Kyocera Corp.	1980s.
Do.	Verneuil	Various producers	1900s.
Do.	Zone melt	Seiko Corp.	1980s.
Star ruby	Melt pulling	Kyocera Corp.	Do.
Do.	do.	Nakazumi Earth Crystals Co.	Do.
Do.	Verneuil	Linde Air Products Co.	1940s.
Star sapphire	do.	do.	Do.

Do., do., Ditto.

TABLE 3

VALUE OF U.S. NATURAL GEMSTONE PRODUCTION, BY TYPE[1]

(Thousand dollars)

Gem materials	2007	2008
Beryl	18	18
Coral, all types	150	150
Diamond	(2)	(2)
Garnet	67	130
Gem feldspar	1,330	916
Geode/nodules	53	91
Opal	328	357
Quartz:		
Macrocrystalline[3]	215	334
Cryptocrystalline[4]	300	344
Sapphire/ruby	283	556
Shell	3,370	2,290
Topaz	(2)	(2)
Tourmaline	59	112
Turquoise	475	508
Other	5,260	5,670
Total	11,900	11,500

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Included with "Other."

[3]Macrocrystalline quartz (crystals recognizable with the naked eye) includes amethyst, aventurine, blue quartz, citrine, hawk's eye, pasiolite, prase, quartz cat's eye, rock crystal, rose quartz, smoky quartz, and tiger's eye.

[4]Cryptocrystalline quartz (microscopically small crystals) includes agate, carnelian, chalcedony, chrysoprase, fossilized wood, heliotrope, jasper, moss agate, onyx, and sard.

TABLE 4

PRICES PER CARAT OF U.S. CUT ROUND DIAMONDS, BY SIZE AND QUALITY IN 2008

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Representative prices		
			January[3]	June[4]	December[5]
0.25	G	VS1	$1,495	$1,495	$1,495
Do.	G	VS2	1,350	1,350	1,350
Do.	G	SI1	1,200	1,200	1,200
Do.	H	VS1	1,400	1,400	1,400
Do.	H	VS2	1,300	1,300	1,300
Do.	H	SI1	1,070	1,070	1,070
0.50	G	VS1	3,200	3,200	3,200
Do.	G	VS2	2,800	2,800	2,800
Do.	G	SI1	2,400	2,400	2,400
Do.	H	VS1	2,800	2,800	2,800
Do.	H	VS2	2,400	2,400	2,400
Do.	H	SI1	2,200	2,200	2,200
1.00	G	VS1	6,500	6,500	6,500
Do.	G	VS2	6,100	6,100	6,100
Do.	G	SI1	5,000	5,000	5,000
Do.	H	VS1	5,500	5,500	5,500
Do.	H	VS2	5,300	5,300	5,300
Do.	H	SI1	4,600	4,600	4,600
2.00	G	VS1	12,300	12,300	12,300
Do.	G	VS2	10,900	10,900	10,900
Do.	G	SI1	9,400	9,400	9,400
Do.	H	VS1	10,200	10,200	10,200
Do.	H	VS2	9,400	9,400	9,400
Do.	H	SI1	7,900	7,900	7,900

Do.Ditto.

[1]Gemological Institute of America (GIA) color grades: D-colorless; E-rare white; G, H, I-traces of color.

[2]Clarity: IF—no blemishes; VVS1—very, very slightly included; VS1—very slightly included; VS2—very slightly included, but not visible; SI1—slightly included.

[3]Source: Jewelers’ Circular Keystone, v. 179, no. 2, February 2008, p. 120.

[4]Source: Jewelers’ Circular Keystone, v. 179, no. 7, July 2008, p. 64.

[5]Source: Jewelers’ Circular Keystone, v. 180, no. 1, January 2009, p. 52.

TABLE 5

PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES IN 2008

Gemstone	Price range per carat	
	January[1]	December[2]
Amethyst	$10–22	$10–22
Blue sapphire	770–1,500	825–1,650
Blue topaz	5–10	5–10
Emerald	2,400–4,000	2,400–4,000
Green tourmaline	45–60	50–70
Cultured saltwater pearl[3]	5	5
Pink tourmaline	60–125	60–135
Rhodolite garnet	20–35	20–35
Ruby	1,850–2,200	1,850–2,200
Tanzanite	300–450	300–475

[1]Source: The Guide, spring/summer 2008, p. 22, 37, 51, 65, 74, 85, 96, 98, 104, and 119. These figures are approximate current wholesale purchase prices paid by retail jewelers on a per stone basis for 1-to-less than carat, fine-quality stones.

[2]Source: The Guide, fall/winter 2008–09, p. 22, 37, 51, 65, 74, 85, 96, 98, 104, and 119. These figures are approximate current wholesale purchase prices paid by retail jewelers on a per stone basis for 1-to-less than carat, fine-quality stones.

[3]Prices are per 4.5 to 5-millimeter pearl.

TABLE 6

U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY[1]

Country	2007 Quantity (carats)	2007 Value[2] (millions)	2008 Quantity (carats)	2008 Value[2] (millions)
Exports:				
Australia	65,000	$18	103,000	$18
Belgium	3,510,000	891	1,600,000	685
Canada	82,400	81	79,700	116
Costa Rica	82,200	7	55,200	6
France	192,000	168	136,000	136
Hong Kong	1,460,000	529	1,340,000	814
India	714,000	502	1,480,000	1,220
Israel	4,500,000	2,390	2,650,000	2,130
Japan	131,000	46	54,800	12
Mexico	907,000	128	678,000	110
Netherlands	9,790	2	19,000	3
Netherlands Antilles	14,900	43	16,200	35
Singapore	125,000	18	98,500	19
South Africa	48,400	12	31,400	4
Switzerland	203,000	149	99,400	270
Taiwan	34,400	6	15,000	12
Thailand	177,000	49	226,000	54
United Arab Emirates	287,000	107	165,000	115
United Kingdom	146,000	52	121,000	84
Other	225,000	105	248,000	103
Total	12,900,000	5,310	9,210,000	5,940
Reexports:				
Armenia	4,760	(3)	13,400	(3)
Australia	30,200	9	33,800	14
Belgium	4,540,000	1,260	5,790,000	1,890
Canada	241,000	155	230,000	195
Dominican Republic	48,700	6	61,400	12
France	11,200	2	30,500	23
Guatemala	89,000	9	104,000	14
Hong Kong	3,900,000	1,030	2,680,000	1,350
India	2,080,000	511	2,250,000	482
Israel	9,700,000	2,470	10,200,000	3,400
Japan	125,000	37	178,000	39
Malaysia	37,000	3	20,100	3
Mexico	33,700	5	4,590	2
Singapore	199,000	26	190,000	22
South Africa	86,400	62	65,700	108
Switzerland	519,000	523	530,000	551
Thailand	205,000	39	152,000	26
United Arab Emirates	671,000	112	1,390,000	250
United Kingdom	513,000	186	499,000	229
Other	184,000	70	331,000	134
Total	23,200,000	6,510	24,800,000	8,750
Grand total	36,100,000	11,800	34,000,000	14,700

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY[1]

	2007		2008	
Kind, range, and country of origin	Quantity (carats)	Value[2] (millions)	Quantity (carats)	Value[2] (millions)
Rough or uncut, natural:[3]				
Angola	8,850	$43	62,300	$34
Australia	228	1	1,620	1
Botswana	207,000	126	108,000	147
Brazil	31,100	5	760	1
Canada	45,200	56	19,900	31
Congo (Kinshasa)	37,400	147	37,100	138
Ghana	7,480	1	1,400	2
Guyana	3,890	1	6,590	1
India	228,000	1	120,000	4
Namibia	6,530	1	6,550	5
Russia	551,000	31	90,200	19
South Africa	213,000	360	119,000	296
Other	26,000	75	153,000	73
Total	1,370,000	848	725,000	752
Cut but unset, not more than 0.5 carat:				
Belgium	494,000	203	295,000	118
Canada	8,350	9	10,900	13
China	68,300	36 r	110,000	34
Dominican Republic	60,500	6 r	65,800	20
Hong Kong	132,000	33	157,000	25
India	7,390,000	1,660	6,520,000	1,430
Israel	696,000	380	512,000	267
Mauritius	6,540	14 r	8,410	14
Mexico	407,000	57	52,600	10
Singapore	631	(3) r	132	(3)
South Africa	4,350	2	12,400	4
Switzerland	1,750	1	760	1
Thailand	105,000	25	72,200	21
United Arab Emirates	122,000	25	69,400	18
Other	39,900	16	71,500	24
Total	9,540,000	2,460 r	7,960,000	2,000
Cut but unset, more than 0.5 carat:				
Belgium	982,000	2,800 r	929,000	3,130
Canada	14,700	51	22,800	78
Hong Kong	31,000	87	76,800	361
India	1,690,000	2,030	1,440,000	2,450
Israel	2,850,000	9,100	2,210,000	9,120
Mexico	39,900	6	389	(3)
Russia	73,200	185 r	57,600	178
South Africa	84,900	712	55,200	759
Switzerland	12,800	238	19,200	383
Thailand	15,800	20 r	11,700	22
United Arab Emirates	53,600	79 r	33,100	124
Other	100	352	101,000	400
Total	5,840,000	15,700	4,960,000	17,000

[r]Revised.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Includes some natural advanced diamond.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN
DIAMOND, BY KIND AND COUNTRY[1]

Kind and country	2007 Quantity (carats)	2007 Value[2] (millions)	2008 Quantity (carats)	2008 Value[2] (millions)
Emerald:				
Belgium	1,310	$1	529	$2
Brazil	1,090,000	6	106,000	6
Canada	2,200	(3) r	2,830	(3)
China	25,900	(3) r	2,210	(3)
Colombia	918,000	120	530,000	155
France	1,020	1	130,000	9
Germany	49,300	2	13,800	3
Hong Kong	161,000	8	877,000	10
India	1,210,000	22	1,800,000	29
Israel	135,000	32	162,000	25
Italy	3,870	2	4,240	2
Switzerland	6,690	8	23,900	24
Thailand	612,000	14	564,000	13
United Kingdom	771	2	1,050	2
Other	66	4	83,300	17
Total	4,220,000	222 r	4,300,000	297
Ruby:				
Belgium	6,640	1	9	(3)
China	2,930	(3) r	7,360	1
Dominican Republic	2,340	(3)	994	(3)
France	2,580	1	1,210	1
Germany	21,100	2	12,400	1
Hong Kong	181,000	3	851,000	10
India	2,100,000	6	2,350,000	5
Israel	7,760	1	1,370	1
Italy	1,010	3	6,030	1
Kenya	9,550	1	(3)	(3)
Sri Lanka	4,300	1	7,260	1
Switzerland	9,710	23	10,600	11
Thailand	2,380,000	70	1,980,000	59
United Arab Emirates	157,000	(3) r	1,760	1
Other	66,400	3	43,300	8
Total	4,960,000	114	5,280,000	100
Sapphire:				
Australia	4,460	2	1,550	(3)
Austria	32,800	(3) r	124	(3)
Belgium	3,910	(3) r	110	1
China	311,000	1	269,000	2
Dominican Republic	3,670	(3)	882	(3)
Germany	65,100	3	36,200	5
Hong Kong	255,000	7	972,000	9
India	1,740,000	7	1,150,000	12
Israel	23,800	3	28,800	4
Italy	3,650	1	2,340	2
Singapore	3,630	(3)	3,630	(3)
Sri Lanka	378,000	50	316,000	46
Switzerland	21,800	21	17,800	19
Thailand	3,740,000	76	2,900,000	75

See footnotes at end of table.

TABLE 8—Continued
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

	2007		2008	
Kind and country	Quantity (carats)	Value[2] (millions)	Quantity (carats)	Value[2] (millions)
Sapphire—Continued:				
United Arab Emirates	4,460	(3) r	8,140	$5
United Kingdom	9,310	2	1,100	4
Other	63,500	6	384,000	7
Total	6,670,000	178 r	6,090,000	191
Other:				
Rough, uncut:				
Australia	NA	4	NA	3
Brazil	NA	11	NA	7
Canada	NA	3	NA	1
China	NA	4	NA	3
Colombia	NA	3	NA	1
Czech Republic	NA	2	NA	2
Germany	NA	1	NA	1
India	NA	3	NA	2
Japan	NA	1	NA	1
Pakistan	NA	2 r	NA	2
Tanzania	NA	2	NA	3
Other	NA	11	NA	16
Total	NA	47 r	NA	42
Cut, set and unset:				
Australia	NA	14	NA	15
Austria	NA	4	NA	4
Brazil	NA	18	NA	19
Canada	NA	1	NA	1
China	NA	55	NA	35
France	NA	2	NA	1
Germany	NA	40	NA	34
Hong Kong	NA	48	NA	32
India	NA	97	NA	74
Israel	NA	5	NA	8
Italy	NA	1	NA	1
South Africa	NA	7	NA	1
Sri Lanka	NA	10	NA	5
Switzerland	NA	4	NA	8
Taiwan	NA	2	NA	1
Tanzania	NA	7	NA	5
Thailand	NA	74	NA	58
United Arab Emirates	NA	1	NA	1
United Kingdom	NA	1	NA	1
Other	NA	11	NA	15
Total	NA	402	NA	319

[r]Revised. NA Not available.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 9

VALUE OF U.S. IMPORTS OF LABORATORY-CREATED

AND IMITATION GEMSTONES, BY COUNTRY[1, 2]

(Thousand dollars)

Country	2007	2008
Laboratory-created, cut but unset:		
Austria	3,420	2,330
Brazil	353	645
Canada	158	24
China	12,800	9,860
Czech Republic	107	55
France	272	298
Germany	12,800 r	12,700
Hong Kong	1,530	898
India	1,190	1,040
Italy	35	48
Japan	176	251
Korea, Republic of	368	207
Netherlands	119	5
South Africa	7	281
Sri Lanka	3,260	1,300
Switzerland	989	620
Taiwan	187	174
Thailand	885	1,330
United Arab Emirates	83	146
Other	2,530	1,960
Total	41,300	34,200
Imitation:[3]		
Austria	72,400 r	73,100
Brazil	17 r	25
China	3,090	21,000
Czech Republic	8,510	7,510
France	8	25
Germany	1,260	723
Hong Kong	104	46
India	142	83
Italy	262	148
Japan	10	58
Korea, Republic of	439	198
Russia	5	15
Taiwan	7	183
Thailand	15	10
United Kingdom	4	193
Other	305	275
Total	86,600	104,000

[r]Revised.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Includes pearls.

Source: U.S. Census Bureau.

TABLE 10

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES[1]

(Thousand carats and thousand dollars)

Stones	2007		2008	
	Quantity	Value[2]	Quantity	Value[2]
Diamonds:				
Rough or uncut	1,370,000	848,000	725,000	752,000
Cut but unset	15,500 r	18,100,000	12,900	19,000,000
Emeralds, cut but unset	4,280 r	222,000 r	4,300	297,000
Coral and similar materials, unworked	6,300	16,800	5,320	12,200
Rubies and sapphires, cut but unset	11,600	291,000	11,400	291,000
Pearls:				
Natural	NA	23,100	NA	14,100
Cultured	NA	55,200 r	NA	34,600
Imitation	NA	4,280	NA	4,190
Other precious and semiprecious stones:				
Rough, uncut	1,260,000	26,400	1,100,000	18,800
Cut, set and unset	NA	361,000	NA	285,000
Other	NA	9,510	NA	9,200
Laboratory-created:				
Cut but unset	163,000	41,300	60,300	34,200
Other	NA	11,400	NA	13,500
Imitation gemstone[3]	NA	86,600	NA	104,000
Total	XX	20,100,000	XX	20,900,000

[r]Revised. NA Not available. XX Not applicable.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Does not include pearls.

Source: U.S. Census Bureau.

TABLE 11

NATURAL DIAMOND: WORLD PRODUCTION, BY COUNTRY AND TYPE[1, 2, 3]

(Thousand carats)

Country and type[4]	2004	2005	2006	2007	2008
Gemstones:					
Angola	5,490 [e]	6,371 [r]	8,258 [r]	8,732 [r]	8,100 [e]
Australia	6,058	8,577	7,305	231	273
Botswana[e]	23,300	23,900	24,000	25,000	25,000
Brazil[e]	300 [5]	208 [r]	181 [r]	182 [r]	200 [p]
Canada	12,618	12,314	13,278	17,144 [r]	14,803 [p]
Central African Republic[e]	263	300	340	370	400
China[e]	100	100	100	100	100
Congo (Kinshasa)	5,900	7,000	5,700	5,300 [e]	5,400
Côte d'Ivoire[e]	201	210	210	210	210
Ghana	725	810	780	720 [e]	520 [e]
Guinea	555	440	380	815 [e]	2,500 [e]
Guyana	445 [r]	357 [r]	341 [r]	269 [r]	269 [p]
Namibia	2,004	1,902	2,400	2,200 [e]	1,500
Russia[e]	23,700	23,000	23,400	23,300	21,925 [5]
Sierra Leone	318	395	401 [r]	360 [e]	220 [e]
South Africa[e]	5,800	6,400	6,100	6,100	5,200
Tanzania[e]	258	185	230	239 [r]	190
Venezuela[e]	40	46	45	45	45
Zimbabwe[e]	151	160	160	100	100
Other[6]	191 [r]	109 [r]	70 [r]	65 [r]	82
Total	88,400	92,800 [r]	93,700 [r]	91,500 [r]	87,000
Industrial:					
Angola[e]	610	708 [r]	918 [r]	970	900
Australia	18,172	25,730	21,915	18,960	15,400
Botswana[e]	7,800	8,000	8,000	8,000	8,000
Brazil[e]	600	600	600	600	600
Central African Republic[e]	88	80	85	93 [r]	80
China[e]	960	960	965	970	1,000
Congo (Kinshasa)	23,600	28,200	22,800	21,300 [r]	21,600
Côte d'Ivoire[e]	99	90	90	90	90
Ghana[e]	180	200	190	180	120
Guinea	185	100	95	200 [e]	600 [e]
Russia[e]	15,200	15,000	15,000	15,000	15,000
Sierra Leone	374 [e]	274	252	240	150
South Africa[e]	8,500	9,400	9,100	9,100	7,700
Tanzania[e]	46	35	42	44 [r]	34
Venezuela[e]	60	69	70	70	70
Zimbabwe[e]	100	900	100	400	400
Other[7]	95 [r]	94 [r]	67 [r]	72 [r]	97
Total	76,700	90,400	80,300	76,300 [r]	71,800
Grand total	165,000	183,000	174,000	168,000 [r]	159,000

[e]Estimated. [p]Preliminary. [r]Revised.

[1]World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through May 19, 2009.

[3]In addition to the countries listed, Nigeria and the Republic of Korea produce natural diamond and synthetic diamond, respectively, but information is inadequate to formulate reliable estimates of output levels.

[4]Includes near-gem and cheap-gem qualities.

[5]Reported figure.

[6]Includes Cameroon, Congo (Brazzaville), Gabon (unspecified), India, Indonesia, Liberia, and Togo (unspecified).

[7]Includes Congo (Brazzaville), India, Indonesia, and Liberia.

2009 Minerals Yearbook

GEMSTONES [ADVANCE RELEASE]

U.S. Department of the Interior
U.S. Geological Survey

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Gemstones

By Donald W. Olson

Domestic survey data and tables were prepared by Connie Lopez, statistical assistant, and the world production table was prepared by Glenn J. Wallace, international data coordinator.

In 2009, the estimated value of natural gemstones produced in the United States was more than $8.41 million, and the estimated value of U.S. laboratory-created gemstone production was more than $27.2 million. The total estimated value of U.S. gemstone production was about $35.6 million. The value of U.S. gemstone imports was $13.3 billion, and the value of combined U.S. gemstone exports and reexports was estimated to be $10.5 billion.

In this report, the terms "gem" and "gemstone" mean any mineral or organic material (such as amber, pearl, petrified wood, and shell) used for personal adornment, display, or object of art because it possesses beauty, durability, and rarity. Of more than 4,000 mineral species, only about 100 possess all these attributes and are considered to be gemstones. Silicates other than quartz are the largest group of gemstones in terms of chemical composition; oxides and quartz are the second largest (table 1). Gemstones are subdivided into diamond and colored gemstones, which in this report designates all natural nondiamond gems. In addition, laboratory-created gemstones, cultured pearls, and gemstone simulants are discussed but are treated separately from natural gemstones (table 2). Trade data in this report are from the U.S. Census Bureau. All percentages in the report were computed using unrounded data. Current information on industrial-grade diamond and industrial-grade garnet can be found in the U.S. Geological Survey (USGS) Minerals Yearbook, volume I, Metals and Minerals, chapters on industrial diamond and industrial garnet, respectively.

Gemstones have fascinated humans since prehistoric times. They have been valued as treasured objects throughout history by all societies in all parts of the world. Amber, amethyst, coral, diamond, emerald, garnet, jade, jasper, lapis lazuli, pearl, rock crystal, ruby, serpentine, and turquoise are some of the first stones known to have been used for making jewelry. These stones served as symbols of wealth and power. Today, gems are worn more for pleasure or in appreciation of their beauty than to demonstrate wealth. In addition to jewelry, gemstones are used for collections, decorative art objects, and exhibits.

Legislation and Government Programs

No industrial diamond remained in the National Defense Stockpile (NDS), which is managed by the Defense National Stockpile Center (DNSC), Defense Logistics Agency. The last stocks of industrial diamond stones were completely sold during 2008 (Lough, 2008). At yearend 2009, DNSC had no plans to stockpile any inventory of industrial diamond in the NDS.

Production

U.S. gemstone production data were based on a survey of more than 230 domestic gemstone producers conducted by the USGS. The survey provided a foundation for projecting the scope and level of domestic gemstone production during the year. However, the USGS survey did not represent all gemstone activity in the United States, which includes thousands of professional and amateur collectors. Consequently, the USGS supplemented its survey with estimates of domestic gemstone production from related published data, contacts with gemstone dealers and collectors, and information gathered at gem and mineral shows.

Commercial mining of gemstones has never been extensive in the United States. More than 60 varieties of gemstones have been produced commercially from domestic mines, but most of the deposits are relatively small compared with those of other mining operations. In the United States, much of the current gemstone mining is conducted by individual collectors, gem clubs, and hobbyists rather than by businesses.

The commercial gemstone industry in the United States consists of individuals and companies that mine gemstones or harvest shell and pearl, firms that manufacture laboratory-created gemstones, and individuals and companies that cut and polish natural and laboratory-created gemstones. The domestic gemstone industry is focused on the production of colored gemstones and on the cutting and polishing of large diamond stones. Industry employment is estimated to be between 1,000 and 1,200.

Most natural gemstone producers in the United States are small businesses that are widely dispersed and operate independently. The small producers probably have an average of less than three employees, including those who only work part time. The number of gemstone mines operating from year to year fluctuates because the uncertainty associated with the discovery and marketing of gem-quality minerals makes it difficult to obtain financing for developing and sustaining economically viable operations.

The total value of natural gemstones produced in the United States during 2009 was estimated to be about $8.41 million (table 3). This production value was a 27% decrease from that of 2008, owing to a 69% decrease in shell production.

Natural gemstone materials indigenous to the United States are collected, produced, and (or) marketed in every State. During 2009, all 50 States produced at least $1,330 worth of gemstone materials. There were 10 States that accounted for 79% of the total value, as reported by survey respondents. These States were, in descending order of production value, Arizona, Oregon, Utah, California, Idaho, Colorado, Arkansas, Montana, North Carolina, and Tennessee. Some States were known for the production of a single gemstone material—Tennessee for freshwater pearls, for example. Other States produced a variety of gemstones; for example, Arizona's gemstone deposits included agate, amethyst, azurite, chrysocolla, garnet, jade, jasper, malachite, obsidian, onyx, opal, peridot, petrified wood, smithsonite, and turquoise. There was also a wide variety of gemstones found and produced in California, Idaho, Montana, and North Carolina.

In August 2009, a 310-carat emerald crystal was found at Adams Emerald Mine, Hiddenite District, North Carolina. A 64.83-carat gem, named the Carolina Emperor, was cut from the crystal. The Carolina Emperor is North America's largest faceted emerald, and its value was estimated to be more than $1.5 million. Of all emeralds found in North America, the 20 largest were found in North Carolina, and the emeralds that have been found in North Carolina are the most valuable that have been found in North America (McClatchy-Tribune News Service, 2010; Speer, 2011).

In 2009, the United States had only one active operation in a known diamond-bearing area in Crater of Diamonds State Park near Murfreesboro in Pike County, AR. The State of Arkansas maintains a dig-for-fee operation for tourists and rockhounds at the park; Crater of Diamonds is the only diamond mine in the world that is open to the public. The diamonds occur in a lamproite breccia tuff associated with a volcanic pipe and in the soil developed from the lamproite breccia tuff. In 2009, 918 diamond stones with an average weight of 0.199 carats were recovered at the Crater of Diamonds State Park. Of the 918 diamond stones recovered, 29 weighed more than 1 carat. Since the diamond-bearing pipe and the adjoining area became a State park in 1972, 28,745 diamond stones with a total carat weight of 5,700.22 have been recovered (Waymon Cox, park interpreter, Crater of Diamonds State Park, written commun., July 19, 2010). Exploration has demonstrated that there is about 78.5 million metric tons (Mt) of diamond-bearing rock in this diamond deposit (Howard, 1999, p. 62). An Arkansas law enacted early in 1999 prohibits commercial diamond mining in the park (Diamond Registry Bulletin, 1999).

No diamond mines have operated commercially in the United States since 2002. Diamond was produced at the Kelsey Lake diamond mine, located close to the Colorado-Wyoming State line near Fort Collins, CO, for several years until April 2002. The Kelsey Lake property has been fully reclaimed.

There has been some interest in exploration for diamond deposits in areas of the United States with geologic settings and terrain that are similar to Canadian diamond mining areas. These areas are in Alaska, Colorado, Minnesota, Montana, and Wyoming (Associated Press, 2002, 2004; Diamond Registry Bulletin, 2005). Even though some exploration has taken place in these States, they remain largely underexplored for diamonds (Iron Range Resources & Rehabilitation Board, 2010). Although exploration and field studies have found many diamond indicators and a number of large diamond deposits, none have attracted long-term investors or been opened as commercially feasible mines thus far.

In addition to natural gemstones, laboratory-created gemstones and gemstone simulants were produced in the United States in 2009. Laboratory-created or synthetic gemstones have the same chemical, optical, and physical properties as the natural gemstones. Simulants have an appearance similar to that of a natural gemstone material, but they have different chemical, optical, and physical properties. Laboratory-created gemstones that have been produced in the United States include alexandrite, diamond, emerald, garnet, moissanite, ruby, sapphire, spinel, turquoise, and zirconia. However, during 2009, only cubic zirconia, diamond, moissanite, and turquoise were produced commercially. Simulants of coral, lapis lazuli, malachite, and turquoise also are manufactured in the United States. In addition, certain colors of laboratory-created sapphire and spinel, used to represent other gemstones, are classified as simulants.

Laboratory-created gemstone production in the United States was valued at more than $27.2 million during 2009, which was a 47% decrease compared with that of 2008. This was owing to a very large decrease in laboratory-created moissanite production. The value of U.S. simulant gemstone output was estimated to be more than $100 million. Five companies in five States, representing virtually the entire U.S. laboratory-created gemstone industry, reported production to the USGS. The States with reported laboratory-created gemstone production were, in descending order of production value, Florida, New York, Massachusetts, North Carolina, and Arizona.

Since the 1950s, when scientists manufactured the first laboratory-created bits of diamond grit using a high-pressure, high-temperature (HPHT) method, this method of growing diamonds has become relatively commonplace in the world as a technology for laboratory-created diamonds, so much so that thousands of small plants throughout China were using the HPHT method and producing laboratory-created diamonds suitable for cutting as gemstones. Gem-quality diamonds of one carat or more are harder to manufacture because at that size it is difficult to consistently produce diamonds of high quality, even in the controlled environment of a lab using the HPHT method. After more than 50 years of development, that situation has changed, and several laboratory-created diamond companies were producing high-quality diamonds that equal those produced from mines (Park, 2007).

Gemesis Corp., Sarasota, FL, consistently produced gem-quality laboratory-created diamond and reported a 10th year of production in 2009. The laboratory-created diamonds are produced using equipment, expertise, and technology developed by a team of scientists from Russia and the University of Florida. The weight of the laboratory-created diamond stones ranges from 1½ to 2 carats, and most of the stones are yellow, brownish yellow, colorless, and green. Gemesis uses diamond-growing machines, each machine capable of growing 3-carat rough diamonds by generating HPHT conditions that recreate the conditions in the Earth's mantle where natural diamonds form (Davis, 2003). Gemesis could be producing as many as 30,000 to 40,000 stones each year, and annual revenues may reach $70 million to $80 million. Gemesis diamonds are available for retail purchase in jewelry stores and on the Internet, and the prices of the Gemesis laboratory-created diamonds are 30% to 50% less than those of comparable natural diamond but above the prices of simulated diamond (Gemesis Corp., 2010).

In the early 2000s, Apollo Diamond, Inc., near Boston, MA, developed and patented a method for growing single, extremely pure, gem-quality diamond crystals by chemical vapor deposition (CVD). The CVD technique transforms carbon into plasma, which is then precipitated onto a substrate as diamond. CVD had been used for more than a decade to cover large surfaces with microscopic diamond crystals, but in developing this process Apollo discovered the temperature, gas composition, and pressure combination that resulted in the growth of a single diamond crystal. These CVD diamonds may not be distinguishable from natural diamond by some tests (Davis, 2003). In 2007, Apollo Diamond produced laboratory-created stones that ranged from 1 to 2 carats and expected to expand to larger stones in the future. Growth of CVD diamonds is limited only by the size of the seed placed in the diamond growing chamber. In 2008, the company increased its production of large stones. Apollo diamonds sell at prices that average 15% less than those of comparable natural diamonds (Apollo Diamond, Inc., 2008). Both Apollo and Gemesis prefer to call their diamonds “cultured” rather than laboratory-created, referring to the fact that the diamonds are grown much like a cultured pearl is grown. In addition to their use as gemstones, CVD diamond could be used to make extremely powerful lasers; to create frictionless medical replacement joints; to create windows on spacecraft; to create surgical diamond blades and scalpels; or as coatings for car parts that would not scratch or wear out. The greatest potential use for CVD diamond is as a material for high-tech uses in computers and other electronic devices that utilize processors (Maney, 2005; Park, 2007).

In the mid-2000s, the Carnegie Institution of Washington Geophysical Laboratory and the University of Alabama jointly developed and patented a faster CVD process and apparatus to produce ½-inch thick 10-carat single diamond crystals using microwave plasma technology. This method has up to 100 times faster growth rates (averaging 100 micrometers per hour) than previous CVD methods and allows multiple crystals to be grown simultaneously. This crystal size is about five times that of commercially available laboratory-created diamonds produced by HPHT methods and other CVD techniques (Willis, 2004; Carnegie Institution of Washington, 2005; Science Blog, 2005). Apollo and the Carnegie Institution have noted that diamonds produced by the CVD method are harder than natural diamonds and diamonds produced by HPHT methods.

Research at the Carnegie Institution continued improving the microwave plasma CVD method, developing a process to anneal the diamonds at temperatures up to 2000 °C using a microwave plasma below atmospheric pressure. In this process, the diamond crystals, which are originally yellow-brown if produced at very high growth rates, are turned colorless or light pink. This low-pressure/high-temperature annealing process enhances the optical properties of this rapid-grown CVD single crystal diamond, and the size of the crystals that can be treated is not limited. This process is thought to produce better synthetic diamonds for high pressure devices and window materials with improved optical properties in the ultraviolet to infrared range. These high-quality, single-crystal diamonds likely will have a variety of applications in addition to their use as gems, such as using the diamond crystals as anvils in high-pressure research or optical uses that take advantage of the outstanding transparency of diamond. Another application might be in quantum computing, by utilizing vacancy centers in the diamond’s crystal lattice for storing quantum information (Carnegie Institution for Science, 2008).

In 2009, Charles & Colvard, Ltd. in North Carolina entered its 12th year as the world’s only manufacturer of moissanite, a gem-quality laboratory-created silicon carbide. Moissanite is also an excellent diamond simulant, but it is being marketed for its own gem qualities. Moissanite exhibits a higher refractive index (brilliance) and higher luster than diamond. Its hardness is between those of corundum (ruby and sapphire) and diamond, which gives it durability (Charles & Colvard, Ltd., 2010b). Charles & Colvard reported that production and sales were down in 2009 compared with those of the previous year as a result of the effects of the economic recession. However, this trend did begin to reverse in the fourth quarter and net sales increased 10% compared with net sales in the third quarter of 2009 (Charles & Colvard, Ltd., 2010a).

U.S. shell production decreased by 69% in 2009 compared with that of 2008. U.S. mussel shells are used as a source of mother-of-pearl and as seed material for culturing pearls. Pearl producers in Japan have begun using manmade seed materials or seed materials from China and other sources in addition to stockpiled material. In addition, the popularity of darker and colored pearls and freshwater pearls that do not use U.S. seed material has increased. In some regions of the United States, shell from mussels was being used more as a gemstone based on its own merit rather than as seed material for pearls. This shell material was being processed into mother-of-pearl and used in beads, jewelry, and watch faces.

Consumption

Historically, diamond gemstones have proven to hold their value despite wars or economic depressions (Schumann, 1998, p. 8), but this did not hold true during the recent worldwide economic recession. Diamond and colored gemstones value and sales decreased during the economic downturn in 2008 and continued into 2009. Gemstone production, trade, and consumption demonstrated significant decreases during 2008, mostly concentrated in the last 4 months of the year, and continued through most of 2009. U.S. gemstone consumption and sales increased in December 2009.

Although the United States accounted for little of the total global gemstone production, it was the world’s leading diamond and nondiamond gemstone market. It was estimated that U.S. gemstone markets accounted for more than 35% of world gemstone demand in 2009. The U.S. market for unset gem-quality diamond during the year was estimated to be about $12.7 billion, a decrease of 35% compared with that of 2008. Domestic markets for natural, unset nondiamond gemstones totaled approximately $779 million in 2009, which was a 30% decrease from that of 2008. These large declines in domestic markets were a reflection of the impact of the global recession on luxury spending.

In the United States, about two-thirds of domestic consumers designate diamond as their favorite gemstone when surveyed (Wade, 2006). The popularity of diamonds with domestic consumers is also evidenced by the U.S. diamond market making up 94% of the total U.S. gemstone market. Colored natural gemstones, colored laboratory-created gemstones, and "fancy" colored diamonds remained popular in 2009, but the values of the domestic markets for almost all types of colored natural, unset nondiamond gemstones decreased from the 2008 values (table 10), also owing to the impact of the recession on luxury spending. The largest demand for colored stones was in the American and Asian colored diamond markets with strong sales of champagne, cognac, grey, black, pink, orange, and yellow stones (Diamond Registry Bulletin, 2007). This trend was first evident in 2007 and has remained through the present.

There were about 200,000 diamond jewelry retail outlets worldwide in 2009. From these retail outlets, about 45% of diamond jewelry was sold in the United States, 33% in Asia, and 11% in Europe. An estimated 32,000 retail outlets specialize in fine jewelry in the United States. The estimated U.S. retail jewelry sales were $59 billion in 2009, down slightly from sales of $60 billion in 2008 (National Jeweler, 2010c). U.S. jewelry sales showed an increase of 5.6% more than that of the previous year during the 2009 holiday shopping season (National Jeweler, 2009).

Prices

Gemstone prices are governed by many factors and qualitative characteristics, including beauty, clarity, defects, demand, durability, and rarity. Diamond pricing, in particular, is complex; values can vary significantly depending on time, place, and the subjective valuations of buyers and sellers. There are more than 14,000 categories used to assess rough diamond and more than 100,000 different combinations of carat, clarity, color, and cut values used to assess polished diamond.

Colored gemstone prices are generally influenced by market supply and demand considerations, and diamond prices are supported by producer controls on the quantity and quality of supply. Values and prices of gemstones produced and (or) sold in the United States are listed in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported, exported, or reexported are listed in tables 6 through 10.

De Beers Group companies remain a significant force, influencing the price of about 40% of gem-quality diamond sales worldwide during 2009 because the companies mine a significant portion of the world's gem-quality diamond produced each year, and they also purchase diamonds from Russia. In 2009, De Beers companies produced 23.6 million carats, a 49% decrease from 2008 production. De Beers companies also sorted and valuated a large portion (by value) of the world's annual supply of rough diamond through De Beers' subsidiary Diamond Trading Co. (DTC), which had marketing agreements with other producers. In 2009, De Beers had diamond sales of $3.84 billion, which was a decrease of 44.3% from diamond sales of $6.89 billion in 2008 (De Beers Group, 2009, p. 17; 2010; National Jeweler, 2010a).

Foreign Trade

During 2009, total U.S. gemstone trade with all countries and territories was valued at about $23.8 billion, which was a decrease of 34% from that of 2008. Diamond accounted for about 94% of the 2009 gemstone trade total. In 2009, U.S. exports and reexports of diamond were shipped to 94 countries and territories, and imports of all gemstones were received from 100 countries and territories (tables 6–10). In 2009, U.S. import quantities in cut diamond decreased by 16%, compared with those of 2008. U.S. imports in rough and unworked diamond decreased by 4% (table 7). The United States remained the world's leading diamond importer and was a significant international diamond transit center as well as the world's leading gem-quality diamond market. In 2009, U.S. export quantities of gem-grade diamond decreased by 54% compared with those of 2008. The large volume of reexports shipped to other centers revealed the significance that the United States had in the world's diamond supply network (table 6). These decreases in trade were owing to the impact of the recession on luxury spending.

Import values of laboratory-created gemstone decreased by 21% for the United States in 2009 compared with those of 2008 (table 10). Again, this decrease in imports was owing to the impact of the recession on luxury spending.

Laboratory-created gemstone imports from Austria, China, Germany, India, Switzerland, and Thailand, with more than $500,000 in imports each, made up about 82% (by value) of the total domestic imports of laboratory-created gemstones during the year (table 9). The marketing of imported laboratory-created gemstones and enhanced gemstones as natural gemstones, and the mixing of laboratory-created materials with natural stones in imported parcels, continued to be problems for some domestic producers in 2009. There also were continuing problems with some simulants being marketed as laboratory-created gemstones during the year.

World Review

The gemstone industry worldwide has two distinct sectors—diamond mining and marketing and colored gemstone production and sales. Most diamond supplies are controlled by a few major mining companies; prices are supported by managing the quality and quantity of the gemstones relative to demand, a function performed by De Beers through DTC. Unlike diamond, colored gemstones are primarily produced at relatively small, low-cost operations with few dominant producers; prices are influenced by consumer demand and supply availability.

In 2009, world natural diamond production totaled about 129 million carats—74.1 million carats gem quality and 54.6 million carats industrial grade (table 11). Most production was concentrated in a few regions—Africa [Angola, Botswana, Congo (Kinshasa), Namibia, and South Africa], Asia (northeastern Siberia and Yakutia in Russia), Australia, North America (Northwest Territories in Canada), and South America (Brazil and Venezuela). In 2009, Russia led the world in total natural diamond output quantity (combined gemstone and industrial) with 25% of the world estimated production. Botswana was the world's leading gemstone diamond producer, followed by Russia, Canada, Angola, Congo (Kinshasa), Guinea, South Africa, and Namibia in descending order of quantity. These eight countries produced 96% (by quantity) of the world's gemstone diamond output in 2009.

In 2002, the international rough-diamond certification system, the Kimberley Process Certification Scheme (KPCS), was agreed upon by United Nations (UN) member nations, the diamond industry, and involved nongovernmental organizations to prevent the shipment and sale of conflict diamonds. Conflict diamonds are diamonds that originate from areas controlled by forces or factions opposed to legitimate and internationally recognized governments, and are used to fund military action in opposition to those governments, or in contravention of the decisions of the U.N. Security Council. The KPCS includes the following key elements: the use of forgery-resistant certificates and tamper-proof containers for shipments of rough diamonds; internal controls and procedures that provide credible assurance that conflict diamonds do not enter the legitimate diamond market; a certification process for all exports of rough diamonds; the gathering, organizing, and sharing of import and export data on rough diamonds with other participants of relevant production; credible monitoring and oversight of the international certification scheme for rough diamonds; effective enforcement of the provisions of the certification scheme through dissuasive and proportional penalties for violations; self regulation by the diamond industry that fulfills minimum requirements; and sharing information with all other participants on relevant rules, procedures, and legislation as well as examples of national certificates used to accompany shipments of rough diamonds (Weldon, 2001). Namibia assumed the chair of KPCS for the period from January 1 through December 31, 2009. Namibia was the seventh in succession to hold the chair after India, South Africa, Canada, Russia, Botswana, and the European Commission (Kimberley Process, 2008a; 2008b). The list of 49 participants, represented 75 nations (including the 27 member nations of the European Community) plus the rough diamond-trading entity of Taipei. During 2009, Cote d' Ivoire was under UN sanctions and was prohibited from trading in rough diamonds; and Venezula voluntarily separated from the KPCS and ceased certification for export of its rough diamonds. In 2009, the KPCS also monitored the diamond sector in Zimbabwe after a diamond rush in 2007 threatened the country's KPCS system, and there were indications of smuggling and reports of violence. The KPCS had engaged Zimbabwean authorities and were working with them to strengthen their certification scheme and help Zimbabwe meet their obligations to the KPCS. The participating nations in the KPCS account for approximately 98% of the global production and trade of rough diamonds (Kimberley Process, 2009a; 2009b).

Globally, the value of production of natural gemstones other than diamond was estimated to be about $2 billion in 2009. Most nondiamond gemstone mines are small, low-cost, and widely dispersed operations in remote regions of developing nations. Foreign countries with major gemstone deposits other than diamond are Afghanistan (aquamarine, beryl, emerald, kunzite, lapis lazuli, ruby, and tourmaline), Australia (beryl, opal, and sapphire), Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline), Burma (beryl, jade, ruby, sapphire, and topaz), Colombia (beryl, emerald, and sapphire), Kenya (beryl, garnet, and sapphire), Madagascar (beryl, rose quartz, sapphire, and tourmaline), Mexico (agate, opal, and topaz), Sri Lanka (beryl, ruby, sapphire, and topaz), Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline), and Zambia (amethyst and beryl). In addition, pearls are cultured throughout the South Pacific and in other equatorial waters; Australia, China, French Polynesia, and Japan were key producers in 2009.

Worldwide in 2009, three small diamond mines and two expansion projects started up. Three of the startups were in Russia, and two were in Guinea (Metals Economics Group, 2010, p. 14).

Burma.—Gemstone sanctions against Burma by the international community, which began in 2008, seemed to be having an effect. Total Burmese gemstone production in 2009 was reported to have decreased by 46% from that of 2008. There was not an increase in gem production in any category except for pearls. Burmese jade production decreased 18% in 2009 from that of 2008, pearl production increased by 5%, peridot production decreased by 66%, ruby decreased by 10%, sapphire decreased by 30%, and spinel decreased by 48%. Gemstone trade was down with all countries participating in the sanctions. Burmese gemstone trade with China, which was not participating in the sanctions, increased in 2009 by 10% from that of 2008. In the United States, the Burmese gemstone sanctions were brought about by the Burma Jade Act of 2008, which was enacted and reported on in the 2008 Gemstone Minerals Yearbook report (Sapora, 2010).

Canada.—Canadian diamond production was more than 10.9 million carats (Mct) with an estimated value of $1.7 billion during 2009, a decrease of about 26% compared with that of 2008. Diamond exploration continued in Canada, with several commercial diamond projects and additional discoveries in Alberta, British Columbia, the Northwest Territories, Nunavut, Ontario, and Quebec. In 2009, Canada produced 15% of the world's natural gemstone diamond output.

The Ekati Diamond Mine, Canada's first operating commercial diamond mine, completed its 11th full year of production in 2009. Ekati produced 4.2 Mct of diamond from 5.10 million metric tons (Mt) of ore. BHP Billiton Ltd. has an 80% controlling ownership in Ekati, which is in the Northwest Territories. Ekati has estimated remaining reserves of 38.5 Mt of ore in kimberlite pipes that contain 18.3 Mct of diamond. BHP Billiton projected the remaining mine life to be 13 years. Approximately 79% of the Ekati 2009 diamond production was gem-grade material (BHP Billiton Ltd., 2010, p. 10; Perron, 2011, p. 1).

The Diavik Diamond Mine, Canada's second diamond mine, also located in the Northwest Territories, completed its seventh full year of production. In 2009, Diavik produced 5.6 million carats of diamond, a decrease of 40% from the previous year's production. This lower production was a consequence of a reduced operating level at the mine intended to balance production with lower market demand that resulted from the downturn in the economy that began in mid-2008. Diavik reacted by temporarily ceasing diamond production at the Diavik Mine between July 14 and August 24, 2009. During this time period, the Diavik Mine was placed on a care-and-maintenance schedule. At yearend 2009, Diavik Diamond Mines estimated the mine's remaining proven and probable reserves to be 19.7 Mt of ore in kimberlite pipes containing 59.1 million carats of diamond and projected the total mine life to be 16 to 22 years. During 2009, Diavik began developing an underground mine, and construction on the underground project was substantially completed during 2009. First ore was expected during the first quarter of 2010, with full production expected in 2013. The mine is an unincorporated joint venture between Diavik Diamond Mines Inc. (60%) and Harry Winston Diamond Mines Ltd. (40%) (Diavik Diamond Mines Inc., 2010; Perron, 2011, p. 2).

Canada's third diamond mine, the Jericho Diamond Mine, is located in Nunavut and was owned by Tahera Diamond Corp. Tahera estimated the Jericho Diamond Mine's reserves to be about 5.5 Mt of ore grading 0.85 carats per ton. The Jericho Diamond Mine experienced startup problems related to ore mining and processing. The mine also suffered financial problems owing to the cost of transporting supplies to the mine site, higher operational costs, higher oil prices, and appreciation of the Canadian dollar versus the U.S. dollar. All of these problems combined to force the company to enter into protection under Canada's "Companies' Creditors Arrangement Act" on January 16, 2008, and the mine suspended production on February 6, 2008. As a result, the mine's 2008 production was only 118,000 carats. At yearend 2009, Tahera was finalizing arrangements to sell all its Jericho mine assets (Perron, 2011, p. 2).

The Snap Lake Mine, which is wholly owned by De Beers Canada Inc., is in the Northwest Territories. The Snap Lake deposit is a tabular-shaped kimberlite dyke rather than the typical kimberlite pipe. The dyke is 2.7 meters thick and dips at an angle of 15°. The deposit was mined using a modified room and pillar underground mining method in 2009. The Snap Lake Mine started mining operations in October 2007, reached commercial production levels in the first quarter of 2008, and officially opened June 25, 2008. The mine was expected to produce 1.4 Mct per year of diamond, and the mine life was expected to be about 20 years. De Beers suspended production for 6 weeks in July and August 2009. This production suspension was scheduled to align production levels with market demand. The mine's production for the year was 440,000 carats, for a recovered grade of 1.25 carats per ton (Perron, 2011, p. 2–3).

The Victor Mine, which also is wholly owned by De Beers Canada, is in northern Ontario on the James Bay coast. The Victor kimberlite consists of two pipes with surface area of 15 hectares (37.1 acres). The Victor Mine initiated mining operations at the end of December 2007 and officially opened on July 26, 2008. The Victor deposit reportedly holds 27.4 Mt of ore with average ore grade of 0.23 carats per ton. At full capacity, the open pit mine was expected to produce 600,000 carats per year, and the mine life was expected to be about 12 years. De Beers also suspended production at this mine for 6 weeks in July and August. In 2009, the mine's production was 696,000 carats valued at $244 million and had an average recovery grade of 0.33 carats per ton (Perron, 2011, p. 3).

China.—During 2009, China became the world's second largest diamond market, following the United States and replacing Japan. The Chinese Government reported that 2009 diamond imports were more than $1.5 billion (National Jeweler, 2010b).

Guinea.—The Mandala alluvial mine, owned by Stellar Diamonds Plc, was producing with positive cash flow at 60% of capacity by yearend 2009. During 2010, the mine's output was expected to be 140,000 carats. Stellar estimated that the deposit contains 536,000 carats of diamond in 1.41 Mt of resources, grading 0.38 carats per ton (Metals Economics Group, 2010, p. 14–15).

Another alluvial mine, Bomboko, owned by West African Diamonds Plc, had increased production to 1,500 carats per month from 35,000 tons per month of ore by October 2009. Visual inspection of stones produced indicated that about 60% was gem quality and 40% was industrial grade. West African estimated that the deposit contains 750,000 carats of diamond in 25 Mt of resources grading 0.03 carats per ton (Metals Economics Group, 2010, p. 14–15).

Russia.—In 2009, Russia was again the world's leading producer of combined natural gemstone and industrial diamonds as it has been every year since 2004. Russian natural diamond production was 32.8 Mct with an estimated value of $2.34 billion, a decrease of about 11% compared with that of the previous year (Metals Economics Group, 2011, p. 12).

The largest mine that came online in 2009 was the underground development of the Arkangelskaya pipe at the Lomonosov Mine in northwestern Russia. Lomonosov started mining the Arkangelskaya pipe in September at 1 million tons per year (Mt/yr) of ore and was estimated to have an optimum production capacity of 4 Mt/yr of ore. Lomonosov is 95% owned by ALROSA Co. Ltd. and 5% owned by the Government of Russia. Lomonosov was estimated to have 27.3 Mct of diamonds contained in 54.8 Mt of ore, grading at an estimated 0.5 carats per ton. The estimated mine life was 17 years, with materials coming from the Arkangelskaya and Karpinskogo-1 pipes (Metals Economics Group, 2010, p. 14–15).

The Mirny Division of Alrosa in Yakutia officially opened the Mir underground mine in August. The Mir was expected to yield 500,000 carats of diamonds from 1 Mt/yr of ore during a projected 50-year mine life. Alrosa had future plans for two additional underground operations parallel to Mir, that would provide an additional 4.5 Mt/yr of ore (Metals Economics Group, 2010, p. 14–15).

A third new mine owned by Alrosa was the Aikhal underground mine in Yakutia. Aikhal began commercial production in December 2009. The mine was estimated to contain 1.25 Mct of diamonds in 12.5 Mt of ore grading 0.10 carats per ton. Aikhal had an estimated 25-year mine life (Metals Economics Group, 2010, p. 14–15).

South Africa.—On September 24, 2009, a rough 507.55-carat (just more than 100 grams) white diamond was mined at the historic Cullinan Mine, where the famous Cullinan diamond (the largest diamond found in recorded history) was discovered in 1905. The Cullinan Mine is owned by Petra Diamonds Cullinan Consortium, whose spokesman said that the gemstone was among the world's 20 largest diamonds ever discovered. Initial examinations of the stone indicated that it is of exceptional color and clarity, and most likely a Type I diamond. The diamond was found with three other exceptionally valuable diamonds, a 168-carat gemstone and two other stones that weighed 58.5 and 53.3 carats. The Cullinan Mine is also the world's primary source for blue diamonds. In May 2009, a fancy vivid blue diamond weighing 7.03 carats (cut from 26.58-carat rough diamond) found at the Cullinan Mine sold for $9.4 million. This was the highest price ever paid for a gemstone sold at auction (Maclean, 2009; Reinke, 2009).

Outlook

As the domestic and global economy improves, Internet sales of diamonds, gemstones, and jewelry were expected to continue to grow and increase in popularity, as were other forms of e-commerce that emerge to serve the diamond and gemstone industry. This is likely to take place as the gemstone industry and its customers become more comfortable with and learn the applications of new e-commerce tools (Profile America, Inc., 2008).

Independent producers, such as Ekati and Diavik in Canada, will likely continue to bring a greater measure of competition to global markets. More competition presumably will bring more supplies and lower prices. Further consolidation of diamond producers and larger quantities of rough diamond being sold outside DTC is expected to continue as the diamond industry adjusts to De Beers' reduced influence on the industry.

More laboratory-created gemstones, simulants, and treated gemstones are likely to enter the marketplace and necessitate more transparent trade industry standards to maintain customer confidence.

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TABLE 1
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0–2.5	1.0–1.1	Single	1.54	Synthetic or pressed plastics, kaurigum	Fossil resin, color, low density, soft, insects.
Apatite	Chlorocalcium phosphate	Colorless, pink, yellow, green, blue, violet	Small	Low	5.0	3.16–3.23	Double	1.63–1.65	Amblygonite, andalusite, brazilianite, precious beryl, titanite, topaz, tourmaline	Crystal habit, color, hardness, appearance.
Azurite	Copper carbonate hydroxide	Azure, dark blue, pale blue	Small to medium	do.	3.5–4.0	3.7–3.9	do.	1.72–1.85	Dumortierite, hauynite, lapis lazuli, lazulite, sodalite	Color, softness, crystal habits, associated minerals.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	do.	High	6.0–6.5	3.64–3.68	do.	1.76–1.80	Sapphire, tanzanite, blue diamond, blue tourmaline, cordierite	Strong blue in ultraviolet light.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5–8.0	2.63–2.80	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	Red	Small	Very high	7.5–8.0	2.63–2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald, natural	do.	Green	Medium	do.	7.5	2.63–2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5–8.0	2.63–2.80	do.	1.58	Genuine emerald	Lack of flaws, brilliant fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5–8.0	2.63–2.80	do.	1.58	Citrine, topaz, glass, doublets	Weak-colored.
Goshenite	do.	Colorless	do.	Low	7.5–8.0	2.63–2.80	do.	1.58	Quartz, glass, white sapphire, white topaz	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5–8.0	2.63–2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49–1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.60	do.	Banded, translucent.
Charoite	Hydrated sodium calcium hydroxi-fluoro-silicate	Lilac, violet, or white	Small to medium	do.	5.0–6.0	2.54–2.78	XX	1.55–1.56	Purple marble	Color, locality.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by direct sunlight, or encandescent light, red by indirect sunlight or fluorescent light	Small to medium	High	8.5	3.50–3.84	Double	1.75	Synthetic	Strong dichroism, color varies from red to green, hardness.
Cat's eye	Beryllium aluminate	Greenish to brownish	Small to large	High	8.5	3.50–3.84	Double	1.75	Synthetic, shell	Density, translucence, chatoyance.
Chrysolite	do.	Yellow, green, and/or brown	Medium	Medium	8.5	3.50–3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Chrysocolla	Hydrated copper silicate	Green, blue	Any	Low	2.0–4.0	2.0–2.4	XX	1.46–1.57	Azurite, dyed chalcedony, malachite, turquoise, variscite	Lack of crystals, color, fracture, low density, softness.
Coral	Calcium carbonate	Orange, red, white, black, purple, or green	Branching, medium	do.	3.5–4.0	2.6–2.7	Double	1.49–1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95–4.10	do.	1.78	Synthetics, including spinel, garnet	Inclusions, fluorescence.
Sapphire, blue	do.	Blue	Medium	High	9.0	3.95–4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, colorless, orange, green, or violet	Medium to large	Medium	9.0	3.95–4.10	do.	1.78	Synthetics, glass and doublets, morganite	Inclusions, double refraction, refractive index.
Sapphire or ruby, stars	do.	Red, pink, violet, blue, or gray	do.	High to low	9.0	3.95–4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.
Sapphire or ruby, synthetic	do.	Yellow, pink, blue, green, orange, violet, or red	Up to 20 carats	Low	9.0	3.95–4.10	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Cubic zirconia	Zirconium and yttrium oxides	Colorless, pink, blue, lavender, yellow	Small	do.	8.25–8.5	5.8	Single	2.17	Diamond, zircon, titania, moissanite	Hardness, density, lack of flaws and inclusions, refractive index.
Diamond	Carbon	White, blue-white, yellow, brown, green, red, pink, blue	Any	Very high	10.0	3.516–3.525	do.	2.42	Zircon, titania, cubic zirconia, moissanite	High index, dispersion, hardness, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green-blue	Large	Low	6.0–6.5	2.56	XX	1.52	Jade, turquoise	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play (schiller)	do.	do.	6.0–6.5	2.56	XX	1.56	do.	Do.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Moonstone	do.	Colorless, white, gray, or yellow with white, blue, or bronze schiller	do.	do.	6.0–6.5	2.77	XX	1.52–1.54	Glass, chalcedony, opal	Pale sheen, opalescent.
Sunstone	do.	Orange, red brown, colorless with gold or red glittery schiller	Small to medium	do.	6.0–6.5	2.77	XX	1.53–1.55	Aventurine, glass	Red glittery schiller.
Garnet	Complex silicate	Brown, black, yellow, green, red, or orange	Small to medium	Low to high	6.5–7.5	3.15–4.30	Single strained	1.79–1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Hematite	Iron oxide	Black, black-gray, brown-red	Medium to large	Low	5.5–6.5	5.12–5.28	XX	2.94–3.22	Davidite, cassiterite, magnetite, neptunite, pyrolusite, wolframite	Crystal habit, streak, hardness.
Jade:										
Jadeite	Complex silicate	Green, yellow, black, white, or mauve	Large	Low to very high	6.5–7.0	3.3–3.5	Crypto-crystalline	1.65–1.68	Nephrite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0–6.5	2.96–3.10	do.	1.61–1.63	Jadeite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Do.
Jet (gagate)	Lignite	Deep black, dark brown	do.	Low	2.5–4.0	1.19–1.35	XX	1.64–1.68	Anthracite, asphalt, cannel coal, onyx, schorl, glass, rubber	Luster, color.
Lapis lazuli	Sodium calcium aluminum silicate	Dark azure-blue to bright indigo blue or even a pale sky blue.	do.	do.	5.0–6.0	2.50–3.0	XX	1.50	Azurite, dumortierite, dyed howlite, lazulite, sodalite, glass	Color, crystal habit, associated minerals, luster, localities.
Malachite	Hydrated copper carbonate	Light to black-green banded	do.	do.	3.5–4.0	3.25–4.10	XX	1.66–1.91	Brochantite, chrysoprase, opaque green gemstones	Color banding, softness, associated minerals.
Moissanite	Silicon carbide	Colorless and pale shades of green, blue, yellow	Small	Low to medium	9.25	3.21	Double	2.65–2.69	Diamond, zircon, titania, cubic zirconia	Hardness, dispersion, lack of flaws and inclusions, refractive index.
Obsidian	Amorphous, variable (usually felsic)	Black, gray, brown, dark green, white, transparent	Large	Low	5.0–5.5	2.35–2.60	XX	1.45–1.55	Aegirine-augite, gadolinite, gagate, hematite, pyrolusite, wolframite	Color, conchoidal fracture, flow bubbles, softness, lack of crystal faces.
Opal	Hydrated silica	Reddish orange, colors flash in white gray, black, red, or yellow	do.	Low to high	5.5–6.5	1.9–2.3	Single	1.45	Glass, synthetics, triplets, chalcedony	Color play (opalescence).

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5–7.0	3.27–3.37	Double (strong)	1.65–1.69	Tourmaline, chrysoberyl	Strong double refraction, low dichroism.
Quartz:										
Agate	Silicon dioxide	Any	Large	Low	7.0	2.58–2.64	XX	XX	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	Large	Medium	7.0	2.65–2.66	Double	1.55	Glass, plastic, fluorite	Macrocrystalline, color, refractive index, transparent, hardness.
Aventurine	do.	Green, red-brown, gold-brown, with metallic iridescent reflection	do.	Low	7.0	2.64–2.69	do.	1.54–1.55	Iridescent analcime, aventurine feldspar, emerald, aventurine glass	Macrocrystalline, color, metallic iridescent flake reflections, hardness.
Cairngorm	do.	Smoky orange or yellow	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Carnelian	do.	Flesh red to brown red	do.	do.	6.5–7.0	2.58–2.64	do.	1.53–1.54	Jasper	Cryptocrystalline, color, hardness.
Chalcedony	do.	Bluish, white, gray	do.	do.	6.5–7.0	2.58–2.64	do.	1.53–1.54	Tanzanite	Do.
Chrysoprase	do.	Green, apple-green	do.	do.	6.5–7.0	2.58–2.64	do.	1.53–1.54	Chrome chalcedony, jade, prase opal, prehnite, smithsonite, variscite, artifically colored green chalcedony	Do.
Citrine	do.	Yellow	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Jasper	do.	Any, striped, spotted, or sometimes uniform	do.	do.	7.0	2.58–2.66	XX	XX	do.	Cryptocrystalline, opaque, vitreous luster, hardness.
Onyx	do.	Many colors	do.	do.	7.0	2.58–2.64	XX	XX	do.	Cryptocrystalline, uniformly banded, hardness.
Petrified wood	do.	Brown, gray, red, yellow	do.	do.	6.5–7.0	2.58–2.91	Double	1.54	Agate, jasper	Color, hardness, wood grain.
Rock crystal	do.	Colorless	do.	do.	7.0	2.65–2.66	do.	1.55	Topaz, colorless sapphire	Do.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Rose	do.	Pink, rose red	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Tiger's eye	do.	Golden yellow, brown, red, blue-black	do.	do.	6.5–7.0	2.58–2.64	XX	1.53–1.54	XX	Macrocrystalline, color, hardness, hatoyancy.
Rhodochrosite	Manganese carbonate	Rose-red to yellowish, stripped	Large	Low	4.0	3.45–3.7	Double	1.6–1.82	Fire opal, rhodonite, tugtupite, tourmaline	Color, crystal habit, reaction to acid, perfect rhombohedral cleavage.
Rhodonite	Manganese iron calcium silicate	Dark red, flesh red, with dendritic inclusions of black manganese oxide	do.	do.	5.5–6.5	3.40–3.74	do.	1.72–1.75	Rhodochrosite, thulite, hessonite, spinel, pyroxmangite, spessartine, tourmaline	Color, black inclusions, lack of reaction to acid, hardness.
Shell:										
Mother-of-pearl	Calcium carbonate	White, cream, green, blue-green, with iridescent play of color	Small	do.	3.5	2.6–2.85	XX	XX	Glass and plastic imitation	Luster, iridescent play of color.
Pearl	do.	White, cream to black, sometimes with hint of pink, green, purple	do.	Low to high	2.5–4.5	2.6–2.85	XX	XX	Cultured and glass or plastic imitation	Luster, iridescence, x-ray of internal structure.
Spinel, natural	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5–3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5–3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5–7.0	3.13–3.20	do.	1.66	Synthetic spinel	Refractive index, color, pleochroism.
Kunzite	do.	Pink to lilac	do.	do.	6.5–7.0	3.13–3.20	do.	1.66	Amethyst, morganite	Do.
Tanzanite	Complex silicate	Blue to lavender	Small	High	6.0–7.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism, color.
Topaz	do.	White, blue, green, pink, yellow, gold	Medium	Low to medium	8.0	3.4–3.6	do.	1.62	Beryl, quartz	Color, density, hardness, refractive index, perfect in basal cleavage.
Tourmaline	do.	Any, including mixed	do.	do.	7.0–7.5	2.98–3.20	do.	1.63	Peridot, beryl, garnet corundum, glass	Double refraction, color, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green with black, brown-red inclusions	Large	Low	6.0	2.60–2.83	do.	1.63	Chrysocolla, dyed howlite, dumortierite, glass, plastics, variscite	Difficult if matrix not present, matrix usually limonitic.
Unakite	Granitic rock, feldspar, epidote, quartz	Olive green, pink, and blue-gray	do.	do.	6.0–7.0	2.60–3.20	XX	XX	XX	Olive green, pink, gray-blue colors.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Zircon	Zirconium silicate	White, blue, brown, yellow, or green	Small to medium	Low to medium	6.0–7.5	4.0–4.8	Double (strong)	1.79–1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

Do., do. Ditto. XX Not applicable.

[1]Small: up to 5 carats; medium: 5 to 50 carats; large: more than 50 carats.

[2]Low: up to $25 per carat; medium: up to $200 per carat; high: more than $200 per carat.

TABLE 2
LABORATORY-CREATED GEMSTONE PRODUCTION METHODS

Gemstone	Production method	Company/producer	Date of first production
Alexandrite	Flux	Creative Crystals Inc.	1970s.
Do.	Melt pulling	J.O. Crystal Co., Inc.	1990s.
Do.	do.	Kyocera Corp.	1980s.
Do.	Zone melt	Seiko Corp.	Do.
Cubic zirconia	Skull melt	Various producers	1970s.
Emerald	Flux	Chatham Created Gems	1930s.
Do.	do.	Gilson	1960s.
Do.	do.	Kyocera Corp.	1970s.
Do.	do.	Lennix	1980s.
Do.	do.	Russia	Do.
Do.	do.	Seiko Corp.	Do.
Do.	Hydrothermal	Biron Corp.	Do.
Do.	do.	Lechleitner	1960s.
Do.	do.	Regency	1980s.
Do.	do.	Russia	Do.
Ruby	Flux	Chatham Created Gems	1950s.
Do.	do.	Douras	1990s.
Do.	do.	J.O. Crystal Co., Inc.	1980s.
Do.	do.	Kashan Created Ruby	1960s.
Do.	Melt pulling	Kyocera Corp.	1970s.
Do.	Verneuil	Various producers	1900s.
Do.	Zone melt	Seiko Corp.	1980s.
Sapphire	Flux	Chatham Created Gems	1970s.
Do.	Melt pulling	Kyocera Corp.	1980s.
Do.	Verneuil	Various producers	1900s.
Do.	Zone melt	Seiko Corp.	1980s.
Star ruby	Melt pulling	Kyocera Corp.	Do.
Do.	do.	Nakazumi Earth Crystals Co.	Do.
Do.	Verneuil	Linde Air Products Co.	1940s.
Star sapphire	do.	do.	Do.

Do., do. Ditto.

TABLE 3
ESTIMATED VALUE OF U.S. NATURAL GEMSTONE PRODUCTION, BY GEM TYPE[1]

(Thousand dollars)

Gem materials	2008	2009
Beryl	18	18
Coral, all types	150	150
Diamond	(2)	(2)
Garnet	130	148
Gem feldspar	916	858
Geode/nodules	91	105
Opal	357	225
Quartz:		
Macrocrystalline[3]	334	231
Cryptocrystalline[4]	344	216
Sapphire/ruby	556	256
Shell	2,290	713
Topaz	(2)	(2)
Tourmaline	112	112
Turquoise	508	531
Other	5,670	4,850
Total	11,500	8,410

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Included with "Other."

[3]Macrocrystalline quartz (crystals recognizable with the naked eye) includes amethyst, aventurine, blue quartz, citrine, hawk's eye, pasiolite, prase, quartz cat's eye, rock crystal, rose quartz, smoky quartz, and tiger's eye.

[4]Cryptocrystalline quartz (microscopically small crystals) includes agate, carnelian, chalcedony, chrysoprase, fossilized wood, heliotrope, jasper, moss agate, onyx, and sard.

TABLE 4
PRICES PER CARAT OF U.S. CUT ROUND DIAMONDS, BY SIZE AND QUALITY IN 2009

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Representative prices		
			January[3]	June[4]	December[5]
0.25	G	VS1	$1,495	$1,430	$1,430
Do.	G	VS2	1,350	1,325	1,325
Do.	G	SI1	1,200	1,125	1,125
Do.	H	VS1	1,400	1,300	1,300
Do.	H	VS2	1,300	1,190	1,190
Do.	H	SI1	1,070	1,050	1,050
0.50	G	VS1	3,200	2,775	2,775
Do.	G	VS2	2,800	2,350	2,350
Do.	G	SI1	2,400	1,875	1,875
Do.	H	VS1	2,800	2,400	2,400
Do.	H	VS2	2,400	2,050	2,050
Do.	H	SI1	2,200	1,725	1,725
1.00	G	VS1	6,500	6,075	6,075
Do.	G	VS2	6,100	5,400	5,400
Do.	G	SI1	5,000	4,575	4,575
Do.	H	VS1	5,500	5,100	5,100
Do.	H	VS2	5,300	4,650	4,650
Do.	H	SI1	4,600	4,350	4,350
2.00	G	VS1	12,300	12,300	12,300
Do.	G	VS2	10,900	10,900	10,900
Do.	G	SI1	9,400	9,400	9,400
Do.	H	VS1	10,200	10,200	10,200
Do.	H	VS2	9,400	9,400	9,400
Do.	H	SI1	7,900	7,900	7,900

Do. Ditto.

[1]Gemological Institute of America (GIA) color grades: D-colorless; E-rare white; G, H, I-traces of color.

[2]Clarity: IF—no blemishes; VVS1—very, very slightly included; VS1—very slightly included; VS2—very slightly included, but not visible; SI1—slightly included.

[3]Source: Jewelers' Circular Keystone, v. 180, no. 2, February 2009, p. 59.

[4]Source: Jewelers' Circular Keystone, v. 180, no. 7, July 2009, p. 41.

[5]Source: Jewelers' Circular Keystone, v. 181, no. 1, January 2010, p. 54.

TABLE 5
PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES IN 2009

Gemstone	Price range per carat	
	January[1]	December[2]
Amethyst	$10–25	$10–25
Blue sapphire	825–1,650	900–1,650
Blue topaz	5–10	5–10
Emerald	2,400–4,000	2,400–4,000
Green tourmaline	50–70	50–70
Cultured saltwater pearl[3]	5	5
Pink tourmaline	60–135	70–150
Rhodolite garnet	20–40	20–40
Ruby	1,850–2,200	1,850–2,200
Tanzanite	300–475	300–375

[1]Source: The Gem Guide—Color, spring/summer 2009, p. 22, 37, 51, 65, 74, 85, 96, 98, 104, and 119. These figures are approximate wholesale purchase prices paid by retail jewelers on a per stone basis for 1-to-less than 1 carat, fine-quality stones.

[2]Source: The Gem Guide, November/December 2009, p. 44, 47, 51, 55, 57, 59, 62, 63, 64, and 65. These figures are approximate wholesale purchase prices paid by retail jewelers on a per stone basis for 1-to-less than 1 carat, fine-quality stones.

[3]Prices are per 4.5 to 5-millimeter pearl.

TABLE 6
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY[1]

	2008		2009	
Country	Quantity (carats)	Value[2] (millions)	Quantity (carats)	Value[2] (millions)
Exports:				
Australia	103,000	$18	37,600	$21
Belgium	1,600,000	685	300,000	150
Canada	79,700	116	46,600	70
Costa Rica	55,200	6	8,470	2
France	136,000	136	49,200	25
Hong Kong	1,340,000	814	807,000	380
India	1,480,000	1,220	962,000	477
Israel	2,650,000	2,130	960,000	482
Japan	54,800	12	17,800	5
Mexico	678,000	110	504,000	79
Netherlands	19,000	3	561	1
Netherlands Antilles	16,200	35	10,600	23
Singapore	98,500	19	31,200	13
South Africa	31,400	4	829	2
Switzerland	99,400	270	152,000	146
Taiwan	15,000	12	12,900	5
Thailand	226,000	54	86,700	40
United Arab Emirates	165,000	115	108,000	46
United Kingdom	121,000	84	27,400	58
Other	248,000	103	156,000	133
Total	9,210,000	5,940	4,280,000	2,160
Reexports:				
Armenia	13,400	(3)	1,670	(3)
Australia	33,800	14	59,600	19
Belgium	5,790,000	1,890	4,130,000	1,110
Canada	230,000	195	139,000	127
Dominican Republic	61,400	12	15,300	3
France	30,500	23	80,800	43
Guatemala	104,000	14	50,300	5
Hong Kong	2,680,000	1,350	3,220,000	1,190
India	2,250,000	482	2,350,000	959
Israel	10,200,000	3,400	6,940,000	2,750
Japan	178,000	39	117,000	24
Malaysia	20,100	3	9,860	1
Mexico	4,590	2	2,990	2
Singapore	190,000	22	193,000	50
South Africa	65,700	108	66,500	55
Switzerland	530,000	551	584,000	492
Thailand	152,000	26	145,000	29
United Arab Emirates	1,390,000	250	749,000	198
United Kingdom	499,000	229	383,000	204
Other	331,000	134	1,710,000	534
Total	24,800,000	8,750	20,900,000	7,780
Grand total	34,000,000	14,700	25,200,000	9,940

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY[1]

Kind, range, and country of origin	2008 Quantity (carats)	2008 Value[2] (millions)	2009 Quantity (carats)	2009 Value[2] (millions)
Rough or uncut, natural:[3]				
Angola	62,300	$34	359,000	$48
Australia	1,620	1	17,700	2
Botswana	108,000	147	88,100	35
Brazil	760	1	443	(4)
Canada	19,900	31	27,300	32
Congo (Kinshasa)	37,100	138	11,600	7
Ghana	1,400	2	250	(4)
Guyana	6,590	1	212	(4)
India	120,000	4	32,700	1
Namibia	6,550	5	10,000	6
Russia	90,200	19	16,500	3
South Africa	119,000	296	104,000	112
Other	153,000	73 r	32,000	43
Total	725,000	752	700,000	289
Cut but unset, not more than 0.5 carat:				
Belgium	295,000	118	344,000	127
Canada	10,900	13	7,910	7
China	110,000	34	25,800	18
Dominican Republic	65,800	20	38,200	10
Hong Kong	157,000	25	239,000	24
India	6,520,000	1,430	5,760,000	1,150
Israel	512,000	267	400,000	198
Mauritius	8,410	14	6,920	15
Mexico	52,600	10	65,900	10
South Africa	12,400	4	1,780	10
Thailand	72,200	21	60,800	17
United Arab Emirates	69,400	18	153,000	30
Other	72,400	25	57,400	38
Total	7,960,000	2,000	7,160,000	1,650
Cut but unset, more than 0.5 carat:				
Belgium	929,000	3,130	640,000	2,130
Canada	22,800	78	20,200	60
Hong Kong	76,800	361	26,800	76
India	1,440,000	2,450	1,110,000	1,930
Israel	2,210,000	9,120	1,670,000	5,350
Mexico	389	(4)	1,810	3
Russia	57,600	178	57,800	137
South Africa	55,200	759	34,700	533
Switzerland	19,200	383	23,500	238
Thailand	11,700	22	3,980	9
United Arab Emirates	33,100	124	33,900	60
Other	101,000	400	53,200	256
Total	4,960,000	17,000	3,670,000	10,800

[r]Revised.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Includes some natural advanced diamond.

[4]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

	2008		2009	
Kind and country	Quantity (carats)	Value[2] (millions)	Quantity (carats)	Value[2] (millions)
Emerald:				
Belgium	529	$2	1,980	$1
Brazil	106,000	6	500,000	7
Canada	2,830	(3)	434	(3)
China	2,210	(3)	4,150	(3)
Colombia	530,000	155	314,000	120
France	130,000	9	315	2
Germany	13,800	3	8,470	2
Hong Kong	877,000	10	334,000	23
India	1,800,000	29	2,410,000	18
Israel	162,000	25	181,000	20
Italy	4,240	2	2,380	1
Switzerland	23,900	24	7,980	8
Thailand	564,000	13	292,000	8
United Kingdom	1,050	2	356	1
Other	83,300	17	38,000	3
Total	4,300,000	297	4,090,000	214
Ruby:				
Belgium	9	(3)	10	(3)
China	7,360	1	2,100	(3)
Dominican Republic	994	(3)	--	--
France	1,210	1	37	(3)
Germany	12,400	1	8,370	(3)
Hong Kong	851,000	10	420,000	1
India	2,350,000	5	2,500,000	2
Israel	1,370	1	5,560	1
Italy	6,030	1	1,330	(3)
Kenya	(3)	(3)	16,700	(3)
Sri Lanka	7,260	1	2,020	1
Switzerland	10,600	11	933	3
Thailand	1,980,000	59	1,750,000	14
United Arab Emirates	1,760	1	64	2
Other	43,300	8	179,000	13
Total	5,280,000	100	4,880,000	37
Sapphire:				
Australia	1,550	(3)	2,340	(3)
Austria	124	(3)	472	(3)
Belgium	110	1	283	1
China	269,000	2	122,000	1
Dominican Republic	882	(3)	600	(3)
Germany	36,200	5	33,200	5
Hong Kong	972,000	9	610,000	13
India	1,150,000	12	2,140,000	6
Israel	28,800	4	9,780	1
Italy	2,340	2	15,000	1
Singapore	3,630	(3)	3,010	(3)
Sri Lanka	316,000	46	240,000	31
Switzerland	17,800	19	14,700	14
Thailand	2,900,000	75	1,730,000	48

See footnotes at end of table.

TABLE 8—Continued

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

Kind and country	2008 Quantity (carats)	2008 Value[2] (millions)	2009 Quantity (carats)	2009 Value[2] (millions)
Sapphire—Continued:				
United Arab Emirates	8,140	$5	2,530	$2
United Kingdom	1,100	4	504	1
Other	384,000	7	68,200	3
Total	6,090,000	191	4,990,000	127
Other:				
Rough, uncut:				
Australia	NA	3	NA	(3)
Brazil	NA	7	NA	(3)
Canada	NA	1	NA	1
China	NA	3	NA	1
Colombia	NA	1	NA	--
Czech Republic	NA	2	NA	2
Germany	NA	1	NA	1
India	NA	2	NA	1
Japan	NA	1	NA	1
Pakistan	NA	2	NA	(3)
Tanzania	NA	3	NA	(3)
Other	NA	16	NA	1
Total	NA	42	NA	8
Cut, set and unset:				
Australia	NA	15	NA	(3)
Austria	NA	4	NA	1
Brazil	NA	19	NA	(3)
Canada	NA	1	NA	(3)
China	NA	35	NA	8
France	NA	1	NA	(3)
Germany	NA	34	NA	11
Hong Kong	NA	32	NA	1
India	NA	74	NA	2
Israel	NA	8	NA	(3)
Italy	NA	1	NA	(3)
South Africa	NA	1	NA	--
Sri Lanka	NA	5	NA	(3)
Switzerland	NA	8	NA	1
Taiwan	NA	1	NA	(3)
Tanzania	NA	5	NA	1
Thailand	NA	58	NA	1
United Arab Emirates	NA	1	NA	(3)
United Kingdom	NA	1	NA	--
Other	NA	15	NA	3
Total	NA	319	NA	29

NA Not available. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 9
VALUE OF U.S. IMPORTS OF LABORATORY-CREATED
AND IMITATION GEMSTONES, BY COUNTRY[1, 2]

(Thousand dollars)

Country	2008	2009
Laboratory-created, cut but unset:		
Austria	2,330	1,430
Brazil	645	374
Canada	24	9
China	9,860	7,600
Czech Republic	55	42
France	298	284
Germany	12,700	11,100
Hong Kong	898	455
India	1,040	2,180
Italy	48	95
Japan	251	61
Korea, Republic of	207	46
Netherlands	5	5
South Africa	281	--
Sri Lanka	1,300	315
Switzerland	620	797
Taiwan	174	161
Thailand	1,330	975
United Arab Emirates	146	98
Other	1,960	3,390
Total	34,200	29,500
Imitation:[3]		
Austria	73,100	47,100
Brazil	25	2
China	21,000	13,300
Czech Republic	7,510	5,080
France	25	--
Germany	723	566
Hong Kong	46	358
India	83	302
Italy	148	123
Japan	58	--
Korea, Republic of	198	131
Russia	15	--
Taiwan	183	--
Thailand	10	39
United Kingdom	193	3
Other	275	208
Total	104,000	67,200

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Includes pearls.

Source: U.S. Census Bureau.

TABLE 10

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES[1]

(Thousand carats and thousand dollars)

Stones	2008		2009	
	Quantity	Value[2]	Quantity	Value[2]
Diamonds:				
Rough or uncut	725	$752,000	700	$289,000
Cut but unset	12,900	19,000,000	10,800	12,400,000
Emeralds, cut but unset	4,300	297,000	4,090	214,000
Coral and similar materials, unworked	5,320	12,200	4,430	10,500
Rubies and sapphires, cut but unset	11,400	291,000	9,880	164,000
Pearls:				
Natural	NA	14,100	NA	21,100
Cultured	NA	34,600	NA	26,900
Imitation	NA	4,190	NA	4,150
Other precious and semiprecious stones:				
Rough, uncut	1,620,000 r	20,900 r	1,080,000	15,000
Cut, set and unset	NA	285,000	NA	NA
Other	NA	9,200	NA	NA
Laboratory-created:				
Cut but unset	60,300	34,200	8,730	29,500
Other	NA	13,500	NA	8,240
Imitation gemstone[3]	NA	104,000	NA	67,200
Total	XX	20,900,000	XX	13,300,000

r Revised. NA Not available. XX Not applicable.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Does not include pearls.

Source: U.S. Census Bureau.

TABLE 11

NATURAL DIAMOND: WORLD PRODUCTION, BY COUNTRY AND TYPE[1, 2, 3]

(Thousand carats)

Country and type[4]	2005	2006	2007	2008	2009
Gemstones:					
Angola	6,371	8,258	8,732	8,016 r	8,100
Australia	8,577	7,305	231	273	60 e
Botswana e	23,900	24,000	25,000	25,000	24,000
Brazil e	208	181	182	182 r	182 [5]
Canada	12,314	13,278	17,144	14,803	10,946
Central African Republic e	300	340	370	302 r	300
China e	100	100	100	100	100
Congo (Kinshasa)	7,000	5,800 r	5,700 r	4,200 r	3,600
Côte d'Ivoire e	210	210	210	210	210
Ghana	810	780	720 e	520 e	500 e
Guinea	440	380	815	2,500	2,400
Guyana	357	341	269	169 r	179
Lesotho	52	231	454	450 e	450 e
Namibia	1,902	2,400	2,266 r	2,435 r	2,300
Russia e	23,000	23,400	23,300	21,925 [5]	17,791 [5]
Sierra Leone	401 r	362 r	362 r	223 r	200 e
South Africa e	6,400	6,100	6,100	5,200	2,400
Tanzania e	185	230	239	202 r	150
Venezuela e	46	45	45	45	45
Zimbabwe e	160	160	100	100	100
Other[6]	109	70	65	105 r	126
Total	92,800	94,000 r	92,400 r	87,000	74,100
Industrial:					
Angola e	708	918	970	900	900
Australia	25,730	21,915	18,960	15,397 r	10,700
Botswana e	8,000	8,000	8,000	8,000	7,000
Brazil e	600	600	600	600	600
Central African Republic e	80	85	93	75 r	60
China e	960	965	970	1,000	1,000
Congo (Kinshasa)	28,200	23,100 r	22,600 r	16,700 r	14,400
Côte d'Ivoire e	90	90	90	90	90
Ghana e	200	190	180	130 r	120
Guinea	100	95	200	600	600 e
Russia e	15,000	15,000	15,000	15,000	15,000
Sierra Leone	267 r	241 r	241 r	149 r	100 e
South Africa e	9,400	9,100	9,100	7,700	3,100
Tanzania e	35	42	44	31 r	27
Venezuela e	69	70	70	70	70
Zimbabwe e	900	900 r	600 r	700 r	700
Other[7]	94	67	72	115 r	140
Total	90,400	81,400 r	77,800 r	67,300 r	54,600
Grand total	183,000	175,000 r	170,000 r	154,000 r	129,000

e Estimated. r Revised.

[1] World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2] Table includes data available through May 19, 2010.

[3] In addition to the countries listed, Nigeria and the Republic of Korea produce natural diamond and synthetic diamond, respectively, but information is inadequate to formulate reliable estimates of output levels.

[4] Includes near-gem and cheap-gem qualities.

[5] Reported figure.

[6] Includes Cameroon, Congo (Brazzaville), Gabon (unspecified), India, Indonesia, Liberia, and Togo (unspecified).

[7] Includes Congo (Brazzaville), India, Indonesia, and Liberia.

2010 Minerals Yearbook

GEMSTONES

U.S. Department of the Interior
U.S. Geological Survey

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Gemstones

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Domestic survey data and tables were prepared by Connie Lopez, statistical assistant, and the world production table was prepared by Glenn J. Wallace, international data coordinator.

In 2010, the estimated value of natural gemstones produced in the United States was more than $10.0 million, and the estimated value of U.S. laboratory-created gemstone production was more than $30.8 million. The total estimated value of U.S. gemstone production was about $40.8 million. The value of U.S. gemstone imports was $19.6 billion, and the value of combined U.S. gemstone exports and reexports was estimated to be $14.9 billion.

In this report, the terms "gem" and "gemstone" mean any mineral or organic material (such as amber, pearl, petrified wood, and shell) used for personal adornment, display, or object of art because it possesses beauty, durability, and rarity. Of more than 4,000 mineral species, only about 100 possess all these attributes and are considered to be gemstones. Silicates other than quartz are the largest group of gemstones in terms of chemical composition; oxides and quartz are the second largest (table 1). Gemstones are subdivided into diamond and colored gemstones, which in this report designates all natural nondiamond gems. In addition, laboratory-created gemstones, cultured pearls, and gemstone simulants are discussed but are treated separately from natural gemstones (table 2). Trade data in this report are from the U.S. Census Bureau. All percentages in the report were computed using unrounded data. Current information on industrial-grade diamond and industrial-grade garnet can be found in the U.S. Geological Survey (USGS) Minerals Yearbook, volume I, Metals and Minerals, chapters on industrial diamond and industrial garnet, respectively.

Gemstones have fascinated humans since prehistoric times. They have been valued as treasured objects throughout history by all societies in all parts of the world. Amber, amethyst, coral, diamond, emerald, garnet, jade, jasper, lapis lazuli, pearl, rock crystal, ruby, serpentine, and turquoise are some of the first stones known to have been used for making jewelry. These stones served as symbols of wealth and power. Today, gems are worn more for pleasure or in appreciation of their beauty than to demonstrate wealth. In addition to jewelry, gemstones are used for collections, decorative art objects, and exhibits.

Production

U.S. gemstone production data were based on a survey of more than 240 domestic gemstone producers conducted by the USGS. The survey provided a foundation for projecting the scope and level of domestic gemstone production during the year. However, the USGS survey did not represent all gemstone activity in the United States, which includes thousands of professional and amateur collectors. Consequently, the USGS supplemented its survey with estimates of domestic gemstone production from related published data, contacts with gemstone dealers and collectors, and information gathered at gem and mineral shows.

Commercial mining of gemstones has never been extensive in the United States. More than 60 varieties of gemstones have been produced commercially from domestic mines, but most of the deposits are relatively small compared with those of other mining operations. In the United States, much of the current gemstone mining is conducted by individual collectors, gem clubs, and hobbyists rather than by businesses.

The commercial gemstone industry in the United States consists of individuals and companies that mine gemstones or harvest shell and pearl, firms that manufacture laboratory-created gemstones, and individuals and companies that cut and polish natural and laboratory-created gemstones. The domestic gemstone industry is focused on the production of colored gemstones and on the cutting and polishing of large diamond stones. Industry employment is estimated to be between 1,000 and 1,200.

Most natural gemstone producers in the United States are small businesses that are widely dispersed and operate independently. The small producers probably have an average of less than three employees, including those who only work part time. The number of gemstone mines operating from year to year fluctuates because the uncertainty associated with the discovery and marketing of gem-quality minerals makes it difficult to obtain financing for developing and sustaining economically viable operations.

The total value of natural gemstones produced in the United States during 2010 was estimated to be about $10.0 million (table 3). This production value was an 8% increase from that of 2009.

Natural gemstone materials indigenous to the United States are collected or produced in every State. During 2010, all 50 States produced at least $1,360 worth of gemstone materials. There were 10 States that accounted for 85% of the total value, as reported by survey respondents. These States were, in descending order of production value, North Carolina, Arizona, Oregon, Utah, California, Tennessee, Montana, Colorado, Idaho, and Arkansas. Some States were known for the production of a single gemstone material—Tennessee for freshwater pearls, for example. Other States produced a variety of gemstones; for example, Arizona's gemstone deposits included agate, amethyst, azurite, chrysocolla, garnet, jade, jasper, malachite, obsidian, onyx, opal, peridot, petrified wood, smithsonite, and turquoise. There was also a wide variety of gemstones found and produced in California, Idaho, Montana, and North Carolina.

In 2010, the United States had only one active operation in a known diamond-bearing area in Crater of Diamonds State Park near Murfreesboro in Pike County, AR. The State of Arkansas maintains a dig-for-fee operation for tourists and rockhounds at the park; Crater of Diamonds is the only diamond mine in the world that is open to the public. The diamonds occur in a lamproite breccia tuff associated with a volcanic pipe and in the soil developed from the lamproite breccia tuff. In 2010, 601 diamond stones with an average weight of 0.218 carat were recovered at the Crater of Diamonds State Park. Of the 601 diamond stones recovered, 23 weighed more than 1 carat. Since the diamond-bearing pipe and the adjoining area became a State park in 1972, 29,906 diamond stones with a total carat weight of 5,981.1 have been recovered (Margi Jenks, park interpreter, Crater of Diamonds State Park, written commun., September 22, 2011). Exploration has demonstrated that this diamond deposit contains about 78.5 million metric tons (Mt) of diamond-bearing rock (Howard, 1999, p. 62). An Arkansas law enacted early in 1999 prohibits commercial diamond mining in the park (Diamond Registry Bulletin, 1999).

A few companies have expressed interest in exploration for diamond deposits in areas of Alaska, Colorado, Minnesota, Montana, and Wyoming with geologic settings and terrain that are similar to Canadian diamond mining areas. Even though some exploration has taken place in these States, they remain largely unexplored for diamonds (Iron Range Resources & Rehabilitation Board, 2012). Although exploration and field studies have found many diamond indicators and a number of large diamond deposits, none have attracted long-term investors or been operated commercially.

In addition to natural gemstones, laboratory-created gemstones and gemstone simulants were produced in the United States in 2010. Laboratory-created or synthetic gemstones have the same chemical, optical, and physical properties as the natural gemstones. Simulants have an appearance similar to that of a natural gemstone material, but they have different chemical, optical, and physical properties. Laboratory-created gemstones that have been produced in the United States include alexandrite, cubic zirconia, diamond, emerald, garnet, moissanite, ruby, sapphire, spinel, and turquoise. However, during 2010, only cubic zirconia, diamond, moissanite, and turquoise were produced commercially. Simulants of amber, chrysocolla, coral, lapis lazuli, malachite, travertine, and turquoise also were manufactured in the United States. In addition, certain colors of laboratory-created sapphire and spinel, used to represent other gemstones, are classified as simulants.

Laboratory-created gemstone production in the United States was valued at more than $30.8 million during 2010, which was a 13% increase compared with that of 2009. The value of U.S. simulant gemstone output was estimated to be more than $100 million. Five companies in five States, representing virtually the entire U.S. laboratory-created gemstone industry, reported production to the USGS. The States with reported laboratory-created gemstone production were, in descending order of production value, Florida, New York, Massachusetts, North Carolina, and Arizona.

Since the 1950s, when scientists manufactured the first laboratory-created bits of diamond grit using a high-pressure, high-temperature (HPHT) method, this method of growing diamonds has become relatively commonplace in the world as a technology for laboratory-created diamonds, so much so that thousands of small plants throughout China were using the HPHT method and producing laboratory-created diamonds suitable for cutting as gemstones. Gem-quality diamonds of 1 carat or more are harder to manufacture because at that size, it is difficult to consistently produce diamonds of high quality, even in the controlled environment of a laboratory using the HPHT method. After more than 50 years of development, that situation has changed, and several laboratory-created diamond companies were producing high-quality diamonds that equal those produced from mines (Park, 2007).

Gemesis Corp. (Sarasota, FL) consistently produced gem-quality laboratory-created diamond and reported an 11th year of production in 2010. The laboratory-created diamonds are produced using equipment, expertise, and technology developed by a team of scientists from Russia and the University of Florida. The weight of the laboratory-created diamond stones ranges from 1½ to 2 carats, and most of the stones are brownish yellow, colorless, green, and yellow. Gemesis uses diamond-growing machines, each machine capable of growing 3-carat rough diamonds by generating HPHT conditions that recreate the conditions in the Earth’s mantle where natural diamonds form (Davis, 2003). Gemesis could be producing as many as 30,000 to 40,000 stones each year, and annual revenues may reach $70 million to $80 million. Gemesis diamonds are available for retail purchase in jewelry stores and on the Internet, and the prices of the Gemesis laboratory-created diamonds are 30% to 50% lower than those of comparable natural diamond but above the prices of simulated diamond (Gemesis Corp., 2010).

In the early 2000s, Apollo Diamond, Inc., near Boston, MA, developed and patented a method for growing single, extremely pure, gem-quality diamond crystals by chemical vapor deposition (CVD). The CVD technique transforms carbon into plasma, which is then precipitated onto a substrate as diamond. CVD had been used for more than a decade to cover large surfaces with microscopic diamond crystals, but in developing this process, Apollo Diamond discovered the temperature, gas composition, and pressure combination that resulted in the growth of a single diamond crystal. These CVD diamonds may not be distinguishable from natural diamond by some tests (Davis, 2003). Apollo Diamond produced laboratory-created stones that ranged from 1 to 2 carats. Growth of CVD diamonds is limited only by the size of the seed placed in the diamond-growing chamber. In 2008, the company increased its production of large stones and sold the diamonds at prices that averaged 15% less than those of comparable natural diamonds on the company Web site and through select jewelers (Apollo Diamond, Inc., 2008). Both Apollo Diamond and Gemesis prefer to call their diamonds “cultured” rather than laboratory-created, referring to the fact that the diamonds are grown much like a cultured pearl is grown.

In 2010, Charles & Colvard, Ltd. in North Carolina entered its 13th year as the world’s only manufacturer of moissanite, a gem-quality laboratory-created silicon carbide. Moissanite is also an excellent diamond simulant, but it is being marketed for its own gem qualities. Moissanite exhibits a higher refractive index (brilliance) and higher luster than diamond. Its hardness is between those of corundum (ruby and sapphire) and diamond, which gives it durability (Charles & Colvard, Ltd., 2010). Charles & Colvard reported that moissanite sales increased by 53% to $12.7 million in 2010 compared with $8.3 million in 2009 (Charles & Colvard, Ltd., 2011).

U.S. mussel shells are used as a source of mother-of-pearl and as seed material for culturing pearls. U.S. shell production increased by 15% in 2010 compared with that of 2009 as were a reflection of the recovery from the impacts of the global recession on luxury spending. This increase was in spite of decreased demands for U.S. shell materials caused by the use of manmade seed materials and seed materials from China and other sources by pearl producers in Japan. The popularity of darker and colored pearls and freshwater pearls that do not use U.S. seed material has also contributed decreased demands for U.S. shell materials. In some regions of the United States, shell from mussels was being used more as a gemstone based on its own merit rather than as seed material for pearls. This shell material was being processed into mother-of-pearl and used in beads, jewelry, and watch faces.

Consumption

Historically, diamond gemstones have proven to hold their value despite wars or economic depressions, but this did not hold true during the recent worldwide economic recession. Diamond and colored gemstones value and sales decreased during the economic downturn in 2008 and continued into 2009, but during 2010 U.S. gemstone consumption and sales increased.

Although the United States accounted for little of the total global gemstone production, it was the world's leading diamond and nondiamond gemstone market. It was estimated that U.S. gemstone markets accounted for more than 35% of world gemstone demand in 2010. The U.S. market for unset gem-quality diamond during the year was estimated to be about $18.6 billion, an increase of 46% compared with that of 2009. Domestic markets for natural, unset nondiamond gemstones totaled approximately $959 million in 2010, which was a 23% increase from that of 2009. These large increases in domestic markets were a reflection of the recovery from the impacts of the global recession on luxury spending.

In the United States, a majority of domestic consumers designate diamond as their favorite gemstone. This popularity of diamonds is evidenced by the U.S. diamond market making up 95% of the total U.S. gemstone market. Colored natural gemstones, colored laboratory-created gemstones, and "fancy" colored diamonds were popular in 2010, with the values of the domestic markets for almost all types of colored natural, unset nondiamond gemstones increased from the 2009 values (table 10), also owing to recovery from the impact of the recession on luxury spending.

The estimated U.S. retail jewelry sales were $63.4 billion in 2010, an increase of 7.7% from sales of $58.8 billion in 2009 (Gassman, 2011). Twenty-five percent of all U.S. jewelers reported jewelry sales increased 20% or more from that of the previous year during the 2010 holiday shopping season (Graff, 2011).

Prices

Gemstone prices are governed by many factors and qualitative characteristics, including beauty, clarity, defects, demand, durability, and rarity. Diamond pricing, in particular, is complex; values can vary significantly depending on time, place, and the subjective valuations of buyers and sellers. There are more than 14,000 categories used to assess rough diamond and more than 100,000 different combinations of carat, clarity, color, and cut values used to assess polished diamond.

Colored gemstone prices are generally influenced by market supply and demand considerations, and diamond prices are supported by producer controls on the quantity and quality of supply. Values and prices of gemstones produced and (or) sold in the United States are listed in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported, exported, or reexported are listed in tables 6 through 10.

De Beers Group companies remain a significant force, influencing the price of gem-quality diamond sales worldwide during 2010 because the companies mine a significant portion of the world's gem-quality diamond produced each year. In 2010, De Beers produced 33 million carats from its independently owned and joint-venture operations in Botswana, Canada, Namibia, and South Africa. De Beers companies also sorted and valuated a large portion (by value) of the world's annual supply of rough diamond through De Beers' subsidiary Diamond Trading Co. (DTC). DTC sales of rough diamonds totaled $5.08 billion during 2010—up $1.85 billion from 2009. DTC rough diamond average prices increased by 27% from those of 2009. In 2010, De Beers had diamond sales of $5.88 billion, which was an increase of 53% from diamond sales of 2009. These increases were driven by strong demand in Chinese and Indian markets (Lee, 2011).

Foreign Trade

During 2010, total U.S. gemstone trade with all countries and territories was valued at about $34.5 billion, which was a increase of 43% from that of 2009. Diamond accounted for about 95% of the 2010 gemstone trade total. In 2010, U.S. exports and reexports of diamond were shipped to 95 countries and territories, and imports of all gemstones were received from 99 countries and territories (tables 6–10). In 2010, U.S. import quantities in cut diamond increased by 24% compared with those of 2009, and their value increased by 45%. U.S. import quantities in rough and unworked diamond decreased by 44%, although their value increased by 81% (table 7). The United States remained the world's leading diamond importer and was a significant international diamond transit center as well as the world's leading gem-quality diamond market. In 2010, U.S. export quantities of gem-grade diamond increased by 80% compared with those of 2009, and their value increased by 33%. The large volume of reexports revealed the significance that the United States had in the world's diamond supply network (table 6). These increases in trade were owing to recovery from the impact of the recession on luxury spending.

Import values of laboratory-created gemstone increased by 10% for the United States in 2010 compared with those of 2009 (table 10). Again, this increase in imports was owing to recovery from the impact of the recession on luxury spending.

Laboratory-created gemstone imports from Austria, China, Germany, Hong Kong, India, Switzerland, and Thailand, with more than $500,000 in imports each, made up about 91% (by value) of the total domestic imports of laboratory-created gemstones during the year (table 9). The marketing of imported laboratory-created gemstones and enhanced gemstones as natural gemstones, and the mixing of laboratory-created materials with natural stones in imported parcels, continued to be problems for some domestic producers in 2009. There also were continuing problems with some simulants being marketed as laboratory-created gemstones during the year.

World Review

The gemstone industry worldwide has two distinct sectors—diamond mining and marketing and colored gemstone production and sales. Most diamond supplies are controlled by a few major mining companies; prices are supported by managing the quality and quantity of the gemstones relative to demand, a function performed by De Beers through DTC. Unlike diamond, colored gemstones are primarily produced at relatively small, low-cost operations with few dominant producers; prices are influenced by consumer demand and supply availability.

In 2010, world natural diamond production totaled about 144 million carats—79.9 million carats gem quality and 63.8 million carats industrial grade (table 11). Most production was concentrated in a few regions—Africa [Angola, Botswana, Congo (Kinshasa), Namibia, and South Africa], Asia (northeastern Siberia and Yakutia in Russia), Australia, North America (Northwest Territories in Canada), and South America (Brazil and Venezuela). In 2010, Russia led the world in total natural diamond output quantity (combined gemstone and industrial) with 23% of the world estimated production. Botswana was the world's leading gemstone diamond producer with 31%; followed by Russia, 22%; Angola, 16%; Canada, 15%; Congo (Kinshasa), 7%; South Africa, 4%; Namibia, 2%; and Guinea, 1%. These eight countries produced 97% (by quantity) of the world's gemstone diamond output in 2010.

In 2002, the international rough-diamond certification system, the Kimberley Process Certification Scheme (KPCS), was agreed upon by United Nations (UN) member nations, the diamond industry, and involved nongovernmental organizations to prevent the shipment and sale of conflict diamonds. Conflict diamonds are diamonds that originate from areas controlled by forces or factions opposed to legitimate and internationally recognized governments, and are used to fund military action in opposition to those governments, or in contravention of the decisions of the UN Security Council. The KPCS includes the following key elements: the use of forgery-resistant certificates and tamper-proof containers for shipments of rough diamonds; internal controls and procedures that provide credible assurance that conflict diamonds do not enter the legitimate diamond market; a certification process for all exports of rough diamonds; the gathering, organizing, and sharing of import and export data on rough diamonds with other participants of relevant production; credible monitoring and oversight of the international certification scheme for rough diamonds; effective enforcement of the provisions of the certification scheme through dissuasive and proportional penalties for violations; self regulation by the diamond industry that fulfills minimum requirements; and sharing information with all other participants on relevant rules, procedures, and legislation as well as examples of national certificates used to accompany shipments of rough diamonds. Israel assumed the chair of KPCS for January 1 through December 31, 2010, the eighth country or organization in succession to hold the chair after Namibia, India, South Africa, Canada, Russia, Botswana, and the European Commission. The 50 participants represented 76 nations (including the 27 member nations of the European Community) plus the rough diamond-trading entity of Taipei. During 2010, Côte d'Ivoire continued to be under UN sanctions and was not trading in rough diamonds, and Venezuela voluntarily suspended exports and imports of rough diamonds until further notice. The participating nations in the KPCS account for approximately 99.8% of the global production and trade of rough diamonds (Kimberley Process, undated).

Globally, the value of production of natural gemstones other than diamond was estimated to be more than $2.5 billion in 2010. Most nondiamond gemstone mines are small, low-cost, and widely dispersed operations in remote regions of developing nations. Foreign countries with major gemstone deposits other than diamond are Afghanistan (aquamarine, beryl, emerald, kunzite, lapis lazuli, ruby, and tourmaline), Australia (beryl, opal, and sapphire), Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline), Burma (beryl, jade, ruby, sapphire, and topaz), Colombia (beryl, emerald, and sapphire), Kenya (beryl, garnet, and sapphire), Madagascar (beryl, rose quartz, sapphire, and tourmaline), Mexico (agate, opal, and topaz), Sri Lanka (beryl, ruby, sapphire, and topaz), Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline), and Zambia (amethyst and beryl). In addition, pearls are cultured throughout the South Pacific and in other equatorial waters; Australia, China, French Polynesia, and Japan were key producers in 2010.

Worldwide diamond exploration allocations decreased by 9% in 2010, to $357 million spent by 99 companies compared with $393 million by 113 companies during 2009. This lowered the diamond share of overall worldwide mineral exploration spending to 3% during 2010. Planned diamond exploration spending in 2010 was at its lowest value since 2003. Africa was the most popular diamond exploration location for the seventh year in a row, although Africa's share of overall exploration spending decreased to 35% in 2010 from almost 50% in 2009. Canada's share of total diamond exploration budgets increased to 29% in 2010 from 18% in 2009. De Beers Group dropped from the position of top diamond explorer that it had held for more than a decade and was replaced by ALROSA Co. Ltd. ALROSA, De Beers Group, and Rio Tinto plc were the three leading diamond exploration companies, accounting for 57% of the estimated $357 million total global diamond exploration budget in 2010 (Metals Economics Group, 2010, p. 8–9; 2011, p. 13).

Worldwide in 2010, diamond prices recovered strongly from the downturn caused by the global recession. The recovery was led by an upturn in the U.S. markets; this was demonstrated by increasing quantity and value of diamond imports in 2010 and improved sales in North America overall (Metals Economics Group, 2011, p. 10).

Worldwide in 2010, three diamond mines started up, including one mine reopening. One of the startups was in Botswana, one in Brazil, and the reopening was in South Africa (Metals Economics Group, 2011, p. 15).

Botswana.—Firestone Diamonds plc received a license for mining the BK11 Mine in July 2010, and began operating phase I of the production plant. Work on phase 2 was completed in the third quarter of 2010, increasing the ore production rate to 1.5 million metric tons (Mt) per year. The mine reached full production of 150,000 carats per year in the fourth quarter of 2010. The BK11 Mine is an open pit operation, which is 90% owned by Firestone Diamonds plc and 10% by a local company. Firestone estimated the BK11 Mine's reserves to be 18.0 Mt at startup (Metals Economics Group, 2011, p. 15).

Brazil.—During the third quarter of 2010, Vaaldiam Mining Inc. started production at its Duas Barras alluvial mining operation. Diamond recovery during the quarter was 643 carats from ore grading 0.03 carat per cubic meter. The ore grade improved after September with the opening of a second mining front that exposed large amounts of better quality gravels. The recovered diamond grade was approximately 0.16 carat per cubic meter. Vaaldiam estimated the reserves for Duas Barras at 2.3 Mt (Metals Economics Group, 2011, p. 15).

Canada.—Canadian diamond production was about 11.8 million carats (Mct) during 2010, an increase of about 8% compared with that of 2009. Diamond exploration continued in Canada, with several commercial diamond projects and additional discoveries in Alberta, British Columbia, the Northwest Territories, the Nunavut Territory, Ontario, and Quebec. In 2010, Canada produced 8.2% of the world's combined natural gemstone and industrial diamond output.

The Diavik Diamond Mine in the Northwest Territories completed its eighth full year of production. In 2010, Diavik produced 6.5 Mct of diamond, an increase of 16% from the previous year's production. At yearend 2010, Diavik estimated the mine's remaining proven and probable reserves to be 18 Mt of ore in kimberlite pipes containing 52.2 Mct of diamond and projected the total mine life to be 16 to 22 years. Diavik began developing an underground mine and substantially completed construction on the project during 2009, and the first ore was produced during the first quarter of 2010, with full production expected in 2013. The mine is an unincorporated joint venture between Diavik Diamond Mine Inc. (60%) and Harry Winston Diamond Mines Ltd. (40%) (Diavik Diamond Mine Inc., 2011; Perron, 2011, p. 2).

The Ekati Diamond Mine completed its twelfth full year of production in 2010. Ekati produced 2.89 Mct of diamond from 4.85 Mt of ore. BHP Billiton Ltd. has an 80% controlling ownership in Ekati, which also is in the Northwest Territories. Ekati has estimated remaining reserves of 38.5 Mt of ore in kimberlite pipes that contain 18.3 Mct of diamond. BHP Billiton projected the remaining mine life to be 12 years. Approximately 21% of the Ekati 2010 production is industrial-grade diamond (BHP Billiton Ltd., 2011, p. 10; Perron, 2011, p. 1).

The Jericho Diamond Mine is in Nunavut and was originally owned by Tahera Diamond Corp. Tahera estimated Jericho Diamond Mine's reserves to be about 5.5 Mt of ore grading 0.85 carat per ton. In 2008, the Jericho Diamond Mine experienced startup problems related to ore mining and processing. The mine also suffered financial problems owing to the cost of transporting supplies to the mine site, high operational costs, high oil prices, and appreciation of the Canadian dollar versus the U.S. dollar. All of these problems combined to force the company to enter into protection under Canada's "Companies' Creditors Arrangement Act" on January 16, 2008, and the mine suspended production on February 6, 2008. At yearend 2009, Tahera was finalizing arrangements to sell all of its Jericho Mine assets (Perron, 2011, p. 2). In July 2010, Shear Minerals Ltd. (now known as Shear Diamonds Ltd.) announced that it had entered into a purchase agreement with Tahera and Benachee Resources Inc. to acquire a 100% interest in the Jericho Diamond Mine, the mine's processing facilities, and all supporting exploration assets in the Kitikmeot region of Nunavut (Shear Minerals Ltd., 2010). Shear Minerals completed the acquisition of the Jericho Diamond Mine in August 2010 with the intention of bringing the mine back into production (Shear Minerals Ltd., 2011).

The Snap Lake Mine, which is wholly owned by De Beers Canada Inc., is in the Northwest Territories. The Snap Lake deposit is a tabular-shaped kimberlite dyke rather than the typical kimberlite pipe. The dyke is 2.5 meters thick and dips at an angle of 12° to 15°. The deposit was mined using a modified room and pillar underground mining method in 2010. The Snap Lake Mine started mining operations in October 2007, reached commercial production levels in the first quarter of 2008, and officially opened on June 25, 2008. The mine was expected to produce 1.4 Mct per year of diamond, and the mine life was expected to be about 20 years. The mine's production for 2010 was 926,000 carats for a recovered grade of 1.2 carats per metric ton (De Beers Canada Inc., 2011; Perron, 2011, p. 2–3).

The Victor Mine, which also is wholly owned by De Beers Canada, is in northern Ontario on the James Bay coast. The Victor kimberlite consists of two pipes with surface area of 15 hectares (37.1 acres). The Victor Mine initiated mining operations at yearend 2007 and was officially opened on July 26, 2008. The Victor Mine reportedly has 27.4 Mt of ore with average ore grade of 0.23 carat per metric ton estimated minable reserves. At full capacity, the open pit mine was expected to produce 600,000 carats per year, and the mine life was expected to be about 12 years. In 2010, the mine's production was 826,000 carats recovered from 2.67 Mt of ore (De Beers Canada Inc., undated; Perron, 2011, p. 3).

South Africa.—Petra Diamonds Ltd. has operated the Kimberley Underground Mines under care-and-maintenance status since 2007. De Beers had closed the mines in August 2005. In September 2007, Petra Diamonds began the process of purchasing De Beers interests in the mines and began rehabilitating the deep underground diamond mines. Petra Diamonds purchased the Kimberley diamond operations from De Beers for $11 million, and Petra Diamonds was given approval to operate the mines under De Beers' licence. After completing the mine rehabilitation, Petra Diamonds reopened the underground mine in September 2010. Petra had been producing from tailings and stockpile for the previous few years. During the fourth quarter of 2010, Kimberley produced 25,000 carats grading 0.14 carat per metric ton, and sold 17,300 carats at an average price of $285 per carat. The Kimberley Mines are 74% owned by Petra Diamonds and 26% by Sedibeng Mining (Pty) Ltd. Petra Diamonds estimated the Kimberley Mine's reserves to be 57.0 Mt. Kimberley's annual production was expected to be 100,000 carats from the processing of 1 Mt per year of ore (Metals Economics Group, 2011, p. 15; Petra Diamonds Ltd., undated).

Outlook

As the domestic and global economy improves, Internet sales of diamonds, gemstones, and jewelry were expected to continue to expand and increase in popularity, as were other forms of e-commerce that emerge to serve the diamond and gemstone industry. Internet sales are expected to add to and partially replace “brick-and-mortar” sales. This is likely to take place as the gemstone industry and its customers become more comfortable with and learn the applications of new e-commerce tools, such as sales Web sites and online social networking Web sites (Dayrit, 2011).

As more independent producers, such as Ekati and Diavik in Canada, come online they will bring a greater measure of competition to global markets that presumably will bring more supplies and lower prices. Further consolidation of diamond producers and larger quantities of rough diamond being sold outside DTC is expected to continue as the diamond industry adjusts to De Beers’ reduced influence on the industry.

More laboratory-created gemstones, simulants, and treated gemstones are likely to enter the marketplace and necessitate more transparent trade industry standards to maintain customer confidence.

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TABLE 1

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0–2.5	1.0–1.1	Single	1.54	Synthetic or pressed plastics, kaurigum	Fossil resin, color, low density, soft, insects.
Apatite	Chlorocalcium phosphate	Colorless, pink, yellow, green, blue, violet	Small	Low	5.0	3.16–3.23	Double	1.63–1.65	Amblygonite, andalusite, brazilianite, precious beryl, titanite, topaz, tourmaline	Crystal habit, color, hardness, appearance.
Azurite	Copper carbonate hydroxide	Azure, dark blue, pale blue	Small to medium	do.	3.5–4.0	3.7–3.9	do.	1.72–1.85	Dumortierite, hauynite, lapis lazuli, lazulite, sodalite	Color, softness, crystal habits, associated minerals.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	do.	High	6.0–6.5	3.64–3.68	do.	1.76–1.80	Sapphire, tanzanite, blue diamond, blue tourmaline, cordierite	Strong blue in ultraviolet light.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5–8.0	2.63–2.80	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	Red	Small	Very high	7.5–8.0	2.63–2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald, natural	do.	Green	Medium	do.	7.5	2.63–2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5–8.0	2.63–2.80	do.	1.58	Genuine emerald	Lack of flaws, brilliant fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5–8.0	2.63–2.80	do.	1.58	Citrine, topaz, glass, doublets	Weak-colored.
Goshenite	do.	Colorless	do.	Low	7.5–8.0	2.63–2.80	do.	1.58	Quartz, glass, white sapphire, white topaz	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5–8.0	2.63–2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49–1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.6	do.	Banded, translucent.
Charoite	Hydrated sodium calcium hydroxi-fluoro-silicate	Lilac, violet, or white	Small to medium	do.	5.0–6.0	2.54–2.78	XX	1.55–1.56	Purple marble	Color, locality.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by direct sunlight, or encandescent light, red by indirect sunlight or fluorescent light	Small to medium	High	8.5	3.50–3.84	Double	1.75	Synthetic	Strong dichroism, color varies from red to green, hardness.
Cat's eye	do.	Greenish to brownish	do.	do.	8.5	3.50–3.84	do.	1.75	Synthetic, shell	Density, translucence, chatoyance.
Chrysolite	do.	Yellow, green, and (or) brown	Medium	Medium	8.5	3.50–3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Chrysocolla	Hydrated copper silicate	Green, blue	Any	Low	2.0–4.0	2.0–2.4	XX	1.46–1.57	Azurite, dyed chalcedony, malachite, turquoise, variscite	Lack of crystals, color, fracture, low density, softness.
Coral	Calcium carbonate	Orange, red, white, black, purple, or green	Branching, medium	do.	3.5–4.0	2.6–2.7	Double	1.49–1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95–4.10	do.	1.78	Synthetics, including spinel, garnet	Inclusions, fluorescence.
Sapphire, blue	do.	Blue	Medium	High	9.0	3.95–4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, colorless, orange, green, or violet	Medium to large	Medium	9.0	3.95–4.10	do.	1.78	Synthetics, glass and doublets, morganite	Inclusions, double refraction, refractive index.
Sapphire or ruby, stars	do.	Red, pink, violet, blue, or gray	do.	High to low	9.0	3.95–4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.
Sapphire or ruby, synthetic	do.	Yellow, pink, blue, green, orange, violet, or red	Up to 20 carats	Low	9.0	3.95–4.10	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Cubic zirconia	Zirconium and yttrium oxides	Colorless, pink, blue, lavender, yellow	Small	do.	8.25–8.5	5.8	Single	2.17	Diamond, zircon, titania, moissanite	Hardness, density, lack of flaws and inclusions, refractive index.
Diamond	Carbon	White, blue-white, yellow, brown, green, red, pink, blue	Any	Very high	10.0	3.516–3.525	do.	2.42	Zircon, titania, cubic zirconia, moissanite	High index, dispersion, hardness, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green-blue	Large	Low	6.0–6.5	2.56	XX	1.52	Jade, turquoise	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play (schiller)	do.	do.	6.0–6.5	2.56	XX	1.56	do.	Do.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Moonstone	Alkali aluminum silicate	Colorless, white, gray, or yellow with white, blue, or bronze schiller	Large	Low	6.0–6.5	2.77	XX	1.52–1.54	Glass, chalcedony, opal	Pale sheen, opalescent.
Sunstone	do.	Orange, red brown, colorless with gold or red glittery schiller	Small to medium	do.	6.0–6.5	2.77	XX	1.53–1.55	Aventurine, glass	Red glittery schiller.
Garnet	Complex silicate	Brown, black, yellow, green, red, or orange	do.	Low to high	6.5–7.5	3.15–4.30	Single strained	1.79–1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Hematite	Iron oxide	Black, black-gray, brown-red	Medium to large	Low	5.5–6.5	5.12–5.28	XX	2.94–3.22	Davidite, cassiterite, magnetite, neptunite, pyrolusite, wolframite	Crystal habit, streak, hardness.
Jade:										
Jadeite	Complex silicate	Green, yellow, black, white, or mauve	Large	Low to very high	6.5–7.0	3.3–3.5	Crypto-crystalline	1.65–1.68	Nephrite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.
Nephrite	Complex hydrous silicate	Green, yellow, black, white, or mauve	do.	Low to very high	6.0–6.5	2.96–3.10	do.	1.61–1.63	Jadeite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Do.
Jet (gagate)	Lignite	Deep black, dark brown	do.	Low	2.5–4.0	1.19–1.35	XX	1.64–1.68	Anthracite, asphalt, cannel coal, onyx, schorl, glass, rubber	Luster, color.
Lapis lazuli	Sodium calcium aluminum silicate	Dark azure-blue to bright indigo blue or even a pale sky blue.	do.	do.	5.0–6.0	2.50–3.0	XX	1.5	Azurite, dumortierite, dyed howlite, lazulite, sodalite, glass	Color, crystal habit, associated minerals, luster, localities.
Malachite	Hydrated copper carbonate	Light to black-green banded	do.	do.	3.5–4.0	3.25–4.10	XX	1.66–1.91	Brochantite, chrysoprase, opaque green gemstones	Color banding, softness, associated minerals.
Moissanite	Silicon carbide	Colorless and pale shades of green, blue, yellow	Small	Low to medium	9.25	3.21	Double	2.65–2.69	Diamond, zircon, titania, cubic zirconia	Hardness, dispersion, lack of flaws and inclusions, refractive index.
Obsidian	Amorphous, variable (usually felsic)	Black, gray, brown, dark green, white, transparent	Large	Low	5.0–5.5	2.35–2.60	XX	1.45–1.55	Aegirine-augite, gadolinite, gagate, hematite, pyrolusite, wolframite	Color, conchoidal fracture, flow bubbles, softness, lack of crystal faces.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Opal	Hydrated silica	Reddish orange, colors flash in white gray, black, red, or yellow	Large	Low to high	5.5–6.5	1.9–2.3	Single	1.45	Glass, synthetics, triplets, chalcedony	Color play (opalescence).
Peridot	Iron magnesium silicate	Yellow and or green	Any	Medium	6.5–7.0	3.27–3.37	Double (strong)	1.65–1.69	Tourmaline, chrysoberyl	Strong double refraction, low dichroism.
Quartz:										
Agate	Silicon dioxide	Any	Large	Low	7.0	2.58–2.64	XX	XX	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65–2.66	Double	1.55	Glass, plastic, fluorite	Macrocrystalline, color, refractive index, transparent, hardness.
Aventurine	do.	Green, red-brown, gold-brown, with metallic iridescent reflection	do.	Low	7.0	2.64–2.69	do.	1.54–1.55	Iridescent analcime, aventurine feldspar, emerald, aventurine glass	Macrocrystalline, color, metallic iridescent flake reflections, hardness.
Cairngorm	do.	Smoky orange or yellow	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Carnelian	do.	Flesh red to brown red	do.	do.	6.5–7.0	2.58–2.64	do.	1.53–1.54	Jasper	Cryptocrystalline, color, hardness.
Chalcedony	do.	Bluish, white, gray	do.	do.	6.5–7.0	2.58–2.64	do.	1.53–1.54	Tanzanite	Do.
Chrysoprase	do.	Green, apple-green	do.	do.	6.5–7.0	2.58-2.64	Double	1.53–1.54	Chrome chalcedony, jade, prase opal, prehnite, smithsonite, variscite, artificially colored green chalcedony	Do.
Citrine	do.	Yellow	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Jasper	do.	Any, striped, spotted, or sometimes uniform	do.	do.	7.0	2.58–2.66	XX	XX	do.	Cryptocrystalline, opaque, vitreous luster, hardness.
Onyx	do.	Many colors	do.	do.	7.0	2.58–2.64	XX	XX	do.	Cryptocrystalline, uniformly banded, hardness.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Petrified wood	Silicon dioxide	Brown, gray, red, yellow	Large	Low	6.5–7.0	2.58–2.91	Double	1.54	Agate, jasper	Color, hardness, wood grain.
Rock crystal	do.	Colorless	do.	do.	7.0	2.65–2.66	do.	1.55	Topaz, colorless sapphire	Do.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Tiger's eye	do.	Golden yellow, brown, red, blue-black	do.	do.	6.5-7.0	2.58–2.64	XX	1.53–1.54	XX	Macrocrystalline, color, hardness, chatoyancy.
Rhodochrosite	Manganese carbonate	Rose-red to yellowish, stripped	do.	do.	4.0	3.45–3.7	Double	1.6–1.82	Fire opal, rhodonite, tugtupite, tourmaline	Color, crystal habit, reaction to acid, perfect rhombohedral cleavage.
Rhodonite	Manganese iron calcium silicate	Dark red, flesh red, with dendritic inclusions of black manganese oxide	do.	do.	5.5–6.5	3.40–3.74	do.	1.72–1.75	Rhodochrosite, thulite, hessonite, spinel, pyroxmangite, spessartine, tourmaline	Color, black inclusions, lack of reaction to acid, hardness.
Shell:										
Mother-of-pearl	Calcium carbonate	White, cream, green, blue-green, with iridescent play of color	Small	do.	3.5	2.6–2.85	XX	XX	Glass and plastic imitation	Luster, iridescent play of color.
Pearl	do.	White, cream to black, sometimes with hint of pink, green, purple	do.	Low to high	2.5–4.5	2.6–2.85	XX	XX	Cultured and glass or plastic imitation	Luster, iridescence, x-ray of internal structure.
Spinel, natural	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5–3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5–3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5–7.0	3.13–3.20	do.	1.66	Synthetic spinel	Refractive index, color, pleochroism.
Kunzite	do.	Pink to lilac	do.	do.	6.5–7.0	3.13–3.20	Double	1.66	Amethyst, morganite	Do.
Tanzanite	Complex silicate	Blue to lavender	Small	High	6.0–7.0	3.3	do.	1.69	Sapphire, synthetics	Strong trichroism, color.
Topaz	Lithium aluminum silicate	White, blue, green, pink, yellow, gold	Medium	Low to medium	8.0	3.4–3.6	do.	1.62	Beryl, quartz	Color, density, hardness, refractive index, perfect in basal cleavage.
Tourmaline	do.	Any, including mixed	do.	do.	7.0–7.5	2.98–3.20	do.	1.63	Peridot, beryl, garnet corundum, glass	Double refraction, color, refractive index.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Turquoise	Copper aluminum phosphate	Blue to green with black, brown-red inclusions	Large	Low	6.0	2.60–2.83	Double	1.63	Chrysocolla, dyed howlite, dumortierite, glass, plastics, variscite	Difficult if matrix not present, matrix usually limonitic.
Unakite	Granitic rock, feldspar, epidote, quartz	Olive green, pink, and blue-gray	do.	do.	6.0–7.0	2.60–3.20	XX	XX	XX	Olive green, pink, gray-blue colors.
Zircon	Zirconium silicate	White, blue, brown, yellow, or green	Small to medium	Low to medium	6.0–7.5	4.0–4.8	Double (strong)	1.79–1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

Do., do. Ditto. XX Not applicable.

[1]Small: up to 5 carats; medium: 5 to 50 carats; large: more than 50 carats.

[2]Low: up to $25 per carat; medium: up to $200 per carat; high: more than $200 per carat.

TABLE 2
LABORATORY-CREATED GEMSTONE PRODUCTION METHODS

Gemstone	Production method	Company/producer	Date of first production
Alexandrite	Flux	Creative Crystals Inc.	1970s.
Do.	Melt pulling	J.O. Crystal Co., Inc.	1990s.
Do.	do.	Kyocera Corp.	1980s.
Do.	Zone melt	Seiko Corp.	Do.
Cubic zirconia	Skull melt	Various producers	1970s.
Emerald	Flux	Chatham Created Gems	1930s.
Do.	do.	Gilson	1960s.
Do.	do.	Kyocera Corp.	1970s.
Do.	do.	Lennix	1980s.
Do.	do.	Russia	Do.
Do.	do.	Seiko Corp.	Do.
Do.	Hydrothermal	Biron Corp.	Do.
Do.	do.	Lechleitner	1960s.
Do.	do.	Regency	1980s.
Do.	do.	Russia	Do.
Ruby	Flux	Chatham Created Gems	1950s.
Do.	do.	Douras	1990s.
Do.	do.	J.O. Crystal Co., Inc.	1980s.
Do.	do.	Kashan Created Ruby	1960s.
Do.	Melt pulling	Kyocera Corp.	1970s.
Do.	Verneuil	Various producers	1900s.
Do.	Zone melt	Seiko Corp.	1980s.
Sapphire	Flux	Chatham Created Gems	1970s.
Do.	Melt pulling	Kyocera Corp.	1980s.
Do.	Verneuil	Various producers	1900s.
Do.	Zone melt	Seiko Corp.	1980s.
Star ruby	Melt pulling	Kyocera Corp.	Do.
Do.	do.	Nakazumi Earth Crystals Co.	Do.
Do.	Verneuil	Linde Air Products Co.	1940s.
Star sapphire	do.	do.	Do.

Do., do. Ditto.

TABLE 3
ESTIMATED VALUE OF U.S. NATURAL GEMSTONE PRODUCTION, BY GEM TYPE[1]

(Thousand dollars)

Gem materials	2009	2010
Beryl	918 r	1,700
Coral, all types	150	150
Diamond	(2)	(2)
Garnet	148	149
Gem feldspar	858	693
Geode/nodules	105	110
Opal	225	189
Quartz:		
Macrocrystalline[3]	231	273
Cryptocrystalline[4]	216	208
Sapphire/ruby	256	344
Shell	713	821
Topaz	(2)	(2)
Tourmaline	112	95
Turquoise	531	449
Other	4,850	4,840
Total	9,310 r	10,000

[r]Revised.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Less than ½ unit.

[3]Macrocrystalline quartz (crystals recognizable with the naked eye) includes amethyst, aventurine, blue quartz, citrine, hawk's eye, pasiolite, prase, quartz cat's eye, rock crystal, rose quartz, smoky quartz, and tiger's eye.

[4]Cryptocrystalline quartz (microscopically small crystals) includes agate, carnelian, chalcedony, chrysoprase, fossilized wood, heliotrope, jasper, moss agate, onyx, and sard.

TABLE 4

PRICES PER CARAT OF U.S. CUT ROUND DIAMONDS, BY SIZE AND QUALITY IN 2010

Carat weight	Description, color[2]	Clarity[1] (GIA terms)	Representative prices		
			January[3]	June[4]	December[5]
0.25	G	VS1	$1,400	$1,400	$1,400
Do.	G	VS2	1,300	1,300	1,300
Do.	G	SI1	1,200	1,200	1,200
Do.	H	VS1	1,350	1,350	1,350
Do.	H	VS2	1,250	1,250	1,250
Do.	H	SI1	1,150	1,150	1,150
0.50	G	VS1	2,650	2,650	2,650
Do.	G	VS2	2,200	2,200	2,200
Do.	G	SI1	1,900	1,900	1,900
Do.	H	VS1	2,350	2,350	2,350
Do.	H	VS2	2,150	2,150	2,150
Do.	H	SI1	1,800	1,800	1,800
1.00	G	VS1	6,400	6,400	6,400
Do.	G	VS2	5,450	5,450	5,450
Do.	G	SI1	4,650	4,650	4,650
Do.	H	VS1	5,300	5,300	5,300
Do.	H	VS2	4,800	4,800	4,800
Do.	H	SI1	4,225	4,225	4,225
2.00	G	VS1	11,400	11,900	12,100
Do.	G	VS2	10,900	11,200	11,500
Do.	G	SI1	8,800	8,800	9,100
Do.	H	VS1	9,300	9,300	9,500
Do.	H	VS2	9,000	9,000	9,100
Do.	H	SI1	8,000	8,000	8,250

Do. Ditto.

[1]Clarity: IF—no blemishes; VVS1—very, very slightly included; VS1—very slightly included; VS2—very slightly included, but not visible; SI1—slightly included.

[2]Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; G, H, I—traces of color.

[3]Source: The Gem Guide, v. 29, no. 1, January/February 2010, p. 20–22.

[4]Source: The Gem Guide, v. 29, no. 4, July/August 2010, p. 20–22.

[5]Source: The Gem Guide, v. 29, no. 6, November/December 2010, p. 20–22.

TABLE 5

PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES IN 2010

Gemstone	Price range per carat	
	January[1]	December[2]
Amethyst	$10–25	$10–25
Blue sapphire	900–1,650	950–1,800
Blue topaz	5–10	5–10
Emerald	2,400–4,000	2,400–4,000
Green tourmaline	50–70	50–70
Cultured saltwater pearl[3]	5	5
Pink tourmaline	70–150	70–150
Rhodolite garnet	20–40	22–45
Ruby	1,850–2,200	1,850–2,200
Tanzanite	300–375	300–375

[1]Source: The Gem Guide, v. 29, no. 1, January/February 2010, p. 48, 51, 55, 59, 61, 63, and 66–69. These figures are approximate wholesale purchase prices paid by retail jewelers on a per stone basis for 1 to less than 1 carat fine-quality stones.

[2]Source: The Gem Guide, v. 29, no. 6, November/December 2010, p. 50, 53, 57, 61, 63, 65, and 68–71. These figures are approximate wholesale purchase prices paid by retail jewelers on a per-stone basis for 1 to less than 1 carat fine-quality stones.

[3]Prices are per 4.5–5-millimeter pearl.

TABLE 6
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY[1]

Country	2009 Quantity (carats)	2009 Value[2] (millions)	2010 Quantity (carats)	2010 Value[2] (millions)
Exports:				
Australia	37,600	$21	33,000	$34
Belgium	300,000	150	346,000	396
Canada	46,600	70	52,000	87
Costa Rica	8,470	2	9,430	2
France	49,200	25	33,000	94
Hong Kong	807,000	380	1,910,000	448
India	962,000	477	1,300,000	825
Israel	960,000	482	419,000	365
Japan	17,800	5	3,400	9
Mexico	504,000	79	561,000	84
Netherlands	561	1	1,150	9
Netherlands Antilles	10,600	23	12,700	34
Singapore	31,200	13	8,690	10
South Africa	829	2	636	7
Switzerland	152,000	146	147,000	177
Taiwan	12,900	5	9,080	4
Thailand	86,700	40	92,500	14
United Arab Emirates	108,000	46	193,000	68
United Kingdom	27,400	58	325,000	58
Other	156,000	133	2,250,000	139
Total	4,280,000	2,160	7,710,000	2,860
Reexports:				
Armenia	1,670	(3)	1,880	(3)
Australia	59,600	19	16,300	16
Belgium	4,130,000	1,110	2,410,000	1,600
Canada	139,000	127	143,000	144
Dominican Republic	15,300	3	10,500	1
France	80,800	43	47,900	78
Guatemala	50,300	5	46,000	5
Hong Kong	3,220,000	1,190	4,340,000	1,820
India	2,350,000	959	2,730,000	1,900
Israel	6,940,000	2,750	4,390,000	4,110
Japan	117,000	24	98,200	32
Malaysia	9,860	1	2,480	2
Mexico	2,990	2	5,780	1
Singapore	193,000	50	65,500	24
South Africa	66,500	55	29,300	45
Switzerland	584,000	492	429,000	565
Thailand	145,000	29	160,000	31
United Arab Emirates	749,000	198	338,000	188
United Kingdom	383,000	204	166,000	269
Other	1,710,000	534	598,000	407
Total	20,900,000	7,780	16,000,000	11,200
Grand total	25,200,000	9,940	23,700,000	14,100

[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY [1]

Kind, range, and country of origin	2009 Quantity (carats)	2009 Value[2] (millions)	2010 Quantity (carats)	2010 Value[2] (millions)
Rough or uncut, natural:[3]				
Angola	359,000	$48	67,000	$132
Australia	17,700	2	8,060	1
Botswana	88,100	35	81,500	68
Brazil	443	(4)	--	--
Canada	27,300	32	35,300	43
Congo (Kinshasa)	11,600	7	6,650	7
Ghana	250	(4)	135	(4)
Guyana	212	(4)	534	(4)
India	32,700	1	12,900	1
Namibia	10,000	6	7,450	9
Russia	16,500	3	37,500	8
South Africa	104,000	112	102,000	223
Other	32,000	43	29,400	31
Total	700,000	289	389,000	524
Cut but unset, not more than 0.5 carat:				
Belgium	344,000	127	281,000	106
Canada	7,910	7	13,000	9
China	25,800	18	37,500	21
Dominican Republic	38,200	10	7,250	2
Hong Kong	239,000	24	180,000	25
India	5,760,000	1,150	7,310,000	1,560
Israel	400,000	198	433,000	207
Mauritius	6,920	15	5,780	15
Mexico	65,900	10	92,300	21
South Africa	1,780	10	9,440	13
Thailand	60,800	17	93,400	14
United Arab Emirates	153,000	30	77,100	17
Other	57,400	39 r	63,900	49
Total	7,160,000	1,650	8,610,000	2,060
Cut but unset, more than 0.5 carat:				
Belgium	640,000	2,130	706,000	2,900
Canada	20,200	60	23,300	83
Hong Kong	26,800	76	42,200	102
India	1,110,000	1,930	1,900,000	3,610
Israel	1,670,000	5,350	2,000,000	7,530
Mexico	1,810	3	1,250	1
Russia	57,800	137	25,300	98
South Africa	34,700	533	63,000	892
Switzerland	23,500	238	11,300	391
Thailand	3,980	9	5,910	13
United Arab Emirates	33,900	60	10,100	42
Other	53,200	256	73,800	343
Total	3,670,000	10,800	4,860,000	16,000

[r]Revised. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Includes some natural advanced diamond.

[4]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

Kind and country	2009 Quantity (carats)	2009 Value[2] (millions)	2010 Quantity (carats)	2010 Value[2] (millions)
Emerald:				
Belgium	1,980	$1	1,340	(3)
Brazil	500,000	7	120,000	$7
Canada	434	(3)	4	(3)
China	4,150	(3)	13,800	1
Colombia	314,000	120	406,000	131
France	315	2	1,480	2
Germany	8,470	2	54,000	2
Hong Kong	334,000	23	246,000	17
India	2,410,000	18	1,810,000	37
Israel	181,000	20	172,000	17
Italy	2,380	1	2,880	(3)
Switzerland	7,980	8	6,290	13
Thailand	292,000	8	487,000	10
United Kingdom	356	1	1,550	2
Other	38,000	3	89,400	15
Total	4,090,000	214	3,410,000	254
Ruby:				
Belgium	10	(3)	16	(3)
China	2,100	(3)	19,200	(3)
France	37	(3)	1,730	(3)
Germany	8,370	(3)	10,900	(3)
Hong Kong	420,000	1	201,000	1
India	2,500,000	2	2,310,000	6
Israel	5,560	1	22,300	(3)
Italy	1,330	(3)	4,300	(3)
Kenya	16,700	(3)	1,810	(3)
Sri Lanka	2,020	1	3,800	(3)
Switzerland	933	3	129	2
Thailand	1,750,000	14	1,880,000	22
United Arab Emirates	64	2	210	(3)
Other	179,000	13	168,000	11
Total	4,880,000	37	4,630,000	42
Sapphire:				
Australia	2,340	(3)	1,190	(3)
Austria	472	(3)	3,380	(3)
Belgium	283	1	2,420	1
China	122,000	1	56,700	3
Dominican Republic	600	(3)	--	--
Germany	33,200	5	123,000	4
Hong Kong	610,000	13	536,000	9
India	2,140,000	6	2,570,000	20
Israel	9,780	1	19,300	2
Italy	15,000	1	5,440	1
Singapore	3,010	(3)	--	--
Sri Lanka	240,000	31	309,000	66
Switzerland	14,700	14	13,700	20
Thailand	1,730,000	48	2,630,000	78
United Arab Emirates	2,530	2	319	(3)
United Kingdom	504	1	610	1

See footnotes at end of table.

TABLE 8—Continued

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

Kind and country	2009 Quantity (carats)	2009 Value[2] (millions)	2010 Quantity (carats)	2010 Value[2] (millions)
Sapphire—Continued:				
Other	68,200	3	44,800	8
Total	4,990,000	127	6,320,000	214
Other:				
Rough, uncut, all countries	NA	8	NA	15
Total	NA	8	NA	15
Cut, set and unset, all countries	NA	29	NA	32
Total	NA	29	NA	32

NA Not available. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 9

VALUE OF U.S. IMPORTS OF LABORATORY-CREATED AND IMITATION GEMSTONES, BY COUNTRY[1, 2]

(Thousand dollars)

Country	2009	2010
Laboratory-created, cut but unset:		
Austria	1,430	1,950
Brazil	374	96
Canada	9	--
China	7,600	5,700
Czech Republic	42	118
France	284	232
Germany	11,100	10,100
Hong Kong	455	549
India	2,180	9,870
Italy	95	78
Japan	61	25
Korea, Republic of	46	53
Netherlands	5	29
Sri Lanka	315	35
Switzerland	797	500
Taiwan	161	186
Thailand	975	723
United Arab Emirates	98	--
Other	3,390	2,050
Total	29,500	32,300
Imitation:[3]		
Austria	47,100	51,400
Brazil	2	--
China	13,300	13,300
Czech Republic	5,080	5,070
France	--	5
Germany	566	726
Hong Kong	358	158
India	302	125
Italy	123	164
Korea, Republic of	131	282
Taiwan	--	25
Thailand	39	28
United Kingdom	3	--
Other	208	406
Total	67,200	71,700

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Includes pearls.

Source: U.S. Census Bureau.

TABLE 10

U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES[1]

(Thousand carats and thousand dollars)

Stones	2009 Quantity	2009 Value[2]		2010 Quantity	2010 Value[2]
Coral and similar materials, unworked	4,430	10,500		5,760	12,000
Diamonds:					
Cut but unset	10,800	12,400,000	r	13,500	18,100,000
Rough or uncut	700	289,000		389	524,000
Emeralds, cut but unset	4,090	214,000		3,140	254,000
Pearls:					
Cultured	NA	26,900		NA	15,800
Imitation	NA	4,150		NA	5,100
Natural	NA	21,100		NA	22,900
Rubies and sapphires, cut but unset	9,880	164,000		10,900	256,000
Other precious and semiprecious stones:					
Rough, uncut	1,080,000	15,000		1,400,000	30,700
Cut, set and unset	NA	247,000		NA	276,000
Other	91,100	11,600		78,100	11,300
Laboratory-created:					
Cut but unset	8,730	29,500		6,800	32,300
Other	NA	8,240		NA	14,600
Imitation gemstone[3]	NA	67,200		NA	66,600
Total	1,200,000	13,500,000	r	1,520,000	19,600,000

[r]Revised. NA Not available.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Does not include pearls.

Source: U.S. Census Bureau.

TABLE 11

NATURAL DIAMOND: WORLD PRODUCTION, BY COUNTRY AND TYPE [1, 2, 3]

(Thousand carats)

Country and type[4]	2006	2007	2008	2009	2010
Gemstones:					
Angola	8,258	8,732	8,016	12,445	12,500 e
Armenia	184	123	101	50	50 e
Australia	7,305	231	273	220 r, e	100 e
Botswana[e]	24,000	25,000	25,000	24,000	25,000
Brazil[e]	181	182	182	200 r, 5	200
Canada	13,278	17,144	14,803	10,946	11,773
Central African Republic[e]	340	370	302 r, 5	249 r, 5	250
China[e]	100	100	100	100	100
Congo (Kinshasa)	5,800	5,700	4,200	3,700 r	5,500
Côte d'Ivoire[e]	-- r	-- r	-- r	-- r	--
Ghana	768	671	478	301 r	300 e
Guinea	355	815	2,500	557 r	550
Guyana	341	269	169	144	144 e
Lesotho	231	454	450 e	450 e	460
Namibia	2,400	2,266	2,435	1,192 r	1,200 e
Russia[e]	23,400	23,300	21,925 5	17,791 5	17,800
Sierra Leone	362	362	223	241 r	240 e
South Africa[e]	6,100	6,100	5,200	2,500 r	3,500
Tanzania[e]	230	239	202	155 r	77
Venezuela[e]	45	45	45	45	45
Zimbabwe[e]	160	100	100	100	50
Other[6]	70	75 r	121 r	79 r	70
Total	93,900 r	92,300 r	86,800 r	75,500 r	79,900
Industrial:					
Angola[e]	918	970	900	1,383 r, 5	1,300
Australia	21,915	18,960	15,397	10,700	9,900
Botswana[e]	8,000	8,000	8,000	7,000	7,000
Brazil[e]	600	600	600	600	600
Central African Republic[e]	85	93	74 5	62 r, 5	60
China[e]	965	970	1,000	1,000	1,000
Congo (Kinshasa)	23,100	22,600	16,700	14,600 r	22,200
Côte d'Ivoire[e]	-- r	-- r	-- r	-- r	--
Ghana	192	168	120	75 r	75 e
Guinea	118	200	600	139 r	130
Russia[e]	15,000	15,000	15,000	15,000	15,000
Sierra Leone	241	241	149	160 r	160 e
South Africa[e]	9,100	9,100	7,700	3,600 r	5,400
Tanzania[e]	42	44	36 r	27	14
Venezuela[e]	70	70	70	70	70
Zimbabwe[e]	900	600	700	850 r	800
Other[7]	67	84 r	145 r	115 r	118
Total	81,300 r	77,700 r	67,200 r	55,400 r	63,800
Grand total	175,000 r	170,000 r	154,000 r	131,000 r	144,000

[e]Estimated. [r]Revised. -- Zero.

[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through June 2, 2011.

[3]In addition to the countries listed, Nigeria and the Republic of Korea produce natural diamond and synthetic diamond, respectively, but information is inadequate to formulate reliable estimates of output levels.

TABLE 11—Continued

NATURAL DIAMOND: WORLD PRODUCTION, BY COUNTRY AND TYPE [1, 2, 3]

[4]Includes near-gem and cheap-gem qualities.

[5]Reported figure.

[6]Includes Cameroon, Congo (Brazzaville), Gabon (unspecified), India, Indonesia, Liberia, and Togo (unspecified).

[7]Includes Congo (Brazzaville), India, Indonesia, and Liberia.

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2011 Minerals Yearbook

GEMSTONES [ADVANCE RELEASE]

U.S. Department of the Interior
U.S. Geological Survey

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Gemstones

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Domestic survey data and tables were prepared by Connie Lopez, statistical assistant, and the world production table was prepared by Glenn J. Wallace, international data coordinator.

In 2011, the estimated value of natural gemstones produced in the United States was more than $11.0 million, and the estimated value of U.S. laboratory-created gemstone production was more than $31.9 million. The total estimated value of U.S. gemstone production was about $43.0 million. The value of U.S. gemstone imports was $23.5 billion, and the value of combined U.S. gemstone exports and reexports was estimated to be $18.2 billion. In 2011, world natural diamond production totaled almost 135 million carats, of which an estimated 74.0 million carats was gem quality.

In this report, the terms "gem" and "gemstone" mean any mineral or organic material (such as amber, pearl, petrified wood, and shell) used for personal adornment, display, or object of art because it possesses beauty, durability, and rarity. Of more than 4,000 mineral species, only about 100 possess all these attributes and are considered to be gemstones. Silicates other than quartz are the largest group of gemstones in terms of chemical composition; oxides and quartz are the second largest (table 1). Gemstones are subdivided into diamond and colored gemstones, which in this report designates all natural nondiamond gems. In addition, laboratory-created gemstones, cultured pearls, and gemstone simulants are discussed but are treated separately from natural gemstones (table 2). Trade data in this report are from the U.S. Census Bureau. All percentages in the report were computed using unrounded data. Current information on industrial-grade diamond and industrial-grade garnet can be found in the U.S. Geological Survey (USGS) Minerals Yearbook, volume I, Metals and Minerals, chapters on industrial diamond and industrial garnet, respectively.

Gemstones have fascinated humans since prehistoric times. They have been valued as treasured objects throughout history by all societies in all parts of the world. Amber, amethyst, coral, diamond, emerald, garnet, jade, jasper, lapis lazuli, pearl, rock crystal, ruby, serpentine, and turquoise are some of the first stones known to have been used for making jewelry. These stones served as symbols of wealth and power. Today, gems are worn more for pleasure or in appreciation of their beauty than to demonstrate wealth. In addition to jewelry, gemstones are used for collections, decorative art objects, and exhibits.

Production

U.S. gemstone production data were based on a survey of more than 250 domestic gemstone producers conducted by the USGS. The survey provided a foundation for projecting the scope and level of domestic gemstone production during the year. However, the USGS survey did not represent all gemstone activity in the United States, which includes thousands of professional and amateur collectors. Consequently, the USGS supplemented its survey with estimates of domestic gemstone production from related published data, contacts with gemstone dealers and collectors, and information gathered at gem and mineral shows.

Commercial mining of gemstones has never been extensive in the United States. More than 60 varieties of gemstones have been produced commercially from domestic mines, but most of the deposits are relatively small compared with those of other mining operations. In the United States, much of the current gemstone mining is conducted by individual collectors, gem clubs, and hobbyists rather than by businesses.

The commercial gemstone industry in the United States consists of individuals and companies that mine gemstones or harvest shell and pearl, firms that manufacture laboratory-created gemstones, and individuals and companies that cut and polish natural and laboratory-created gemstones. The domestic gemstone industry is focused on the production of colored gemstones and on the cutting and polishing of large diamond stones. Industry employment is estimated to be between 1,000 and 1,200.

Most natural gemstone producers in the United States are small businesses that are widely dispersed and operate independently. The small producers probably have an average of less than three employees, including those who only work part time. The number of gemstone mines operating from year to year fluctuates because the uncertainty associated with the discovery and marketing of gem-quality minerals makes it difficult to obtain financing for developing and sustaining economically viable operations.

The total value of natural gemstones produced in the United States was estimated to be about $11.0 million during 2011 (table 3). This production value was a 10% increase from that of 2010.

Natural gemstone materials indigenous to the United States are collected or produced in every State. During 2011, all 50 States produced at least $1,390 worth of gemstone materials. There were 11 States that accounted for 90% of the total value, as reported by survey respondents. These States were, in descending order of production value, Arizona, North Carolina, Oregon, Utah, California, Tennessee, Montana, Arkansas, Colorado, Idaho, and Maine. Some States were known for the production of a single gemstone material—Tennessee for freshwater pearls, for example. Other States produced a variety of gemstones; for example, Arizona's gemstone deposits included agate, amethyst, azurite, chrysocolla, garnet, jade, jasper, malachite, obsidian, onyx, opal, peridot, petrified wood, smithsonite, and turquoise. A wide variety of gemstones also was found and produced in California, Idaho, Montana, and North Carolina.

In 2011, the United States had only one active operation in a known diamond-bearing area in Crater of Diamonds State Park near Murfreesboro in Pike County, AR. The State of Arkansas maintains a dig-for-fee operation for tourists and rockhounds at the park; Crater of Diamonds is the only diamond mine in the world that is open to the public. The diamonds occur in a lamproite breccia tuff associated with a volcanic pipe and in the soil developed from the lamproite breccia tuff. In 2011, 560 diamond stones with an average weight of 0.267 carat were recovered at the Crater of Diamonds State Park. Of the 560 diamond stones recovered, 30 weighed more than 1 carat. Since the diamond-bearing pipe and the adjoining area became a State park in 1972 through yearend 2011, 29,906 diamond stones with a total carat weight of 5,981.1 have been recovered (Margi Jenks, park interpreter, Crater of Diamonds State Park, written commun., January 22, 2013). Exploration has demonstrated that this diamond deposit contains about 78.5 million metric tons (Mt) of diamond-bearing rock (Howard, 1999, p. 62). An Arkansas law enacted early in 1999 prohibits commercial diamond mining in the park (Diamond Registry Bulletin, 1999).

A few companies have expressed interest in exploration for diamond deposits in areas of Alaska, Colorado, Minnesota, Montana, and Wyoming with geologic settings and terrain that are similar to Canadian diamond mining areas. Even though some exploration has taken place in these States, they remain largely unexplored for diamonds (Iron Range Resources & Rehabilitation Board, 2012). Although exploration and field studies have found many diamond indicators and a number of large diamond deposits, none have attracted long-term investors or been operated commercially.

In addition to natural gemstones, laboratory-created gemstones and gemstone simulants were produced in the United States in 2011. Laboratory-created or synthetic gemstones have the same chemical, optical, and physical properties as natural gemstones. Simulants have an appearance similar to that of a natural gemstone material, but they have different chemical, optical, and physical properties. Laboratory-created gemstones that have been produced in the United States include alexandrite, cubic zirconia, diamond, emerald, garnet, moissanite, ruby, sapphire, spinel, and turquoise. However, during 2011, only cubic zirconia, diamond, moissanite, and turquoise were produced commercially. Simulants of amber, chrysocolla, coral, lapis lazuli, malachite, travertine, and turquoise also were manufactured in the United States. In addition, certain colors of laboratory-created sapphire and spinel, used to represent other gemstones, are classified as simulants.

Laboratory-created gemstone production in the United States was valued at more than $31.9 million during 2011, which was a 4% increase compared with that of 2010. The value of U.S. simulant gemstone output was estimated to be more than $100 million. Five companies in five States, representing virtually the entire U.S. laboratory-created gemstone industry, reported production to the USGS. The States with reported laboratory-created gemstone production were, in descending order of production value, Florida, New York, Massachusetts, North Carolina, and Arizona.

Since the 1950s, when scientists manufactured the first laboratory-created bits of diamond grit using a high-pressure, high-temperature (HPHT) method, this method of growing diamonds has become relatively commonplace in the world as a technology for laboratory-created diamonds, so much so that thousands of small plants throughout China were using the HPHT method and producing laboratory-created diamonds suitable for cutting as gemstones. Gem-quality diamonds of 1 carat or more are harder to manufacture because at that size, it is difficult to consistently produce diamonds of high quality, even in the controlled environment of a laboratory using the HPHT method. After more than 50 years of development, that situation changed, and several laboratory-created diamond companies were able to produce high-quality diamonds that equaled those produced from mines (Park, 2007).

Gemesis Corp. (Sarasota, FL) consistently produced gem-quality laboratory-created diamond and reported production in 2011. The weight of the laboratory-created diamond stones ranges from 1½ to 2 carats, and most of the stones are brownish yellow, colorless, green, and yellow. Gemesis uses diamond-growing machines capable of growing 3-carat rough diamonds by generating HPHT conditions that recreate the conditions in the Earth’s mantle where natural diamonds form (Davis, 2003). The prices of the Gemesis laboratory-created diamonds are 30% to 50% lower than those of comparable natural diamond but above the prices of simulated diamond (Gemesis Corp., 2010).

In the early 2000s, Apollo Diamond, Inc., near Boston, MA, developed and patented a method for growing single, extremely pure, gem-quality diamond crystals by chemical vapor deposition (CVD). The CVD technique transforms carbon into plasma, which is then precipitated onto a substrate as diamond. CVD had been used for more than a decade to cover large surfaces with microscopic diamond crystals, but in developing this process, Apollo Diamond discovered the temperature, gas composition, and pressure combination that resulted in the growth of a single diamond crystal. Apollo Diamond produced laboratory-created stones that ranged from 1 to 2 carats. Beginning in 2008, Apollo Diamond increased its production of large stones and sold the diamonds at prices that averaged 15% less than those of comparable natural diamonds (Apollo Diamond, Inc., 2008). Apollo Diamond and Gemesis prefer to call their diamonds “cultured” rather than laboratory-created, referring to the fact that the diamonds are grown much like a cultured pearl is grown.

During 2011, Apollo Diamond ceased manufacture of single-crystal CVD diamond for gemstone and industrial use. On August 31, 2011, SCIO Diamond Technology Corp. acquired the diamond growing machines and the related intellectual property rights from Apollo Diamond and on June 5, 2012, acquired the remainder of the assets including cultured diamond gemstone-related technology, inventory, and various intellectual property rights. SCIO Diamond Technology transferred all diamond growing equipment to their labs in Greenville, SC, and planned to begin manufacturing single-crystal CVD diamonds during 2012 (Yahoo Finance, 2012).

Charles & Colvard, Ltd. in North Carolina was the world’s only manufacturer of moissanite, a gem-quality laboratory-created silicon carbide. Moissanite is an excellent diamond simulant, but it is being marketed for its own gem qualities. Moissanite exhibits a higher refractive index (brilliance) and higher luster than diamond. Its hardness is between those of corundum (ruby and sapphire) and diamond, which gives it durability (Charles & Colvard, Ltd., 2010). Charles & Colvard reported that moissanite sales increased by 26% to just more than $16 million in 2011 compared with $12.7 million in 2010 (Bracken, 2012).

U.S. mussel shells are used as a source of mother-of-pearl and as seed material for culturing pearls. U.S. shell production increased slightly in 2011 compared with that of 2010. This increase was in spite of decreased demands for U.S. shell materials caused by the use of manmade seed materials and seed materials from China and other sources by pearl producers in Japan. The popularity of darker and colored pearls and freshwater pearls that do not use U.S. seed material has also contributed decreased demands for U.S. shell materials. In some regions of the United States, shell from mussels was being used more as a gemstone based on its own merit rather than as seed material for pearls. This shell material was being processed into mother-of-pearl and used in beads, jewelry, and watch faces.

Consumption

Historically, diamond gemstones have proven to hold their value despite wars or economic depressions, but this did not hold true during the recent worldwide economic recession. Diamond and colored gemstones value and sales decreased during the economic downturn in 2008 and continued into 2009, but during 2010 and 2011 U.S. gemstone consumption and sales increased.

Although the United States accounted for little of the total global gemstone production, it was the world's leading diamond and nondiamond gemstone market. It was estimated that U.S. gemstone markets accounted for more than 35% of world gemstone demand in 2011. The U.S. market for unset gem-quality diamond during the year was estimated to be about $22.3 billion, an increase of 20% compared with that of 2010. Domestic markets for natural, unset nondiamond gemstones totaled approximately $1.19 billion in 2011, which was a 24% increase from that of 2010. These large increases in domestic markets were a reflection of the recovery from the impacts of the global recession on luxury spending.

In the United States, a majority of domestic consumers designate diamond as their favorite gemstone. This popularity of diamonds is evidenced by the U.S. diamond market making up 95% of the total U.S. gemstone market. Colored natural gemstones, colored laboratory-created gemstones, and "fancy" colored diamonds were popular in 2011, with the values of the domestic markets for almost all types of colored natural, unset nondiamond gemstones increased from the 2010 values (table 10), also owing to recovery from the impact of the recession on luxury spending.

The estimated U.S. retail jewelry sales were $68.3 billion in 2011, an increase of 11% from sales of $61.5 billion in 2010 (Gassman, 2012). Fifty-nine percent of all U.S. jewelers reported jewelry sales increased during the holiday shopping season from that of the previous year holiday shopping season (Graff, 2012).

Prices

Gemstone prices are governed by many factors and qualitative characteristics, including beauty, clarity, defects, demand, durability, and rarity. Diamond pricing, in particular, is complex; values can vary significantly depending on time, place, and the subjective valuations of buyers and sellers. More than 14,000 categories are used to assess rough diamond and more than 100,000 different combinations of carat, clarity, color, and cut values can be used to assess polished diamond.

Colored gemstone prices are generally influenced by market supply and demand considerations, and diamond prices are supported by producer controls on the quantity and quality of supply. Values and prices of gemstones produced and (or) sold in the United States are listed in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported, exported, or reexported are listed in tables 6 through 10.

De Beers Group companies remain a significant force, influencing the price of gem-quality diamond sales worldwide during 2011 because the companies mine a significant portion of the world's gem-quality diamond produced each year. In 2011, De Beers production from its independently owned and joint-venture operations in Botswana, Canada, Namibia, and South Africa decreased 5% to 31.3 million carats (Mct), compared with that of 2010. De Beers companies also sorted and valuated a large portion (by value) of the world's annual supply of rough diamond through De Beers' subsidiary Diamond Trading Co. (DTC). DTC sales of rough diamonds increased 27% during 2011 compared with those of 2010 and totaled $6.5 billion during 2011. DTC rough diamond average prices increased by 29% from those of 2010. In 2011, De Beers had total diamond and jewelry sales of $7.4 billion, which was an increase of 26% compared with those of 2010 (DeMarco, 2012).

Foreign Trade

During 2011, total U.S. gemstone trade with all countries and territories was valued at about $41.7 billion, which was an increase of 24% from that of 2010. Diamond accounted for about 97% of the 2011 gemstone trade total value. In 2011, U.S. exports and reexports of diamond were shipped to 92 countries and territories, and imports of all gemstones were received from 97 countries and territories (tables 6–10). In 2011, U.S. import quantities in cut diamond decreased slightly compared with those of 2010, and their value increased by 20%. U.S. import quantities in rough and unworked diamond increased by 81%, although their value increased by 20% (table 7). The United States remained the world's leading diamond importer and was a significant international diamond transit center as well as the world's leading gem-quality diamond market. In 2011, U.S. export and reexports quantities of gem-grade diamond decreased by 32% compared with those of 2010, and their value increased by 29%. The large volume of reexports revealed the significance of the United States in the world's diamond supply network (table 6).

Import values of laboratory-created gemstone increased by 27% for the United States in 2011 compared with those of 2010 (table 10). This increase in imports was owing to recovery from the impact of the recession on luxury spending.

Laboratory-created gemstone imports from Austria, Belgium, China, Germany, India, and Malaysia, with more than $33 million in imports, accounted for about 90% (by value) of the total domestic imports of laboratory-created gemstones during the year (table 9). The marketing of imported laboratory-created gemstones and enhanced gemstones as natural gemstones, and the mixing of laboratory-created materials with natural stones in imported parcels, continued to be problems for some domestic producers in 2011. Problems continued with some simulants being marketed as laboratory-created gemstones during the year.

World Review

The gemstone industry worldwide has two distinct sectors—diamond mining and marketing and colored gemstone production and sales. Most diamond supplies are controlled by a few major mining companies; prices are supported by managing the quality and quantity of the gemstones relative to demand, a function performed by De Beers through DTC. Unlike diamond, colored gemstones are primarily produced at relatively small, low-cost operations with few dominant producers; prices are influenced by consumer demand and supply availability.

In 2011, world natural diamond production totaled about 135 Mct—74.0 Mct gem quality and 60.5 Mct industrial grade (table 11). Most production was concentrated in a few regions—Africa [Angola, Botswana, Congo (Kinshasa), Namibia, and South Africa], Asia (northeastern Siberia and Yakutia in Russia), Australia, North America (Northwest Territories in Canada), and South America (Brazil and Venezuela). In 2011, Russia led the world in total natural diamond output quantity (combined gemstone and industrial) with 25% of the estimated world production. Botswana was the world's leading gemstone diamond producer with 34%; followed by Russia, 25%; Canada, 15%; Angola, 11%; Congo (Kinshasa), 5%; South Africa, 4%; Namibia, 2%; and Zimbabwe and Lesotho, with 1% each. These nine countries produced 98% (by quantity) of the world's gemstone diamond output in 2011.

In 2002, the international rough-diamond certification system, the Kimberley Process Certification Scheme (KPCS), was agreed upon by United Nations (UN) member nations, the diamond industry, and involved nongovernmental organizations to prevent the shipment and sale of conflict diamonds. Conflict diamonds are diamonds that originate from areas controlled by forces or factions opposed to legitimate and internationally recognized governments, and are used to fund military action in opposition to those governments, or in contravention of the decisions of the UN Security Council. The KPCS includes the following key elements: the use of forgery-resistant certificates and tamper-proof containers for shipments of rough diamonds; internal controls and procedures that provide credible assurance that conflict diamonds do not enter the legitimate diamond market; a certification process for all exports of rough diamonds; the gathering, organizing, and sharing of import and export data on rough diamonds with other participants of relevant production; credible monitoring and oversight of the international certification scheme for rough diamonds; effective enforcement of the provisions of the certification scheme through dissuasive and proportional penalties for violations; self regulation by the diamond industry that fulfills minimum requirements; and sharing information with all other participants on relevant rules, procedures, and legislation as well as examples of national certificates used to accompany shipments of rough diamonds. Congo (Kinshasa) assumed the chair of KPCS for January 1 through December 31, 2011, the ninth country or organization in succession to hold the chair after Israel, Namibia, India, South Africa, Canada, Russia, Botswana, and the European Commission. The 54 participants represented 80 nations (including the 27 member nations of the European Community) plus the rough diamond-trading entity of Taipei. During 2011, Côte d'Ivoire continued to be under UN sanctions and was not trading in rough diamonds, and Venezuela voluntarily suspended exports and imports of rough diamonds until further notice. The participating nations in the KPCS account for approximately 99.8% of the global production and trade of rough diamonds (Kimberley Process, undated).

Globally, the value of production of natural gemstones other than diamond was estimated to be more than $2.5 billion in 2011. Most nondiamond gemstone mines are small, low-cost, and widely dispersed operations in remote regions of developing nations. Foreign countries with major gemstone deposits other than diamond are Afghanistan (aquamarine, beryl, emerald, kunzite, lapis lazuli, ruby, and tourmaline), Australia (beryl, opal, and sapphire), Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline), Burma (beryl, jade, ruby, sapphire, and topaz), Colombia (beryl, emerald, and sapphire), Kenya (beryl, garnet, and sapphire), Madagascar (beryl, rose quartz, sapphire, and tourmaline), Mexico (agate, opal, and topaz), Sri Lanka (beryl, ruby, sapphire, and topaz), Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline), and Zambia (amethyst and beryl). In addition, pearls are cultured throughout the South Pacific and in other equatorial waters; Australia, China, French Polynesia, and Japan were key producers in 2011.

Worldwide diamond exploration allocations increased in 2011 after 3 years of declines with 70 companies allocating $449 million, compared with 99 companies allocating $357 million during 2010. This made the diamond share of overall worldwide exploration spending 3%. Africa no longer was the most popular diamond exploration location, after 7 years in a row of being the leading exploration spending spot (Metals Economics Group, 2011).

Worldwide in 2011, average diamond values increased 10% to $97.67 per carat from the 2010 average value of $88.79 per carat. This increase was reflected in increases in the U.S. markets, which demonstrated increasing quantity and value of diamond imports in 2011 compared with those of 2010, and improved sales in North America overall (Metals Economics Group, 2012).

Despite higher diamond prices, only two new projects were commissioned in 2011. The Kao Mine in Lesotho began operation, and the expansion of the Williamson Mine in Tanzania was commissioned in December 2011 (Metals Economics Group, 2012).

Canada.—Canadian diamond production was about 10.8 Mct during 2011, a decrease of about 8% compared with that of 2010. Diamond exploration continued in Canada, with several commercial diamond projects and additional discoveries in Alberta, British Columbia, the Northwest Territories, the Nunavut Territory, Ontario, and Quebec. In 2011, Canada produced 8% of the world's combined natural gemstone and industrial diamond output.

The Ekati Diamond Mine, Canada's first operating commercial diamond mine, completed its 13th full year of production in 2011. Ekati produced 2.07 Mct of diamond from 4.60 Mt of ore. BHP Billiton Ltd. has an 80% controlling ownership in Ekati, which is in the Northwest Territories. Ekati has estimated remaining reserves of 33.9 Mt of ore in kimberlite pipes that contain 16.2 Mct of diamond. BHP Billiton projected the remaining mine life to be 11 years. Approximately 21% of the Ekati 2011 diamond production is industrial-grade material (Perron, 2011, p. 1; BHP Billiton Ltd., 2012, p. 10).

The Diavik Diamond Mine, Canada's second diamond mine, also located in the Northwest Territories, completed its ninth full year of production. Diavik produces an average of 2 million metric tons per year (Mt/yr), grading an average of 3.1 carats per ton. At yearend 2011, Diavik estimated the mine's remaining proven and probable reserves to be 18.9 Mt of ore in kimberlite pipes containing 58.9 Mct of diamond and projected the total mine life to be 16 to 22 years. Diavik began developing an underground mine and substantially completed construction on the project during 2009. The first ore was produced from the underground mine during the first quarter of 2010, with full production expected in 2013. The mine is an unincorporated joint venture between Diavik Diamond Mine Inc. (60%) and Harry Winston Diamond Mines Ltd. (40%) (Perron, 2011, p. 2; Diavik Diamond Mine Inc., 2012, p. 5).

Canada's third diamond mine, the Jericho Diamond Mine in Nunavut, was originally owned by Tahera Diamond Corp. Tahera estimated the Jericho Diamond Mine's reserves to be about 5.5 Mt of ore grading 0.85 carats per ton. The Jericho Diamond Mine experienced startup problems related to ore mining and processing. The mine also suffered financial problems owing to the cost of transporting supplies to the mine site, high operational costs, high oil prices, and appreciation of the Canadian dollar versus the U.S. dollar. All of these problems combined to force the company to enter into protection under Canada's "Companies' Creditors Arrangement Act" on January 16, 2008, and the mine suspended production on February 6, 2008. At yearend 2009, Tahera was finalizing arrangements to sell all of its Jericho Diamond Mine assets (Perron, 2011, p. 2). In July 2010, Shear Minerals Ltd. (now known as Shear Diamonds Ltd.) announced that it had entered into a purchase agreement with Tahera and Benachee Resources Inc. to acquire a 100% interest in the Jericho Diamond Mine, the mine's processing facilities, and all supporting exploration assets in the Kitikmeot region of Nunavut (Shear Minerals Ltd., 2010). Shear Minerals completed the acquisition of the Jericho Diamond Mine in August 2010 with the intention of bringing the mine back into production during 2012 (Shear Minerals Ltd., 2011).

The Snap Lake Mine, in the Northwest Territories, is wholly owned by De Beers Canada Inc. The Snap Lake deposit is a tabular-shaped kimberlite dyke rather than the typical kimberlite pipe. The dyke is 2.5 meters thick and dips at an angle of 12° to 15°. The deposit was mined using a modified room and pillar underground mining method in 2011. The Snap Lake Mine started mining operations in October 2007, reached commercial production levels in the first quarter of 2008, and officially opened June 25, 2008. The mine was expected to produce 1.4 Mct per year of diamond, and the mine life was expected to be about 20 years. The mine's production for 2011 amounted to 881,000 carats for a recovered grade of 1.2 carats per ton (De Beers Canada Inc., 2011; Perron, 2011, p. 2–3; De Beers Group Inc., 2012).

The Victor Mine, in northern Ontario on the James Bay coast, also is wholly owned by De Beers Canada. The Victor kimberlite consists of two pipes with surface area of 15 hectares. The Victor Mine initiated mining operations at yearend 2007 and was officially opened on July 26, 2008. The Victor reportedly has 27.4 Mt of ore with average ore grade of 0.23 carats per ton estimated minable reserves. At full capacity, the open pit mine was expected to produce 600,000 carats per year, and the mine life was expected to be about 12 years. In 2011, the mine's production was 779,000 carats recovered from 2.67 Mt of ore (Perron, 2011, p. 3; De Beers Group Inc., 2012; De Beers Canada Inc., undated).

Lesotho.—The Kao Mine, owned by Namakwa Batla Diamonds Co., began processing kimberlite ore in late November 2011 and began commercial production in March 2012. Namakwa expected production of 170,000 carats for 2012 (Metals Economics Group, 2012).

Tanzania.—Refurbishing of the plant at the Williamson Mine began in December 2011. The Williamson Mine is 75% owned by Petra Diamond Ltd. and 25% by the Government of Tanzania. Petra began operating the newly rebuilt plant in March 2012, but was waiting for a secure electrical supply before committing to the full expansion to mining 10 Mt/yr of ore (Metals Economics Group, 2012, p. 24).

Outlook

As the domestic and global economy improves, Internet sales of diamonds, gemstones, and jewelry were expected to continue to expand and increase in popularity, as were other forms of e-commerce that emerge to serve the diamond and gemstone industry. Internet sales are expected to add to and partially replace "brick-and-mortar" sales. This is likely to take place as the gemstone industry and its customers become more comfortable with and learn the applications of new e-commerce tools, such as sales Web sites and online social networking Web sites (Dayrit, 2011).

As more independent producers, such as Ekati and Diavik in Canada, come online they will bring a greater measure of competition to global markets that presumably will bring more supplies and lower prices. Further consolidation of diamond producers and larger quantities of rough diamond being sold outside DTC is expected to continue as the diamond industry adjusts to De Beers' reduced influence on the industry.

More laboratory-created gemstones, simulants, and treated gemstones are likely to enter the marketplace and necessitate more transparent trade industry standards to maintain customer confidence.

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TABLE 1
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0–2.5	1.0–1.1	Single	1.54	Synthetic or pressed plastics, kaurigum	Fossil resin, color, low density, soft, insects.
Apatite	Chlorocalcium phosphate	Colorless, pink, yellow, green, blue, violet	Small	Low	5.0	3.16–3.23	Double	1.63–1.65	Amblygonite, andalusite, brazilianite, precious beryl, titanite, topaz, tourmaline	Crystal habit, color, hardness, appearance.
Azurite	Copper carbonate hydroxide	Azure, dark blue, pale blue	Small to medium	do.	3.5–4.0	3.7–3.9	do.	1.72–1.85	Dumortierite, hauynite, lapis lazuli, lazulite, sodalite	Color, softness, crystal habits, associated minerals.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	do.	High	6.0–6.5	3.64–3.68	do.	1.76–1.80	Sapphire, tanzanite, blue diamond, blue tourmaline, cordierite	Strong blue in ultraviolet light.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5–8.0	2.63–2.80	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	Red	Small	Very high	7.5–8.0	2.63–2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald, natural	do.	Green	Medium	do.	7.5	2.63–2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5–8.0	2.63–2.80	do.	1.58	Genuine emerald	Lack of flaws, brilliant fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5–8.0	2.63–2.80	do.	1.58	Citrine, topaz, glass, doublets	Weak-colored.
Goshenite	do.	Colorless	do.	Low	7.5–8.0	2.63–2.80	do.	1.58	Quartz, glass, white sapphire, white topaz	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5–8.0	2.63–2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49–1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.60	do.	Banded, translucent.
Charoite	Hydrated sodium calcium hydroxi-fluoro-silicate	Lilac, violet, or white	Small to medium	do.	5.0–6.0	2.54–2.78	XX	1.55–1.56	Purple marble	Color, locality.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by direct sunlight, or incandescent light, red by indirect sunlight or fluorescent light	do.	High	8.5	3.50–3.84	Double	1.75	Synthetic	Strong dichroism, color varies from red to green, hardness.
Cat's eye	do.	Greenish to brownish	Small to large	do.	8.5	3.50–3.84	do.	1.75	Synthetic, shell	Density, translucence, chatoyance.
Chrysolite	do.	Yellow, green, and (or) brown	Medium	Medium	8.5	3.50–3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Chrysocolla	Hydrated copper silicate	Green, blue	Any	Low	2.0–4.0	2.0–2.4	XX	1.46–1.57	Azurite, dyed chalcedony, malachite, turquoise, variscite	Lack of crystals, color, fracture, low density, softness.
Coral	Calcium carbonate	Orange, red, white, black, purple, or green	Branching, medium	do.	3.5–4.0	2.6–2.7	Double	1.49–1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95–4.10	do.	1.78	Synthetics, including spinel, garnet	Inclusions, fluorescence.
Sapphire, blue	do.	Blue	Medium	High	9.0	3.95–4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, colorless, orange, green, or violet	Medium to large	Medium	9.0	3.95–4.10	do.	1.78	Synthetics, glass and doublets, morganite	Inclusions, double refraction, refractive index.
Sapphire or ruby, stars	do.	Red, pink, violet, blue, or gray	do.	High to low	9.0	3.95–4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.
Sapphire or ruby, synthetic	do.	Yellow, pink, blue, green, orange, violet, or red	Up to 20 carats	Low	9.0	3.95–4.10	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Cubic zirconia	Zirconium and yttrium oxides	Colorless, pink, blue, lavender, yellow	Small	do.	8.25–8.5	5.8	Single	2.17	Diamond, zircon, titania, moissanite	Hardness, density, lack of flaws and inclusions, refractive index.
Diamond	Carbon	White, blue-white, yellow, brown, green, red, pink, blue	Any	Very high	10.0	3.516–3.525	do.	2.42	Zircon, titania, cubic zirconia, moissanite	High index, dispersion, hardness, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green-blue	Large	Low	6.0–6.5	2.56	XX	1.52	Jade, turquoise	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play (schiller)	do.	do.	6.0–6.5	2.56	XX	1.56	do.	Do.
Moonstone	do.	Colorless, white, gray, or yellow with white, blue, or bronze schiller	do.	do.	6.0–6.5	2.77	XX	1.52–1.54	Glass, chalcedony, opal	Pale sheen, opalescent.
Sunstone	do.	Orange, red brown, colorless with gold or red glittery schiller	Small to medium	do.	6.0–6.5	2.77	XX	1.53–1.55	Aventurine, glass	Red glittery schiller.
Garnet	Complex silicate	Brown, black, yellow, green, red, or orange	do.	Low to high	6.5–7.5	3.15–4.30	Single strained	1.79–1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Hematite	Iron oxide	Black, black-gray, brown-red	Medium to large	Low	5.5–6.5	5.12–5.28	XX	2.94–3.22	Davidite, cassiterite, magnetite, neptunite, pyrolusite, wolframite	Crystal habit, streak, hardness.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Jade:										
Jadeite	Complex silicate	Green, yellow, black, white, or mauve	Large	Low to very high	6.5–7.0	3.3–3.5	Crypto-crystalline	1.65–1.68	Nephrite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0–6.5	2.96–3.10	do.	1.61–1.63	Jadeite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Do.
Jet (gagate)	Lignite	Deep black, dark brown	do.	Low	2.5–4.0	1.19–1.35	XX	1.64–1.68	Anthracite, asphalt, cannel coal, onyx, schorl, glass, rubber	Luster, color.
Lapis lazuli	Sodium calcium aluminum silicate	Dark azure-blue to bright indigo blue or even a pale sky blue.	do.	do.	5.0–6.0	2.50–3.0	XX	1.50	Azurite, dumortierite, dyed howlite, lazulite, sodalite, glass	Color, crystal habit, associated minerals, luster, localities.
Malachite	Hydrated copper carbonate	Light to black-green banded	do.	do.	3.5–4.0	3.25–4.10	XX	1.66–1.91	Brochantite, chrysoprase, opaque green gemstones	Color banding, softness, associated minerals.
Moissanite	Silicon carbide	Colorless and pale shades of green, blue, yellow	Small	Low to medium	9.25	3.21	Double	2.65–2.69	Diamond, zircon, titania, cubic zirconia	Hardness, dispersion, lack of flaws and inclusions, refractive index.
Obsidian	Amorphous, variable (usually felsic)	Black, gray, brown, dark green, white, transparent	Large	Low	5.0–5.5	2.35–2.60	XX	1.45–1.55	Aegirine-augite, gadolinite, gagate, hematite, pyrolusite, wolframite	Color, conchoidal fracture, flow bubbles, softness, lack of crystal faces.
Opal	Hydrated silica	Reddish orange, colors flash in white gray, black, red, or yellow	do.	Low to high	5.5–6.5	1.9–2.3	Single	1.45	Glass, synthetics, triplets, chalcedony	Color play (opalescence).
Peridot	Iron magnesium silicate	Yellow and (or) green	Any	Medium	6.5–7.0	3.27–3.37	Double (strong)	1.65–1.69	Tourmaline, chrysoberyl	Strong double refraction, low dichroism.
Quartz:										
Agate	Silicon dioxide	Any	Large	Low	7.0	2.58–2.64	XX	XX	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65–2.66	Double	1.55	Glass, plastic, fluorite	Macrocrystalline, color, refractive index, transparent, hardness.
Aventurine	do.	Green, red-brown, gold-brown, with metallic iridescent reflection	do.	Low	7.0	2.64–2.69	do.	1.54–1.55	Iridescent analcime, aventurine feldspar, emerald, aventurine glass	Macrocrystalline, color, metallic iridescent flake reflections, hardness.
Cairngorm	do.	Smoky orange or yellow	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Carnelian	Silicon dioxide	Flesh red to brown red	Large	Low	6.5–7.0	2.58–2.64	Double	1.53–1.54	Jasper	Cryptocrystalline, color, hardness.
Chalcedony	do.	Bluish, white, gray	do.	do.	6.5–7.0	2.58–2.64	do.	1.53–1.54	Tanzanite	Do.
Chrysoprase	do.	Green, apple-green	do.	do.	6.5–7.0	2.58-2.64	do.	1.53–1.54	Chrome chalcedony, jade, prase opal, prehnite, smithsonite, variscite, artificially colored green chalcedony	Do.
Citrine	do.	Yellow	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Jasper	do.	Any, striped, spotted, or sometimes uniform	do.	do.	7.0	2.58–2.66	XX	XX	do.	Cryptocrystalline, opaque, vitreous luster, hardness.
Onyx	do.	Many colors	do.	do.	7.0	2.58–2.64	XX	XX	do.	Cryptocrystalline, uniformly banded, hardness.
Petrified wood	do.	Brown, gray, red, yellow	do.	do.	6.5–7.0	2.58–2.91	Double	1.54	Agate, jasper	Color, hardness, wood grain.
Rock crystal	do.	Colorless	do.	do.	7.0	2.65–2.66	do.	1.55	Topaz, colorless sapphire	Do.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Tiger's eye	do.	Golden yellow, brown, red, blue-black	do.	do.	6.5-7.0	2.58–2.64	XX	1.53–1.54	XX	Macrocrystalline, color, hardness, chatoyancy.
Rhodochrosite	Manganese carbonate	Rose-red to yellowish, stripped	do.	do.	4.0	3.45–3.7	Double	1.6–1.82	Fire opal, rhodonite, tugtupite, tourmaline	Color, crystal habit, reaction to acid, perfect rhombohedral cleavage.
Rhodonite	Manganese iron calcium silicate	Dark red, flesh red, with dendritic inclusions of black manganese oxide	do.	do.	5.5–6.5	3.40–3.74	do.	1.72–1.75	Rhodochrosite, thulite, hessonite, spinel, pyroxmangite, spessartine, tourmaline	Color, black inclusions, lack of reaction to acid, hardness.
Shell:										
Mother-of-pearl	Calcium carbonate	White, cream, green, blue-green, with iridescent play of color	Small	do.	3.5	2.6–2.85	XX	XX	Glass and plastic imitation	Luster, iridescent play of color.
Pearl	do.	White, cream to black, sometimes with hint of pink, green, purple	do.	Low to high	2.5–4.5	2.6–2.85	XX	XX	Cultured and glass or plastic imitation	Luster, iridescence, x-structure, ray.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Spinel, natural	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5–3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5–3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5–7.0	3.13–3.20	do.	1.66	Synthetic spinel	Refractive index, color, pleochroism.
Kunzite	do.	Pink to lilac	do.	do.	6.5–7.0	3.13–3.20	do.	1.66	Amethyst, morganite	Do.
Tanzanite	Complex silicate	Blue to lavender	Small	High	6.0–7.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism, color.
Topaz	do.	White, blue, green, pink, yellow, gold	Medium	Low to medium	8.0	3.4–3.6	do.	1.62	Beryl, quartz	Color, density, hardness, refractive index, perfect in basal cleavage.
Tourmaline	do.	Any, including mixed	do.	do.	7.0–7.5	2.98–3.20	do.	1.63	Peridot, beryl, garnet corundum, glass	Double refraction, color, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green with black, brown-red inclusions	Large	Low	6.0	2.60–2.83	do.	1.63	Chrysocolla, dyed howlite, dumortierite, glass, plastics, variscite	Difficult if matrix not present, matrix usually limonitic.
Unakite	Granitic rock, feldspar, epidote, quartz	Olive green, pink, and blue-gray	do.	do.	6.0–7.0	2.60–3.20	XX	XX	XX	Olive green, pink, gray-blue colors.
Zircon	Zirconium silicate	White, blue, brown, yellow, or green	Small to medium	Low to medium	6.0–7.5	4.0–4.8	Double (strong)	1.79–1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

Do., do. Ditto. XX Not applicable.

[1]Small: up to 5 carats; medium: 5 to 50 carats; large: more than 50 carats.

[2]Low: up to $25 per carat; medium: up to $200 per carat; high: more than $200 per carat.

TABLE 2
LABORATORY-CREATED GEMSTONE PRODUCTION METHODS

Gemstone	Production method	Company/producer	Date of first production
Alexandrite	Flux	Creative Crystals Inc.	1970s.
Do.	Melt pulling	J.O. Crystal Co., Inc.	1990s.
Do.	do.	Kyocera Corp.	1980s.
Do.	Zone melt	Seiko Corp.	Do.
Cubic zirconia	Skull melt	Various producers	1970s.
Emerald	Flux	Chatham Created Gems	1930s.
Do.	do.	Gilson	1960s.
Do.	do.	Kyocera Corp.	1970s.
Do.	do.	Lennix	1980s.
Do.	do.	Russia	Do.
Do.	do.	Seiko Corp.	Do.
Do.	Hydrothermal	Biron Corp.	Do.
Do.	do.	Lechleitner	1960s.
Do.	do.	Regency	1980s.
Do.	do.	Russia	Do.
Ruby	Flux	Chatham Created Gems	1950s.
Do.	do.	Douras	1990s.
Do.	do.	J.O. Crystal Co., Inc.	1980s.
Do.	do.	Kashan Created Ruby	1960s.
Do.	Melt pulling	Kyocera Corp.	1970s.
Do.	Verneuil	Various producers	1900s.
Do.	Zone melt	Seiko Corp.	1980s.
Sapphire	Flux	Chatham Created Gems	1970s.
Do.	Melt pulling	Kyocera Corp.	1980s.
Do.	Verneuil	Various producers	1900s.
Do.	Zone melt	Seiko Corp.	1980s.
Star ruby	Melt pulling	Kyocera Corp.	Do.
Do.	do.	Nakazumi Earth Crystals Co.	Do.
Do.	Verneuil	Linde Air Products Co.	1940s.
Star sapphire	do.	do.	Do.

Do., do. Ditto.

TABLE 3
ESTIMATED VALUE OF U.S. NATURAL GEMSTONE PRODUCTION, BY GEM TYPE[1]

(Thousand dollars)

Gem materials	2010	2011
Beryl	1,700	1,740
Coral, all types	150	150
Diamond	(2)	(2)
Garnet	149	110
Gem feldspar	693	756
Geode/nodules	110	110
Opal	189	71
Quartz:		
Macrocrystalline[3]	273	333
Cryptocrystalline[4]	208	248
Sapphire/ruby	344	343
Shell	821	832
Topaz	(2)	(2)
Tourmaline	95	73
Turquoise	449	1,330
Other	4,840	4,950
Total	10,000	11,000

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Less than ½ unit.

[3]Macrocrystalline quartz (crystals recognizable with the naked eye) includes amethyst, aventurine, blue quartz, citrine, hawk's eye, pasiolite, prase, quartz cat's eye, rock crystal, rose quartz, smoky quartz, and tiger's eye.

[4]Cryptocrystalline quartz (microscopically small crystals) includes agate, carnelian, chalcedony, chrysoprase, fossilized wood, heliotrope, jasper, moss agate, onyx, and sard.

TABLE 4
PRICES PER CARAT OF U.S. CUT ROUND DIAMONDS, BY SIZE AND QUALITY IN 2011

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Representative prices		
			January[3]	June[4]	December[5]
0.25	G	VS1	$1,400	$1,650	$1,650
Do.	G	VS2	1,300	1,600	1,600
Do.	G	SI1	1,200	1,250	1,250
Do.	H	VS1	1,350	1,600	1,600
Do.	H	VS2	1,250	1,500	1,500
Do.	H	SI1	1,150	1,200	1,200
0.50	G	VS1	2,650	3,600	3,600
Do.	G	VS2	2,200	3,100	3,100
Do.	G	SI1	1,900	2,500	2,500
Do.	H	VS1	2,350	3,170	3,170
Do.	H	VS2	2,150	2,750	2,750
Do.	H	SI1	1,800	2,250	2,250
1.00	G	VS1	6,400	8,500	8,500
Do.	G	VS2	5,450	8,000	8,000
Do.	G	SI1	4,650	6,500	6,500
Do.	H	VS1	5,300	7,700	7,700
Do.	H	VS2	4,800	7,200	7,200
Do.	H	SI1	4,225	5,900	5,900
2.00	G	VS1	12,100	15,500	15,500
Do.	G	VS2	11,500	13,200	13,200
Do.	G	SI1	9,100	11,200	11,200
Do.	H	VS1	9,500	13,300	13,300
Do.	H	VS2	9,100	11,700	11,700
Do.	H	SI1	8,250	10,300	10,300

Do. Ditto.

[1]Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; G, H, I—traces of color.

[2]Clarity: IF—no blemishes; VVS1—very, very slightly included; VS1—very slightly included; VS2—very slightly included, but not visible; SI1—slightly included.

[3]Source: The Gem Guide, v. 30, no. 1, January/February 2011, p. 20–22.

[4]Source: The Gem Guide, v. 30, no. 4, July/August 2011, p. 20–22.

[5]Source: The Gem Guide, v. 30, no. 6, November/December 2011, p. 20–22.

TABLE 5
PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES IN 2011

Gemstone	Price range per carat	
	January[1]	December[2]
Amethyst	$10–25	$10–25
Blue sapphire	950–1,800	950–1,900
Blue topaz	5–10	5–10
Emerald	2,400–4,000	2,600–4,400
Green tourmaline	50–70	50–70
Cultured saltwater pearl[3]	5	5
Pink tourmaline	70–150	65–170
Rhodolite garnet	22–45	22–45
Ruby	1,850–2,200	2,200–2,600
Tanzanite	300–375	300–375

[1]Source: The Gem Guide, v. 30, no. 1, January/February 2011, p. 50, 53, 57, 61, 63, 65, and 68–71. These figures are approximate wholesale purchase prices paid by retail jewelers on a per stone basis for 1-to-less than 1 carat, fine-quality stones.

[2]Source: The Gem Guide, v. 30, no. 6, November/December 2011, p. 50, 53, 57, 61, 63, 65, and 68–71. These figures are approximate wholesale purchase prices paid by retail jewelers on a per-stone basis for 1-to-less than 1 carat, fine-quality stones.

[3]Prices are per 4.5 to 5-millimeter pearl.

TABLE 6
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY[1]

Country	2010 Quantity (carats)	2010 Value[2] (millions)	2011 Quantity (carats)	2011 Value[2] (millions)
Exports:				
Aruba	5,460	$9	3,390	$11
Australia	33,000	34	11,700	25
Austria	440	2	544	1
Bahamas, The	870	3	852	5
Belgium	346,000	396	269,000	370
Belize	371	1	142	(3)
Brazil	20,200	3	7,130	2
Canada	52,000	87	52,400	96
Cayman Islands	1,240	5	1,190	6
China	23,300	34	13,900	39
Costa Rica	9,430	2	7,760	1
Curacao	--	--	6,150	17
Denmark	368	1	190	(3)
Dominican Republic	1,680,000	10	44,300	11
France	33,000	94	1,200	34
Germany	3,720	4	22,500	4
Honduras	300	1	113	(3)
Hong Kong	1,910,000	448	2,320,000	522
India	1,300,000	825	768,000	579
Ireland	10,000	39	895	5
Israel	419,000	365	293,000	756
Italy	1,600	3	3,020	15
Jamaica	179	(3)	440	2
Japan	3,400	9	6,830	3
Lebanon	1,410	2	4,800	5
Malaysia	505	2	255	(3)
Mexico	561,000	84	604,000	97
Netherlands	1,150	9	474	1
Netherlands Antilles (former)	12,700	34	5,860	15
New Zealand	630	2	429	2
Panama	443	(3)	609	2
Qatar	4,370	7	--	--
Russia	460,000	2	639	3
Singapore	8,690	10	6,050	3
South Africa	636	7	510	4
Sweden	145	(3)	2,510	7
Switzerland	147,000	177	190,000	257
Taiwan	9,080	4	497	2
Thailand	92,500	14	168,000	22
United Arab Emirates	193,000	68	131,000	66
United Kingdom	325,000	58	492,000	76
Vietnam	2,610	2	564	(3)
Other	27,500 r	7 r	12,500	5
Total	7,710,000	2,860	5,450,000	3,070
Reexports:				
Armenia	1,880	(3)	11,000	5
Aruba	3,320	3	2,290	4
Australia	16,300	16	2,980	18
Austria	4,500	(3)	301	3
Belgium	2,410,000	1,600	956,000	2,240
Botswana	370	2	7	(3)
Canada	143,000	144	129,000	150
China	28,700	18	32,900	43
France	47,900	78	6,560	126
Germany	5,820	2	2,230	3
Guatemala	46,000	5	52,600	4
Hong Kong	4,340,000	1,820	2,830,000	2,470
India	2,730,000	1,900	3,510,000	2,940

See footnotes at end of table.

TABLE 6—Continued
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY[1]

	2010		2011	
Country	Quantity (carats)	Value[2] (millions)	Quantity (carats)	Value[2] (millions)
Israel	4,390,000	$4,110	2,000,000	$5,140
Italy	24,900	5	7,270	3
Japan	98,200	32	47,200	34
Laos	4,260	1	4,850	3
Lebanon	7,860	5	3,040	5
Malaysia	2,480	2	376	4
Mexico	5,780	1	2,900	3
Namibia	6,180	10	4,450	11
Netherlands	458,000	304	108,000	365
Netherlands Antilles (former)	16,100	38	4,360	16
Saint Kitts and Nevis	424	1	333	(3)
Singapore	65,500	24	5,080	41
South Africa	29,300	45	8,040	76
Spain	2,600	3	207	(3)
Switzerland	429,000	565	83,500	604
Taiwan	17,900	6	18,000	15
Thailand	160,000	31	178,000	60
United Arab Emirates	338,000	188	511,000	322
United Kingdom	166,000	269	31,500	399
Other	27,300 r	10 r	17,300	24
Total	16,000,000	11,200	10,600,000	15,100
Grand total	23,700,000	14,100	16,000,000	18,200

[r]Revised. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY[1]

Kind, range, and country of origin	2010 Quantity (carats)	2010 Value[2] (millions)	2011 Quantity (carats)	2011 Value[2] (millions)
Rough or uncut, natural:[3]				
Angola	67,000	$132	26,700	$168
Belgium	114	(4)	2,640	4
Botswana	81,500	68	84,100	159
Brazil	--	--	110	2
Canada	35,300	43	20,100	37
Central African Republic	669	3	394	(4)
Congo (Kinshasa)	6,650	7	6,460	8
India	12,900	1	170,000	2
Israel	10,000	2	1,030	2
Lesotho	488	18	932	40
Namibia	7,450	9	3,820	4
Russia	37,500	8	118,000	18
Sierra Leone	4,100	4	3,180	10
South Africa	102,000	223	199,000	173
Other	22,700 r	27 r	68,200	3
Total	389,000	524 r	704,000	630
Cut but unset, not more than 0.5 carat:				
Australia	5,690	3	4,110	4
Belgium	281,000	106	277,000	102
Botswana	8,240	13	6,890	18
Brazil	238	(4)	4,470	1
Canada	13,000	9	23,600	8
China	37,500	21	34,300	31
Dominican Republic	7,250	2	3,430	1
Hong Kong	180,000	25	197,000	30
India	7,310,000	1,560	6,990,000	1,850
Israel	433,000	207	414,000	236
Mauritius	5,780	15	6,220	17
Mexico	92,300	21	76,300	21
Namibia	3,220	7	2,060	5
Russia	2,470	2	585	1
South Africa	9,440	13	4,910	7
Sri Lanka	1,020	(4)	2,980	1
Switzerland	807	(4)	40,600	2
Thailand	93,400	14	93,000	13
United Arab Emirates	77,100	17	112,000	42
United Kingdom	2,790	1	24,700	4
Vietnam	27,100	21	30,400	29
Other	12,400 r	2 r	11,600	3
Total	8,610,000	2,060	8,360,000	2,430
Cut but unset, more than 0.5 carat:				
Armenia	430	(4)	3,170	3
Australia	6,600	37	4,710	41
Belgium	706,000	2,900	733,000	3,550
Botswana	12,500	54	11,200	63
Brazil	424	4	294	7
Canada	23,300	83	16,200	67
Central African Republic	4	(4)	35	2
China	19,300	60	35,000	102
Costa Rica	31	1	5	(4)
France	1,650	26	1,240	23
Germany	662	8	3,050	13
Hong Kong	42,200	102	48,500	107
India	1,900,000	3,610	1,970,000	4,410
Indonesia	44	3	41	1
Israel	2,000,000	7,530	1,970,000	8,950
Italy	5,260	16	3,320	11
Japan	595	2	1,380	2
Lebanon	1,150	2	1,470	3

See footnotes at end of table.

TABLE 7—Continued

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY[1]

	2010		2011	
Kind, range, and country of origin	Quantity (carats)	Value[2] (millions)	Quantity (carats)	Value[2] (millions)
Lesotho	--	--	136	$28
Madagascar	55	$1	--	--
Mauritius	3,220	18	2,720	16
Mexico	1,250	1	465	2
Namibia	9,620	35	16,800	89
Netherlands	244	3	284	5
Philippines	868	1	145	1
Russia	25,300	98	17,100	100
Singapore	1,710	2	245	1
South Africa	63,000	892	42,700	900
Sri Lanka	1,130	8	3,920	4
Switzerland	11,300	391	18,900	541
Tanzania	66	1	--	--
Thailand	5,910	13	11,200	26
United Arab Emirates	10,100	42	38,400	100
United Kingdom	3,550	53	3,880	85
Vietnam	3,410	4	1,920	2
Other	1,260 r	137 r	1,750	7
Total	4,860,000	16,000	4,970,000	19,300

r Revised. -- Zero.

[1] Data are rounded to no more than three significant digits; may not add to totals shown.

[2] Customs value.

[3] Includes some natural advanced diamond.

[4] Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

Kind and country	2010 Quantity (carats)	2010 Value[2] (millions)	2011 Quantity (carats)	2011 Value[2] (millions)
Emerald:				
Belgium	1,340	(3)	737	$1
Brazil	120,000	$7	186,000	9
Canada	4	(3)	1,390	--
China	13,800	1	34,100	--
Colombia	406,000	131	365,000	161
France	1,480	2	152	2
Germany	54,000	2	9,940	3
Hong Kong	246,000	17	118,000	11
India	1,810,000	37	1,400,000	57
Israel	172,000	17	138,000	15
Italy	2,880	(3)	9,050	6
Switzerland	6,290	13	71,900	61
Thailand	487,000	10	374,000	11
United Kingdom	1,550	2	760	1
Other	89,400	15	43,400	10
Total	3,410,000	254	2,760,000	348
Ruby:				
Belgium	16	(3)	41	(3)
China	19,200	(3)	730	(3)
France	1,730	(3)	15	1
Germany	10,900	(3)	14,000	(3)
Hong Kong	201,000	1	137,000	4
India	2,310,000	6	2,020,000	4
Israel	22,300	(3)	4,570	(3)
Italy	4,300	(3)	9,910	1
Kenya	1,810	(3)	1,050	(3)
Sri Lanka	3,800	(3)	633	(3)
Switzerland	129	2	55,900	4
Thailand	1,880,000	22	1,640,000	23
United Arab Emirates	210	(3)	--	--
Other	168,000	11 r	45,100	7
Total	4,630,000	42	3,920,000	45
Sapphire:				
Belgium	2,420	1	1,720	2
China	56,700	3	163,000	5
France	1,160	2	2,460	2
Germany	123,000	4	32,200	11
Hong Kong	536,000	9	237,000	15
India	2,570,000	20	2,970,000	18
Israel	19,300	2	13,000	3
Italy	5,440	1	93,200	6
Madagascar	2,940	4	31,700	3
South Africa	33,700	1	3,680	1
Sri Lanka	309,000	66	256,000	77
Switzerland	13,700	20	91,800	26
Thailand	2,630,000	78	3,050,000	109
United Kingdom	610	1	1,040	3
Other	11,900 r	2 r	40,500	1
Total	6,320,000	214	6,980,000	282
Other:				
Rough, uncut, all countries	NA	15	NA	23
Cut, set and unset, all countries	NA	32	NA	37

r Revised. NA Not available. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 9
VALUE OF U.S. IMPORTS OF LABORATORY-CREATED
AND IMITATION GEMSTONES, BY COUNTRY[1, 2]

(Thousand dollars)

Country	2010	2011
Laboratory-created, cut but unset:		
Austria	1,950	2,340
Belgium	1,320	882
China	5,700	4,770
Germany	10,100	9,970
India	9,870	11,900
Malaysia	(3)	3,120
Other	3,350 r	3,710
Total	32,300	36,700
Imitation:[4]		
Austria	51,400	48,300
China	13,300	19,500
Czech Republic	5,070	5,540
Other	1,920 r	2,010
Total	71,700	75,400

[r]Revised.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Less than ½ unit.
[4]Includes pearls.

Source: U.S. Census Bureau.

TABLE 10
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES[1]

(Thousand carats and thousand dollars)

Stones	2010 Quantity	2010 Value[2]	2011 Quantity	2011 Value[2]
Coral and similar materials, unworked	5,760	12,000	5,370	11,800
Diamonds:				
Cut but unset	13,500	18,100,000	13,300	21,700,000
Rough or uncut	389	524,000	704	630,000
Emeralds, cut but unset	3,140	254,000	2,760	348,000
Pearls:				
Cultured	NA	15,800	NA	27,300
Imitation	NA	5,100	NA	5,930
Natural	NA	22,900	NA	18,600
Rubies and sapphires, cut but unset	10,900	256,000	10,900	328,000
Other precious and semiprecious stones:				
Rough, uncut	1,400,000	30,700	1,670,000	15,000
Cut, set and unset	NA	276,000	NA	301,000
Other	78,100	11,300	33,600	7,240
Laboratory-created:				
Cut but unset	6,800	32,300	6,230	36,700
Other	NA	14,600	NA	22,800
Imitation gemstone[3]	NA	66,600	NA	69,400
Total	1,520,000	19,600,000	1,740,000	23,500,000

NA Not available.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Does not include pearls.

Source: U.S. Census Bureau.

TABLE 11

NATURAL DIAMOND: WORLD PRODUCTION, BY COUNTRY AND TYPE[1, 2, 3]

(Thousand carats)

Country and type[4]	2007	2008	2009	2010	2011
Gemstones:					
Angola	8,732	8,016	12,445	7,600 r	8,100
Armenia	123	101	50	50 e	80
Australia	231	273	220 e	100 e	86
Botswana[e]	25,000	25,000	24,000	25,000	25,000
Brazil	182 e	71 r	21 r	25 r	25 p
Canada	17,144	14,803	10,946	11,773	10,795
Central African Republic[e]	370	302 5	249 5	240 r	250
China[e]	100	100	100	100	100
Congo (Kinshasa)	5,700	4,200	3,700	3,400 r	3,900
Ghana	671	478	301	267 r	300 e
Guinea	815	2,500	557	280 r	300 e
Guyana	269	169 r	144	50 e	50
Lesotho[e]	454 5	450	450	460	450
Namibia	2,266	2,435	1,192	1,693 r	1,700 e
Russia[e]	23,300	21,925 5	17,791 5	17,800	18,500
Sierra Leone	362	223	241	306 r	280 e
South Africa[e]	6,100	5,200	2,500	3,500	2,800
Tanzania[e]	239	202	155	77	51
Venezuela[e]	45	45	45	45	45
Zimbabwe[e]	100	100	100	900 r	1,000
Other[6]	75	121	79	221 r	221
Total	92,300	86,700 r	75,300 r	73,900 r	74,000
Industrial:					
Angola[e]	970	900	1,383 5	900 r	900
Australia	18,960	15,397	10,700	9,900 e	7,500 e
Botswana[e]	8,000	8,000	7,000	7,000	7,000
Brazil[e]	600	600	600	600	600
Central African Republic[e]	93	74 5	62 5	62 r	62
China[e]	970	1,000	1,000	1,000	1,000
Congo (Kinshasa)	22,600	16,700	14,600	13,400 r	15,600
Ghana	168	120	75	67 r	67 e
Guinea	200	600	139	94 r	95 e
Russia[e]	15,000	15,000	15,000	15,000	15,000
Sierra Leone	241	149	160	131 r	120 e
South Africa[e]	9,100	7,700	3,600	5,400	4,200
Tanzania[e]	44	36	27	14	9
Venezuela[e]	70	70	70	70	70
Zimbabwe[e]	600	700	850	7,500	8,000
Other[7]	84	145	115	285 r	285
Total	77,700	67,200	55,400	61,400 r	60,500
Grand total	170,000	154,000	131,000	135,000 r	135,000

[e]Estimated. [p]Preliminary. [r]Revised.

[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through June 2, 2012.

[3]In addition to the countries listed, Nigeria and the Republic of Korea produce natural diamond, but information is inadequate to formulate reliable estimates of output levels.

[4]Includes near-gem and cheap-gem qualities.

[5]Reported figure.

[6]Includes Cameroon, Congo (Brazzaville), Gabon (unspecified), India, Indonesia, Liberia, and Togo (unspecified).

[7]Includes Congo (Brazzaville), India, Indonesia, and Liberia.

science for a changing world

2012 Minerals Yearbook

GEMSTONES [ADVANCE RELEASE]

U.S. Department of the Interior
U.S. Geological Survey

August 2014

Gemstones

By Donald W. Olson

Domestic survey data and tables were prepared by Connie Lopez, statistical assistant, and the world production table was prepared by Glenn J. Wallace, international data coordinator.

In 2012, the estimated value of natural gemstones produced in the United States was $11.3 million (table 3) and the estimated value of U.S. laboratory-created gemstone production was $31.2 million. The total estimated value of U.S. gemstone production was $42.6 million. The value of U.S. gemstone imports was $21.3 billion (table 10) and the value of combined U.S. gemstone exports and reexports was estimated to be $16.9 billion (table 6). In 2012, world natural diamond production totaled 128 million carats, of which an estimated 92 million carats were gem quality (table 11).

In this report, the terms “gem” and “gemstone” mean any mineral or organic material (such as amber, pearl, petrified wood, and shell) used for personal adornment, display, or object of art because it possesses beauty, durability, and rarity. Of more than 4,000 mineral species, only about 100 possess all these attributes and are considered to be gemstones. Silicates other than quartz are the largest group of gemstones in terms of chemical composition; oxides and quartz are the second largest (table 1). Gemstones are subdivided into diamond and colored gemstones, which in this report designates all natural nondiamond gems. In addition, laboratory-created gemstones, cultured pearls, and gemstone simulants are discussed but are treated separately from natural gemstones (table 2). Trade data in this report are from the U.S. Census Bureau. All percentages in the report were computed using unrounded data. Current information on industrial-grade diamond and industrial-grade garnet can be found in the U.S. Geological Survey (USGS) Minerals Yearbook, volume I, Metals and Minerals, chapters on industrial diamond and industrial garnet, respectively.

Gemstones have fascinated humans since prehistoric times. They have been valued as treasured objects throughout history by all societies in all parts of the world. Amber, amethyst, coral, diamond, emerald, garnet, jade, jasper, lapis lazuli, pearl, rock crystal, ruby, serpentine, and turquoise are some of the first stones known to have been used for making jewelry. These stones served as symbols of wealth and power. Today, gems are worn more for pleasure or in appreciation of their beauty than to demonstrate wealth. In addition to jewelry, gemstones are used for collections, decorative art objects, and exhibits.

Production

U.S. gemstone production data were based on a survey of more than 250 domestic gemstone producers conducted by the USGS. The survey provided a foundation for projecting the scope and level of domestic gemstone production during the year. However, the USGS survey did not represent all gemstone activity in the United States, which includes thousands of professional and amateur collectors. Consequently, the USGS supplemented its survey with estimates of domestic gemstone production from related published data, contacts with gemstone dealers and collectors, and information gathered at gem and mineral shows.

Commercial mining of gemstones has never been extensive in the United States. More than 60 varieties of gemstones have been produced commercially from domestic mines, but most of the deposits are relatively small compared with those of other mining operations. In the United States, much of the current gemstone mining is conducted by individual collectors, gem clubs, and hobbyists rather than by businesses.

The commercial gemstone industry in the United States consists of individuals and companies that mine gemstones or harvest shell and pearl, firms that manufacture laboratory-created gemstones, and individuals and companies that cut and polish natural and laboratory-created gemstones. The domestic gemstone industry is focused on the production of colored gemstones and on the cutting and polishing of large diamond stones. Industry employment is estimated to be between 1,200 and 1,500 individuals.

Most natural gemstone producers in the United States are small businesses that are widely dispersed and operate independently. The small producers probably have an average of three employees, including those who only work part time. The number of gemstone mines operating from year to year fluctuates because the uncertainty associated with the discovery and marketing of gem-quality minerals makes it difficult to obtain financing for developing and sustaining economically viable operations.

The total value of natural gemstones produced in the United States was estimated to be $11.3 million during 2012 (table 3). This production value was a 3% increase from that of 2011.

Natural gemstone materials indigenous to the United States are collected or produced in every State. During 2012, each of the 50 States produced at least $1,410 worth of gemstone materials. There were 11 States that accounted for 90% of the total value, as reported by survey respondents. These States were, in descending order of production value, Arizona, North Carolina, Oregon, California, Utah, Tennessee, Montana, Colorado, Arkansas, Idaho, and Maine. Some States were known for the production of a single gemstone material—Tennessee for freshwater pearls, for example. Other States produced a variety of gemstones; for example, Arizona’s gemstone deposits included agate, amethyst, azurite, chrysocolla, garnet, jade, jasper, malachite, obsidian, onyx, opal, peridot, petrified wood, smithsonite, and turquoise. A wide variety of gemstones also was found and produced in California, Idaho, Montana, and North Carolina.

In 2012, the United States had only one active operation in a known diamond-bearing area in Crater of Diamonds State Park near Murfreesboro in Pike County, AR. The State of Arkansas maintains a dig-for-fee operation for tourists and amateur collectors at the park; Crater of Diamonds is the only diamond mine in the world that is open to the public. The diamonds occur in a lamproite breccia tuff associated with a volcanic pipe and in the soil developed from the lamproite breccia tuff. In 2012, 530 diamond stones with an average weight of 0.180 carat were recovered at the Crater of Diamonds State Park. Of the 530 diamond stones recovered, 13 weighed more than 1 carat. Since the diamond-bearing pipe and the adjoining area became a State park in 1972 through yearend 2012, 30,436 diamond stones with a total weight of 6,076.5 carats have been recovered (Margi Jenks, park interpreter, Crater of Diamonds State Park, written commun., January 22, 2013). Exploration has demonstrated that this diamond deposit contains about 78.5 million metric tons (Mt) of diamond-bearing rock (Howard, 1999, p. 62). An Arkansas law enacted early in 1999 prohibits commercial diamond mining in the park.

In addition to natural gemstones, laboratory-created gemstones and gemstone simulants were produced in the United States in 2012. Laboratory-created or synthetic gemstones have the same chemical, optical, and physical properties as natural gemstones. Simulants have an appearance similar to that of a natural gemstone material, but they have different chemical, optical, and physical properties. Laboratory-created gemstones that have been produced in the United States include alexandrite, cubic zirconia, diamond, emerald, garnet, moissanite, ruby, sapphire, spinel, and turquoise. However, during 2012, only cubic zirconia, diamond, moissanite, and turquoise were produced commercially. Simulants of amber, chrysocolla, coral, lapis lazuli, malachite, travertine, and turquoise also were manufactured in the United States. In addition, certain colors of laboratory-created sapphire and spinel, used to represent other gemstones, are classified as simulants.

Laboratory-created gemstone production in the United States was valued at $31.2 million during 2012, which was a slight decrease compared with that of 2011. The value of U.S. simulant gemstone output was estimated to be more than $100 million. Five companies in five States, representing virtually the entire U.S. laboratory-created gemstone industry, reported production to the USGS. The States with reported laboratory-created gemstone production were, in descending order of production value, Florida, New York, North Carolina, South Carolina, and Arizona.

Since the 1950s, when scientists manufactured the first laboratory-created bits of diamond grit using a high-pressure, high-temperature (HPHT) method, this method of growing diamonds has become relatively commonplace in the world as a technology for laboratory-created diamonds, so much so that thousands of small plants throughout China were using the HPHT method and producing laboratory-created diamonds suitable for cutting as gemstones. Gem-quality diamonds of 1 carat or more are harder to manufacture because at that size, it is difficult to consistently produce diamonds of high quality, even in the controlled environment of a laboratory using the HPHT method. After more than 50 years of development, several laboratory-created diamond companies were able to produce relatively large high-quality diamonds that equaled those produced from mines (Park, 2007).

Gemesis Corp. (Sarasota, FL) reported production of gem-quality laboratory-created diamond in 2012. The weight of the laboratory-created diamond stones ranged from 1.5 to 2 carats, and most of the stones were brownish yellow, colorless, green, or yellow. Gemesis uses diamond-growing machines capable of growing 3-carat rough diamonds by generating HPHT conditions that recreate the conditions in the Earth's mantle where natural diamonds form (Davis, 2003). The prices of the Gemesis laboratory-created diamonds are lower than those of comparable natural diamond but above the prices of simulated diamond.

In the early 2000s, Apollo Diamond, Inc., near Boston, MA, developed and patented a method for growing single, extremely pure, gem-quality diamond crystals by chemical vapor deposition (CVD). The CVD technique transforms carbon into plasma, which is then precipitated onto a substrate as diamond. CVD had been used for more than a decade to cover large surfaces with microscopic diamond crystals, but in developing this process, Apollo Diamond discovered the temperature, gas composition, and pressure combination that resulted in the growth of a single diamond crystal. Apollo Diamond was able to produce laboratory-created stones that ranged from 1 to 2 carats. During 2011, Apollo Diamond ceased manufacture of single-crystal CVD diamond for gemstone and industrial use. During 2011 and 2012, SCIO Diamond Technology Corp. (Greenville, SC) acquired all diamond growing equipment and machines, cultured diamond gemstone-related technology, inventory, and various intellectual property rights from Apollo Diamond (SCIO Diamond Technology Corp., 2012). SCIO Diamond Technology Corp. and Gemesis Corp. prefer to call their diamonds "cultured" rather than laboratory-created, referring to the fact that the diamonds are grown much like a cultured pearl is grown. Scio Diamond designed and built a new production facility in Greenville, SC, and relocated all production equipment from Massachusetts to South Carolina. Production began in July 2012, and over the next 6 months, Scio Diamond produced more than 15,000 carats of laboratory-created single crystal rough diamond. Scio Diamond began shipping laboratory-created CVD rough diamonds in September 2012 (SCIO Diamond Technology Corp., 2013).

Charles & Colvard, Ltd. in North Carolina was the world's only manufacturer of moissanite, a gem-quality laboratory-created silicon carbide. Moissanite is an excellent diamond simulant, but it is being marketed for its own gem qualities. Moissanite exhibits a higher refractive index (brilliance) and higher luster than diamond. Its hardness is between those of corundum (ruby and sapphire) and diamond, which gives it durability (Charles & Colvard, Ltd., 2010). Charles & Colvard reported that moissanite sales increased by 40% to just more than $22.4 million in 2012 compared with $16.0 million in 2011 (Charles & Colvard, Ltd., 2013).

U.S. mussel shells are used as a source of mother-of-pearl and as seed material for culturing pearls. U.S. shell production decreased slightly in 2012 compared with that of 2011. This decrease was owing to decreased demand for U.S. shell materials that was caused by the use of manmade seed materials and seed materials from China and other sources by pearl producers in Japan. The popularity of darker and colored pearls and freshwater pearls that do not use U.S. seed material has also contributed to decreased demand for U.S. shell materials. In some regions of the United States, shell from mussels was being used more as a gemstone based on its own merit rather than as seed material for pearls. This shell material was being processed into mother-of-pearl and used in beads, jewelry, and watch faces.

Consumption

Historically, diamond gemstones have proven to hold their value despite wars or economic depressions, but this did not hold true during the recent worldwide economic recession. Diamond and colored gemstones value and sales in the United States decreased during the economic downturn in 2008 and continued into 2009, returned to pre-downturn levels during 2010, and again declined by about 10% from 2010 to 2012.

Although the United States accounted for little of the total global gemstone production, it was the world's leading diamond and nondiamond gemstone market. It was estimated that U.S. gemstone markets accounted for more than 35% of world gemstone demand in 2012. The U.S. market for unset gem-quality diamond during the year was estimated to be $20.2 billion, a decrease of 10% compared with that of 2011. Domestic markets for natural, unset nondiamond gemstones totaled $772 million in 2012, which was a 35% decrease from that of 2011.

In the United States, the majority of domestic consumers designate diamond as their favorite gemstone. This popularity of diamonds is evidenced by the diamond market accounting for 96% of the total value of the U.S. gemstone market. Colored natural gemstones, colored laboratory-created gemstones, and "fancy" colored diamonds were popular in 2012, although the values of the domestic consumption for almost all types of colored natural, unset nondiamond gemstones decreased from the 2011 values.

The estimated U.S. retail jewelry sales were a record $71.3 billion in 2012, an increase of 5.9% from sales of $67.3 billion in 2011 (Gassman, 2013). U.S. jewelers reported jewelry sales during the 2012 holiday shopping season increased 8.9% to $20.6 billion from $18.9 billion in sales during the 2011 holiday shopping season (IDEX Magazine, 2013).

Prices

Gemstone prices are governed by many factors and qualitative characteristics, including beauty, clarity, defects, demand, durability, and rarity. Diamond pricing, in particular, is complex; values can vary significantly depending on time, place, and the subjective valuations of buyers and sellers. More than 14,000 categories are used to assess rough diamond and more than 100,000 different combinations of carat, clarity, color, and cut values can be used to assess polished diamond.

Colored gemstone prices are generally influenced by market supply and demand considerations, and diamond prices are supported by producer controls on the quantity and quality of supply. Values and prices of gemstones produced and (or) sold in the United States are listed in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported, exported, or reexported are listed in tables 6 through 10.

De Beers Group companies remained a significant force, influencing the price of gem-quality diamond sales worldwide during 2012 because the companies mine a significant portion of the world's gem-quality diamond produced each year. In 2012, De Beers production from its independently owned and joint-venture operations in Botswana, Canada, Namibia, and South Africa decreased 10.9% to 27.9 million carats (Mct), compared with 31.3 Mct in 2011. De Beers companies also sorted and valuated a large portion (by value) of the world's annual supply of rough diamond through De Beers' subsidiary Diamond Trading Co. (DTC). DTC sales of rough diamonds decreased by 15% during 2012 to $5.5 billion compared with $6.5 billion during 2011. In 2012, De Beers had total diamond and jewelry sales of $6.1 billion, which was a decrease of 16% compared with those of 2011 (Greve, 2013).

Foreign Trade

During 2012, total U.S. gemstone trade with all countries and territories was valued at about $38.3 billion, which was a decrease of 8% from that of 2011. Diamond accounted for about 97% of the 2012 gemstone trade total value. In 2012, U.S. exports and reexports of diamond were shipped to 90 countries and territories, and imports of all gemstones were received from 95 countries and territories (tables 6–10). In 2012, U.S. import quantities in cut diamond decreased by 10% compared with those of 2011, and their value decreased by 9%. U.S. import quantities in rough and unworked diamond increased by 15%, although their value decreased by 13% (table 7, 10). The United States remained the world's leading diamond importer and was a significant international diamond transit center as well as the world's leading gem-quality diamond market. In 2012, U.S. export and reexport quantities of gem-grade diamond increased by 43% compared with those of 2011, but their value decreased by 7%. The large volume of reexports revealed the significance of the United States in the world's diamond supply network (table 6).

Import values of laboratory-created gemstone decreased slightly for the United States in 2012 compared with those of 2011 (table 10). Laboratory-created gemstone imports from Austria, Belgium, China, Germany, India, and Malaysia, with more than $26.7 million in imports, accounted for about 80% (by value) of total domestic imports of laboratory-created gemstones during the year (table 9). The marketing of imported laboratory-created gemstones and enhanced gemstones as natural gemstones and the mixing of laboratory-created materials with natural stones in imported parcels continued to be an issue for some domestic producers in 2012. In addition, problems continued with some simulants being marketed as laboratory-created gemstones during the year.

World Review

The worldwide gemstone industry has two distinct sectors—diamond mining and marketing and colored gemstone production and sales. Most diamond supplies are controlled by a few major mining companies; prices are supported by managing the quality and quantity of the gemstones relative to demand, a function performed by De Beers through DTC. Unlike diamond, colored gemstones are primarily produced at relatively small, low-cost operations with few dominant producers; prices are influenced by consumer demand and supply availability.

In 2012, world natural diamond production totaled 128 Mct—92 Mct gem quality and 36 Mct industrial grade (table 11). Most production was concentrated in a few regions—Africa [Angola, Botswana, Congo (Kinshasa), Namibia, and South Africa], Asia (northeastern Siberia and Yakutia in Russia), Australia, North America (Northwest Territories in Canada), and South America (Brazil and Venezuela). In 2012, Russia led the world in total natural diamond output quantity (combined gemstone and industrial) with 27.3% of the estimated world production. Congo (Brazzaville) was the world's leading gemstone diamond producer with 23.4%; followed by Russia, 22.5%; Botswana, 15.6%; Zimbabwe, 11.9%; Canada, 11.3%; Angola, 8.1%; South Africa, 3.1%; and Namibia, 1.8%. These eight countries produced 98% (by quantity) of the world's gemstone diamond output in 2012.

In 2002, the international rough-diamond certification system, the Kimberley Process Certification Scheme (KPCS), was agreed upon by United Nations (UN) member nations, the diamond industry, and involved nongovernmental organizations to prevent the shipment and sale of conflict diamonds. Conflict diamonds are diamonds that originate from areas controlled by forces or factions opposed to legitimate and internationally recognized governments, and are used to fund military action in opposition to those governments, or in contravention of the decisions of the UN Security Council. The KPCS includes the following key elements: the use of forgery-resistant certificates and tamper-proof containers for shipments of rough diamonds; internal controls and procedures that provide credible assurance that conflict diamonds do not enter the legitimate diamond market; a certification process for all exports of rough diamonds; the gathering, organizing, and sharing of import and export data on rough diamonds with other participants of relevant production; credible monitoring and oversight of the international certification scheme for rough diamonds; effective enforcement of the provisions of the certification scheme through dissuasive and proportional penalties for violations; self regulation by the diamond industry that fulfills minimum requirements; and sharing information with all other participants on relevant rules, procedures, and legislation as well as examples of national certificates used to accompany shipments of rough diamonds. The United States assumed the chair of KPCS for January 1 through December 31, 2012, the tenth country or organization in succession to hold the chair after Congo (Kinshasa), Israel, Namibia, India, South Africa, Canada, Russia, Botswana, and the European Commission. The 54 participants represented 80 nations (including the 27 member nations of the European Community) plus the rough diamond-trading entity of Taipei. During 2012, Côte d'Ivoire continued to be under UN sanctions and was not trading in rough diamonds, and Venezuela voluntarily suspended exports and imports of rough diamonds until further notice. The participating nations in the KPCS account for approximately 99.8% of the global production and trade of rough diamonds (Kimberley Process, undated).

Globally, the value of production of natural gemstones other than diamond was estimated to be more than $2.5 billion in 2012. Most nondiamond gemstone mines are small, low-cost, and widely dispersed operations in remote regions of developing nations. Foreign countries with major gemstone deposits other than diamond are Afghanistan (aquamarine, beryl, emerald, kunzite, lapis lazuli, ruby, and tourmaline), Australia (beryl, opal, and sapphire), Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline), Burma (beryl, jade, ruby, sapphire, and topaz), Colombia (beryl, emerald, and sapphire), Kenya (beryl, garnet, and sapphire), Madagascar (beryl, rose quartz, sapphire, and tourmaline), Mexico (agate, opal, and topaz), Sri Lanka (beryl, ruby, sapphire, and topaz), Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline), and Zambia (amethyst and beryl). In addition, pearls are cultured throughout the South Pacific and in other equatorial waters; Australia, China, French Polynesia, and Japan were key producers in 2012.

Worldwide diamond exploration spending increased 16% in 2012 with 65 companies allocating $520 million, compared with 70 companies allocating $449 million during 2011. The diamond share of overall worldwide mineral exploration spending was 2.5%. Africa was the leading diamond exploration location (SNL Metals Economics Group, 2012).

Worldwide in 2012, average diamond values decreased 13.9% to $100.00 per carat from the 2011 average value of $116.19 per carat. This decrease was influenced the first half of the year by fears of global recession stalling demand in the Far East and India. The second half of the year was influenced by slow growth in China and more declines in India (SNL Metals Economics Group, 2013).

Two new diamond projects were commissioned in 2012. The Karowe Mine in Botswana began operation, and the expansion of the Koidu Mine in Sierra Leone was commissioned in early 2012 (SNL Metals Economics Group, 2013).

Botswana.—Commissioning of the Karowe Mine, owned by Lucara Diamond Corp. was completed in May and commercial production began in July. During 2012, production was 303,060 carats, and when ramped up to full capacity in 2013, production was expected to be 400,000 carats per year (SNL Metals Economics Group, 2013).

Canada.—Canadian diamond production was 10.5 Mct during 2012, a decrease of 3% compared with that of 2011. Diamond exploration continued in Canada, with several commercial diamond projects and additional discoveries in Alberta, British Columbia, the Northwest Territories, the Nunavut Territory, Ontario, and Quebec. In 2012, Canada produced 8% of the world's combined natural gemstone and industrial diamond output.

The Ekati Diamond Mine, Canada's first operating commercial diamond mine, completed its 14th full year of production in 2012. Ekati produced 1.45 Mct of diamond from 4.24 Mt of ore. This was a 29% decrease compared with that of 2011. Approximately 21% of the Ekati 2011 diamond production was industrial-grade material (BHP Billiton Ltd., 2013, p. 10). During 2012, Harry Winston Diamond Corp.

entered into an agreement with BHP Billiton Canada Inc. to purchase BHP Billiton's diamond assets, which included its 80% controlling interest in the Ekati Diamond Mine and its diamond sorting and sales facilities for $500 million (DeMarco, 2012).

The Diavik Diamond Mine, Canada's second diamond mine, also located in the Northwest Territories, completed its 10th full year of production. Diavik produces an average of 2 Mt of ore annually, grading an average of 3.1 carats per ton. During 2012, Diavik produced 7.2 Mct of rough diamond. At yearend 2012, Diavik estimated the mine's remaining proven and probable reserves to be 18.3 Mt of ore in kimberlite pipes containing 2.9 carats of diamond per ton and projected the total mine life to be 16 to 22 years. Diavik began developing an underground mine and substantially completed construction on the project during 2009. The first ore was produced from the underground mine during the first quarter of 2010, with full production expected in 2013. The mine is an unincorporated joint venture between Diavik Diamond Mine Inc. (60%) and Harry Winston Diamond Mines Ltd. (40%) (Diavik Diamond Mine Inc., 2013, p. 6).

The Snap Lake Mine, in the Northwest Territories, is wholly owned by De Beers Canada Inc. The Snap Lake deposit is a tabular-shaped kimberlite dyke rather than the typical kimberlite pipe. The dyke is 2.5 meters thick and dips at an angle of 12° to 15°. The deposit was mined using a modified room and pillar underground mining method in 2012. The Snap Lake Mine started mining operations in October 2007, reached commercial production levels in the first quarter of 2008, and officially opened June 25, 2008. The mine was expected to produce 1.4 Mct per year of diamond, and the mine life was expected to be about 20 years. The mine's production for 2012 was 870,000 carats (De Beers Canada Inc., 2011; De Beers Group Inc., 2013, p. 23).

The Victor Mine, in northern Ontario on the James Bay coast, also is wholly owned by De Beers Canada. The Victor kimberlite consists of two pipes with a total surface area of 15 hectares. The Victor Mine initiated mining operations at yearend 2007 and was officially opened on July 26, 2008. The Victor Mine has 27.4 Mt of reserves with average ore grade of 0.23 carat per ton. At full capacity, the open pit mine was expected to produce 600,000 carats per year, and the mine life was expected to be about 12 years. In 2012, the mine's production was 690,000 carats (De Beers Group Inc., 2013, p.23; De Beers Canada Inc., undated).

Sierra Leone.—An expansion of the Koidu Mine, which is wholly owned by Koidu Holdings SA, involved the redevelopment of the K1 kimberlite pipe and commissioning of a new plant to increase capacity to 500,000 carats per year from 120,000 carats per year. The plant was commissioned in September 2012 (SNL Metals Economics Group, 2013, p. 26).

Outlook

As the domestic and global economies improve, Internet sales of diamonds, gemstones, and jewelry were expected to continue to expand and increase in popularity, as were other forms of e-commerce that emerge to serve the diamond and gemstone industry. Internet sales are expected to add to and partially replace "brick-and-mortar" sales. This is likely to take place as the gemstone industry and its customers become more comfortable with and learn the applications of new e-commerce tools, such as sales Web sites and online social networking Web sites (PR Newsline Services, 2012).

As more independent producers, such as Ekati and Diavik in Canada, come online they will bring a greater measure of competition to global markets that presumably will result in increased supply and lower prices. Further consolidation of diamond producers and larger quantities of rough diamond being sold outside DTC is expected to continue as the diamond industry adjusts to De Beers' reduced influence on the industry.

More laboratory-created gemstones, simulants, and treated gemstones are likely to enter the marketplace and necessitate more transparent trade industry standards to maintain customer confidence.

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TABLE 1
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0–2.5	1.0–1.1	Single	1.54	Synthetic or pressed plastics, kaurigum	Fossil resin, color, low density, soft, insects.
Apatite	Chlorocalcium phosphate	Colorless, pink, yellow, green, blue, violet	Small	Low	5.0	3.16–3.23	Double	1.63–1.65	Amblygonite, andalusite, brazilianite, precious beryl, titanite, topaz, tourmaline	Crystal habit, color, hardness, appearance.
Azurite	Copper carbonate hydroxide	Azure, dark blue, pale blue	Small to medium	do.	3.5–4.0	3.7–3.9	do.	1.72–1.85	Dumortierite, hauynite, lapis lazuli, lazulite, sodalite	Color, softness, crystal habits, associated minerals.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	do.	High	6.0–6.5	3.64–3.68	do.	1.76–1.80	Sapphire, tanzanite, blue diamond, blue tourmaline, cordierite	Strong blue in ultraviolet light.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5–8.0	2.63–2.80	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	Red	Small	Very high	7.5–8.0	2.63–2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald, natural	do.	Green	Medium	do.	7.5	2.63–2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5–8.0	2.63–2.80	do.	1.58	Genuine emerald	Lack of flaws, brilliant fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5–8.0	2.63–2.80	do.	1.58	Citrine, topaz, glass, doublets	Weak-colored.
Goshenite	do.	Colorless	do.	Low	7.5–8.0	2.63–2.80	do.	1.58	Quartz, glass, white sapphire, white topaz	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5–8.0	2.63–2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49–1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.60	do.	Banded, translucent.
Charoite	Hydrated sodium calcium hydroxi-fluoro-silicate	Lilac, violet, or white	Small to medium	do.	5.0–6.0	2.54–2.78	XX	1.55–1.56	Purple marble	Color, locality.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by direct sunlight, or incandescent light, red by indirect sunlight or fluorescent light	do.	High	8.5	3.50–3.84	Double	1.75	Synthetic	Strong dichroism, color varies from red to green, hardness.
Cat's eye	do.	Greenish to brownish	Small to large	do.	8.5	3.50–3.84	do.	1.75	Synthetic, shell	Density, translucence, chatoyance.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Chrysoberyl:—Continued										
Chrysolite	do.	Yellow, green, and (or) brown	Medium	Medium	8.5	3.50–3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Chrysocolla	Hydrated copper silicate	Green, blue	Any	Low	2.0–4.0	2.0–2.4	XX	1.46–1.57	Azurite, dyed chalcedony, malachite, turquoise, variscite	Lack of crystals, color, fracture, low density, softness.
Coral	Calcium carbonate	Orange, red, white, black, purple, or green	Branching, medium	do.	3.5–4.0	2.6–2.7	Double	1.49–1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95–4.10	do.	1.78	Synthetics, including spinel, garnet	Inclusions, fluorescence.
Sapphire, blue	do.	Blue	Medium	High	9.0	3.95–4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, colorless, orange, green, or violet	Medium to large	Medium	9.0	3.95–4.10	do.	1.78	Synthetics, glass and doublets, morganite	Inclusions, double refraction, refractive index.
Sapphire or ruby, stars	do.	Red, pink, violet, blue, or gray	do.	High to low	9.0	3.95–4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.
Sapphire or ruby, synthetic	do.	Yellow, pink, blue, green, orange, violet, or red	Up to 20 carats	Low	9.0	3.95–4.10	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Cubic zirconia	Zirconium and yttrium oxides	Colorless, pink, blue, lavender, yellow	Small	do.	8.25–8.5	5.8	Single	2.17	Diamond, zircon, titania, moissanite	Hardness, density, lack of flaws and inclusions, refractive index.
Diamond	Carbon	White, blue-white, yellow, brown, green, red, pink, blue	Any	Very high	10.0	3.516–3.525	do.	2.42	Zircon, titania, cubic zirconia, moissanite	High index, dispersion, hardness, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green-blue	Large	Low	6.0–6.5	2.56	XX	1.52	Jade, turquoise	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play (schiller)	do.	do.	6.0–6.5	2.56	XX	1.56	do.	Do.
Moonstone	do.	Colorless, white, gray, or yellow with white, blue, or bronze schiller	do.	do.	6.0–6.5	2.77	XX	1.52–1.54	Glass, chalcedony, opal	Pale sheen, opalescent.
Sunstone	do.	Orange, red brown, colorless with gold or red glittery schiller	Small to medium	do.	6.0–6.5	2.77	XX	1.53–1.55	Aventurine, glass	Red glittery schiller.
Garnet	Complex silicate	Brown, black, yellow, green, red, or orange	do.	Low to high	6.5–7.5	3.15–4.30	Single strained	1.79–1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Hematite	Iron oxide	Black, black-gray, brown-red	Medium to large	Low	5.5–6.5	5.12–5.28	XX	2.94–3.22	Davidite, cassiterite, magnetite, neptunite, pyrolusite, wolframite	Crystal habit, streak, hardness.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Jade:										
Jadeite	Complex silicate	Green, yellow, black, white, or mauve	Large	Low to very high	6.5–7.0	3.3–3.5	Crypto-crystalline	1.65–1.68	Nephrite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0–6.5	2.96–3.10	do.	1.61–1.63	Jadeite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Do.
Jet (gagate)	Lignite	Deep black, dark brown	do.	Low	2.5–4.0	1.19–1.35	XX	1.64–1.68	Anthracite, asphalt, cannel coal, onyx, schorl, glass, rubber	Luster, color.
Lapis lazuli	Sodium calcium aluminum silicate	Dark azure-blue to bright indigo blue or even a pale sky blue	do.	do.	5.0–6.0	2.50–3.0	XX	1.50	Azurite, dumortierite, dyed howlite, lazulite, sodalite, glass	Color, crystal habit, associated minerals, luster, localities.
Malachite	Hydrated copper carbonate	Light to black-green banded	do.	do.	3.5–4.0	3.25–4.10	XX	1.66–1.91	Brochantite, chrysoprase, opaque green gemstones	Color banding, softness, associated minerals.
Moissanite	Silicon carbide	Colorless and pale shades of green, blue, yellow	Small	Low to medium	9.25	3.21	Double	2.65–2.69	Diamond, zircon, titania, cubic zirconia	Hardness, dispersion, lack of flaws and inclusions, refractive index.
Obsidian	Amorphous, variable (usually felsic)	Black, gray, brown, dark green, white, transparent	Large	Low	5.0–5.5	2.35–2.60	XX	1.45–1.55	Aegirine-augite, gadolinite, gagate, hematite, pyrolusite, wolframite	Color, conchoidal fracture, flow bubbles, softness, lack of crystal faces.
Opal	Hydrated silica	Reddish orange, colors flash in white gray, black, red, or yellow	do.	Low to high	5.5–6.5	1.9–2.3	Single	1.45	Glass, synthetics, triplets, chalcedony	Color play (opalescence).
Peridot	Iron magnesium silicate	Yellow and (or) green	Any	Medium	6.5–7.0	3.27–3.37	Double (strong)	1.65–1.69	Tourmaline, chrysoberyl	Strong double refraction, low dichroism.
Quartz:										
Agate	Silicon dioxide	Any	Large	Low	7.0	2.58–2.64	XX	XX	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65–2.66	Double	1.55	Glass, plastic, fluorite	Macrocrystalline, color, refractive index, transparent, hardness.
Aventurine	do.	Green, red-brown, gold-brown, with metallic iridescent reflection	do.	Low	7.0	2.64–2.69	do.	1.54–1.55	Iridescent analcime, aventurine feldspar, emerald, aventurine glass	Macrocrystalline, color, metallic iridescent flake reflections, hardness.

See footnotes at end of table.

TABLE 1—Continued
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Quartz:—Continued										
Cairngorm	do.	Smoky orange or yellow	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Carnelian	do.	Flesh red to brown red	do.	do.	6.5–7.0	2.58–2.64	do.	1.53–1.54	Jasper	Cryptocrystalline, color, hardness.
Chalcedony	do.	Bluish, white, gray	do.	do.	6.5–7.0	2.58–2.64	do.	1.53–1.54	Tanzanite	Do.
Chrysoprase	do.	Green, apple-green	do.	do.	6.5–7.0	2.58-2.64	do.	1.53–1.54	Chrome chalcedony, jade, prase opal, prehnite, smithsonite, variscite, artificially colored green chalcedony	Do.
Citrine	do.	Yellow	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Jasper	do.	Any, striped, spotted, or sometimes uniform	do.	do.	7.0	2.58–2.66	XX	XX	do.	Cryptocrystalline, opaque, vitreous luster, hardness.
Onyx	do.	Many colors	do.	do.	7.0	2.58–2.64	XX	XX	do.	Cryptocrystalline, uniformly banded, hardness.
Petrified wood	do.	Brown, gray, red, yellow	do.	do.	6.5–7.0	2.58–2.91	Double	1.54	Agate, jasper	Color, hardness, wood grain.
Rock crystal	do.	Colorless	do.	do.	7.0	2.65–2.66	do.	1.55	Topaz, colorless sapphire	Do.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Tiger's eye	do.	Golden yellow, brown, red, blue-black	do.	do.	6.5-7.0	2.58–2.64	XX	1.53–1.54	XX	Macrocrystalline, color, hardness, chatoyancy.
Rhodochrosite	Manganese carbonate	Rose-red to yellowish, stripped	do.	Low	4.0	3.45–3.7	Double	1.6–1.82	Fire opal, rhodonite, tugtupite, tourmaline	Color, crystal habit, reaction to acid, perfect rhombohedral cleavage.
Rhodonite	Manganese iron calcium silicate	Dark red, flesh red, with dendritic inclusions of black manganese oxide	do.	do.	5.5–6.5	3.40–3.74	do.	1.72–1.75	Rhodochrosite, thulite, hessonite, spinel, pyroxmangite, spessartine, tourmaline	Color, black inclusions, lack of reaction to acid, hardness.
Shell:										
Mother-of-pearl	Calcium carbonate	White, cream, green, blue-green, with iridescent play of color	Small	do.	3.5	2.6–2.85	XX	XX	Glass and plastic imitation	Luster, iridescent play of color.

See footnotes at end of table.

TABLE 1—Continued

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size[1]	Cost[2]	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Shell:—Continued										
Pearl	do.	White, cream to black, sometimes with hint of pink, green, purple	do.	Low to high	2.5–4.5	2.6–2.85	XX	XX	Cultured and glass or plastic imitation	Luster, iridescence, x-ray of internal structure.
Spinel, natural	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5–3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5–3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5–7.0	3.13–3.20	do.	1.66	Synthetic spinel	Refractive index, color, pleochroism.
Kunzite	do.	Pink to lilac	do.	do.	6.5–7.0	3.13–3.20	do.	1.66	Amethyst, morganite	Do.
Tanzanite	Complex silicate	Blue to lavender	Small	High	6.0–7.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism, color.
Topaz	do.	White, blue, green, pink, yellow, gold	Medium	Low to medium	8.0	3.4–3.6	do.	1.62	Beryl, quartz	Color, density, hardness, refractive index, perfect in basal cleavage.
Tourmaline	do.	Any, including mixed	do.	do.	7.0–7.5	2.98–3.20	do.	1.63	Peridot, beryl, garnet corundum, glass	Double refraction, color, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green with black, brown-red inclusions	Large	Low	6.0	2.60–2.83	do.	1.63	Chrysocolla, dyed howlite, dumortierite, glass, plastics, variscite	Difficult if matrix not present, matrix usually limonitic.
Unakite	Granitic rock, feldspar, epidote, quartz	Olive green, pink, and blue-gray	do.	do.	6.0–7.0	2.60–3.20	XX	XX	XX	Olive green, pink, gray-blue colors.
Zircon	Zirconium silicate	White, blue, brown, yellow, or green	Small to medium	Low to medium	6.0–7.5	4.0–4.8	Double (strong)	1.79–1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

Do., do. Ditto. XX Not applicable.

[1]Small: up to 5 carats; medium: 5 to 50 carats; large: more than 50 carats.

[2]Low: up to $25 per carat; medium: up to $200 per carat; high: more than $200 per carat.

TABLE 2
LABORATORY-CREATED GEMSTONE PRODUCTION METHODS

Gemstone	Production method	Company/producer	Date of first production
Alexandrite	Flux	Creative Crystals Inc.	1970s.
Do.	Melt pulling	J.O. Crystal Co., Inc.	1990s.
Do.	do.	Kyocera Corp.	1980s.
Do.	Zone melt	Seiko Corp.	Do.
Cubic zirconia	Skull melt	Various producers	1970s.
Emerald	Flux	Chatham Created Gems	1930s.
Do.	do.	Gilson	1960s.
Do.	do.	Kyocera Corp.	1970s.
Do.	do.	Lennix	1980s.
Do.	do.	Russia	Do.
Do.	do.	Seiko Corp.	Do.
Do.	Hydrothermal	Biron Corp.	Do.
Do.	do.	Lechleitner	1960s.
Do.	do.	Regency	1980s.
Do.	do.	Russia	Do.
Ruby	Flux	Chatham Created Gems	1950s.
Do.	do.	Douras	1990s.
Do.	do.	J.O. Crystal Co., Inc.	1980s.
Do.	do.	Kashan Created Ruby	1960s.
Do.	Melt pulling	Kyocera Corp.	1970s.
Do.	Verneuil	Various producers	1900s.
Do.	Zone melt	Seiko Corp.	1980s.
Sapphire	Flux	Chatham Created Gems	1970s.
Do.	Melt pulling	Kyocera Corp.	1980s.
Do.	Verneuil	Various producers	1900s.
Do.	Zone melt	Seiko Corp.	1980s.
Star ruby	Melt pulling	Kyocera Corp.	Do.
Do.	do.	Nakazumi Earth Crystals Co.	Do.
Do.	Verneuil	Linde Air Products Co.	1940s.
Star sapphire	do.	do.	Do.

Do., do. Ditto.

TABLE 3
ESTIMATED VALUE OF U.S. NATURAL GEMSTONE PRODUCTION,
BY GEM TYPE[1]

(Thousand dollars)

Gem materials	2011	2012
Beryl	1,740	1,790
Coral, all types	150	150
Diamond	(2)	(2)
Garnet	110	98
Gem feldspar	756	757
Geode/nodules	110	89
Opal	71	74
Quartz:		
Macrocrystalline[3]	333	383
Cryptocrystalline[4]	248	261
Sapphire/ruby	343	360
Shell	832	810
Topaz	(2)	(2)
Tourmaline	73	99
Turquoise	1,330	1,320
Other	4,950	5,140
Total	11,000	11,300

[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Less than ½ unit.
[3]Macrocrystalline quartz (crystals recognizable with the naked eye) includes amethyst, aventurine, blue quartz, citrine, hawk's eye, pasiolite, prase, quartz cat's eye, rock crystal, rose quartz, smoky quartz, and tiger's eye.
[4]Cryptocrystalline quartz (microscopically small crystals) includes agate, carnelian, chalcedony, chrysoprase, fossilized wood, heliotrope, jasper, moss agate, onyx, and sard.

TABLE 4
PRICES PER CARAT OF U.S. CUT ROUND DIAMONDS, BY SIZE AND QUALITY IN 2012

Carat weight	Description, color[1]	Clarity[2] (GIA terms)	Representative prices January[3]	Representative prices June[4]	Representative prices December[5]
0.25	G	VS1	$1,650	$1,650	$1,650
Do.	G	VS2	1,600	1,600	1,600
Do.	G	SI1	1,250	1,250	1,250
Do.	H	VS1	1,600	1,600	1,600
Do.	H	VS2	1,500	1,500	1,500
Do.	H	SI1	1,200	1,200	1,200
0.50	G	VS1	3,600	3,600	3,600
Do.	G	VS2	3,100	3,100	3,100
Do.	G	SI1	2,500	2,500	2,500
Do.	H	VS1	3,170	3,170	3,170
Do.	H	VS2	2,750	2,750	2,750
Do.	H	SI1	2,250	2,250	2,250
1.00	G	VS1	8,500	8,000	7,810
Do.	G	VS2	8,000	7,500	6,800
Do.	G	SI1	6,500	6,200	6,205
Do.	H	VS1	7,700	7,700	6,885
Do.	H	VS2	7,200	7,200	6,300
Do.	H	SI1	5,900	5,900	5,780
2.00	G	VS1	15,500	15,500	14,870
Do.	G	VS2	13,200	13,200	12,880
Do.	G	SI1	11,200	11,200	10,660
Do.	H	VS1	13,300	13,300	12,710
Do.	H	VS2	11,700	11,700	10,800
Do.	H	SI1	10,300	10,300	9,950

Do. Ditto.

[1]Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; G, H, I—traces of color.

[2]Clarity: IF—no blemishes; VVS1—very, very slightly included; VS1—very slightly included; VS2—very slightly included, but not visible; SI1—slightly included.

[3]Source: The Gem Guide, v. 31, no. 1, January/February 2012, p. 20–22.

[4]Source: The Gem Guide, v. 31, no. 4, July/August 2012, p. 20–22.

[5]Source: The Gem Guide, v. 31, no. 6, November/December 2012, p. 20–22.

TABLE 5
PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES IN 2012

Gemstone	Price range per carat January[1]	Price range per carat December[2]
Amethyst	$10–25	$10–25
Blue sapphire	950–1,900	1,000–1,900
Blue topaz	5–10	5–10
Emerald	2,600–4,400	2,600–4,400
Green tourmaline	50–70	50–70
Cultured saltwater pearl[3]	5	5
Pink tourmaline	65–170	65–170
Rhodolite garnet	22–45	22–45
Ruby	2,200–2,600	2,200–2,600
Tanzanite	300–375	300–375

[1]Source: The Gem Guide, v. 31, no. 1, January/February 2012, p. 50, 53, 57, 61, 63, 65, and 68–71. These figures are approximate wholesale purchase prices paid by retail jewelers on a per stone basis for 1 to less than 1 carat, fine-quality stones.

[2]Source: The Gem Guide, v. 31, no. 6, November/December 2012, p. 50, 53, 57, 61, 63, 65, and 68–71. These figures are approximate wholesale purchase prices paid by retail jewelers on a per stone basis for 1 to less than 1 carat, fine-quality stones.

[3]Prices are per 4.5–5-millimeter pearl.

TABLE 6
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY[1]

Country	2011 Quantity (carats)	2011 Value[2] (millions)	2012 Quantity (carats)	2012 Value[2] (millions)
Exports:				
Aruba	3,390	$11	851	$3
Australia	11,700	25	14,100	21
Austria	544	1	114	1
Bahamas, The	852	5	753	3
Belgium	269,000	370	393,000	210
Belize	142	1 r	140	(3)
Brazil	7,130	2	31,100	9
Canada	52,400	96	48,600	114
Cayman Islands	1,190	6	731	2
China	13,900	39	21,500	22
Costa Rica	7,760	1	4,800	2
Curacao	6,150	17	13,700	42
Denmark	190	(3)	271	1
Dominican Republic	44,300	11	34,500	14
France	1,200	34	869	32
Germany	22,500	4	838	3
Honduras	113	(3)	199	1
Hong Kong	2,320,000	522	2,390,000	411
India	768,000	579	526,000	262
Ireland	895	5	12,100	77
Israel	293,000	756	575,000	1,530
Italy	3,020	15	3,000	2
Jamaica	440	2	479	2
Japan	6,830	3	13,800	5
Lebanon	4,800	5	3,330	3
Malaysia	255	1 r	156	1
Mexico	604,000	97	469,000	88
Netherlands	474	1	233	1
Netherlands Antilles (former)	5,860	15	--	--
New Zealand	429	2	668	2
Panama	609	2	158	(3)
Qatar	--	--	117	7
Russia	639	3	--	--
Singapore	6,050	3	3,600	11
South Africa	510	4	36,800	22
Sweden	2,510	7	179	1
Switzerland	190,000	257	9,320	34
Taiwan	497	2	430	2
Thailand	168,000	22	116,000	39
United Arab Emirates	131,000	66	45,100	55
United Kingdom	492,000	76	8,680	67
Vietnam	564	1 r	6,990	10
Other	12,500	5	10,700	19
Total	5,450,000	3,070	4,790,000	3,130
Reexports:				
Armenia	11,000	5	1,980	1
Aruba	2,290	4	2,680	5
Australia	2,980	18	7,410	23
Austria	301	3	1,680	3
Belgium	956,000	2,240	816,000	2,330
Botswana	7	(3)	886	1
Canada	129,000	150	129,000	176
China	32,900	43	25,100	30
France	6,560	126	7,740	177
Germany	2,230	3	1,560	5

See footnotes at end of table.

TABLE 6—Continued
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY[1]

Country	2011 Quantity (carats)	2011 Value[2] (millions)	2012 Quantity (carats)	2012 Value[2] (millions)
Guatemala	52,600	4	16,100	1
Hong Kong	2,830,000	2,470	2,820,000	2,480
India	3,510,000	2,940	3,320,000	2,340
Israel	2,000,000	5,140	1,350,000	3,780
Italy	7,270	3	8,960	15
Japan	47,200	34	32,100	40
Laos	4,850	3	9,700	5
Lebanon	3,040	5	4,450	3
Malaysia	376	4	368	5
Mexico	2,900	3	2,780	6
Namibia	4,450	11	3,660	9
Netherlands	108,000	365	116,000	288
Netherlands Antilles (former)	4,360	16	--	--
Saint Kitts and Nevis	333	(3)	--	--
Singapore	5,080	41	17,700	90
South Africa	8,040	76	10,900	41
Spain	207	1 r	89	1
Switzerland	83,500	604	117,000	957
Taiwan	18,000	15	1,330	60
Thailand	178,000	60	215,000	76
United Arab Emirates	511,000	322	492,000	441
United Kingdom	31,500	399	32,100	312
Other	17,300	24	8,560,000	13,701
Total	10,600,000	15,100	18,100,000	13,800
Grand total	16,000,000	18,200	22,900,000	16,900

[r]Revised. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY[1]

	2011		2012	
Kind, range, and country of origin	Quantity (carats)	Value[2] (millions)	Quantity (carats)	Value[2] (millions)
Rough or uncut, natural:[3]				
Angola	26,700	$168	15,900	$84
Belgium	2,640	4	2,160	3
Botswana	84,100	159	56,800	108
Brazil	110	2	1,880	1
Canada	20,100	37	30,800	52
Central African Republic	394	1 r	98	1
Congo (Kinshasa)	6,460	8	5,250	15
India	170,000	2	339,000	2
Israel	1,030	2	7,110	12
Lesotho	932	40	418	9
Namibia	3,820	4	7,970	27
Russia	118,000	18	55,400	57
Sierra Leone	3,180	10	978	3
South Africa	199,000	173	248,000	171
Other	68,200	3	41,500	8
Total	704,000	631	813,000	553
Cut but unset, not more than 0.5 carat:				
Australia	4,110	4	8,150	4
Belgium	277,000	102	402,000	134
Botswana	6,890	18	5,420	19
Brazil	4,470	1	2,860	2
Canada	23,600	8	7,980	6
China	34,300	31	56,900	60
Dominican Republic	3,430	1	6,960	1
Hong Kong	197,000	30	273,000	49
India	6,990,000	1,850	5,860,000	2
Israel	414,000	236	394,000	209
Mauritius	6,220	17	4,700	16
Mexico	76,300	21	114,000	30
Namibia	2,060	5	3,920	11
Russia	585	1	171	(4)
South Africa	4,910	7	7,710	18
Sri Lanka	2,980	1	--	--
Switzerland	40,600	2	947	3
Thailand	93,000	13	72,300	9
United Arab Emirates	112,000	42	132,000	38
United Kingdom	24,700	4	45,000	6
Vietnam	30,400	29	46,700	66
Other	11,600	3	29,400	1,510
Total	8,360,000	2,430	7,470,000	2,190
Cut but unset, more than 0.5 carat:				
Armenia	3,170	3	272	1
Australia	4,710	41	5,790	37
Belgium	733,000	3,550	707,000	3,370
Botswana	11,200	63	9,410	54
Brazil	294	7	1,390	4
Canada	16,200	67	18,000	74
Central African Republic	35	2	--	--
China	35,000	102	64,100	306
Costa Rica	5	(4)	--	--
France	1,240	23	844	20
Germany	3,050	12	3,680	13
Hong Kong	48,500	107	58,400	144
India	1,970,000	4,410	1,680,000	3,900
Indonesia	41	1	52	1
Israel	1,970,000	8,950	1,830,000	7,990

See footnotes at end of table.

TABLE 7—Continued

U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY[1]

	2011		2012	
Kind, range, and country of origin	Quantity (carats)	Value[2] (millions)	Quantity (carats)	Value[2] (millions)
Italy	3,320	11	3,520	11
Japan	1,380	2	666	8
Lebanon	1,470	3	173	1
Lesotho	136	28	--	--
Mauritius	2,720	16	1,910	11
Mexico	465	2	1,270	1
Namibia	16,800	89	14,200	79
Netherlands	284	5	146	2
Philippines	145	1	--	--
Russia	17,100	100	19,200	93
Singapore	245	1	26,800	15
South Africa	42,700	900	22,600	625
Sri Lanka	3,920	4	75	(4)
Switzerland	18,900	541	8,460	380
Thailand	11,200	26	12,100	33
United Arab Emirates	38,400	100	44,300	164
United Kingdom	3,880	85	4,740	84
Vietnam	1,920	2	2,230	3
Other	1,750	7	4,240	22
Total	4,970,000	19,300	4,550,000	17,400

[r]Revised. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Includes some natural advanced diamond.

[4]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

Kind and country	2011 Quantity (carats)	2011 Value[2] (millions)	2012 Quantity (carats)	2012 Value[2] (millions)
Emerald:				
Belgium	737	$1	2,150	$4
Brazil	186,000	9	136,000	13
Canada	1,390	(3) r	3,340	(3)
China	34,100	(3) r	4,660	(3)
Colombia	365,000	161	201,000	172
France	152	2	163	1
Germany	9,940	3	9,190	3
Hong Kong	118,000	11	147,000	49
India	1,400,000	57	1,650,000	54
Israel	138,000	15	144,000	38
Italy	9,050	6	7,790	1
Switzerland	71,900	61	8,460	20
Thailand	374,000	11	334,000	17
United Kingdom	760	1	314	2
Other	43,400	10	252,000	34
Total	2,760,000	348	2,890,000	408
Ruby:				
Belgium	41	(3)	252	1
China	730	(3)	2,900	(3)
France	15	1	238	5
Germany	14,000	(3)	37,700	1
Hong Kong	137,000	4	64,400	16
India	2,020,000	4	2,600,000	4
Israel	4,570	(3)	4,580	7
Italy	9,910	1	15,200	(3)
Kenya	1,050	(3)	54	(3)
Sri Lanka	633	(3)	10,100	3
Switzerland	55,900	4	1,870	2
Thailand	1,640,000	23	1,420,000	44
United Arab Emirates	--	--	974	(3)
Other	45,100	7	110,000	31
Total	3,920,000	45	4,260,000	114
Sapphire:				
Belgium	1,720	2	1,780	4
China	163,000	5	41,100	1
France	2,460	2	6,480	2
Germany	32,200	11	146,000	3
Hong Kong	237,000	15	333,000	36
India	2,970,000	18	1,990,000	15
Israel	13,000	3	9,760	2
Italy	93,200	6	15,900	1
Madagascar	31,700	3	14,300	5
South Africa	3,680	1	14,400	(3)
Sri Lanka	256,000	77	332,000	87
Switzerland	91,800	26	16,600	31
Thailand	3,050,000	109	2,990,000	79
United Kingdom	1,040	3	769	1
Other	40,500	1	38,900	2
Total	6,980,000	282	5,940,000	269

See footnotes at end of table.

TABLE 8—Continued
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY[1]

Kind and country	2011 Quantity (carats)	2011 Value[2] (millions)	2012 Quantity (carats)	2012 Value[2] (millions)
Other:				
Rough, uncut, all countries	NA	23	NA	25
Cut, set and unset, all countries	NA	37	NA	33

[r] Revised. NA Not available. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 9
VALUE OF U.S. IMPORTS OF LABORATORY-CREATED AND IMITATION GEMSTONES, BY COUNTRY[1, 2]

(Thousand dollars)

Country	2011	2012
Laboratory-created, cut but unset:		
Austria	2,340	2,640
Belgium	882	1,310
China	4,770	7,170
Germany	9,970	9,320
India	11,900	5,380
Malaysia	3,120	822
Other	3,710	6,570
Total	36,700	33,200
Imitation:[3]		
Austria	48,300	47,600
China	19,500	11,700
Czech Republic	5,540	3,890
Other	2,010	1,680
Total	75,400	64,800

[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Includes pearls.

Source: U.S. Census Bureau.

TABLE 10
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES[1]

(Thousand carats and thousand dollars)

Stones	2011		2012	
	Quantity	Value[2]	Quantity	Value[2]
Coral and similar materials, unworked	5,370	11,800	6,340	13,400
Diamonds:				
Cut but unset	13,300	21,700,000	12,000	19,600,000
Rough or uncut	704	630,000	813	551,000
Emeralds, cut but unset	2,760	348,000	2,900	408,000
Pearls:				
Cultured	NA	27,300	NA	31,800
Imitation	NA	5,930	NA	7,310
Natural	NA	18,600	NA	30,200
Rubies and sapphires, cut but unset	10,900	328,000	10,200	383,000
Other precious and semiprecious stones:				
Rough, uncut	1,670,000	15,000	2,160,000	15,300
Cut, set and unset	NA	301,000	--	--
Other	33,600	7,240	9,710	153,000
Laboratory-created:				
Cut but unset	6,230	36,700	9,160	33,200
Other	NA	22,800	NA	25,400
Imitation gemstone[3]	NA	69,400	NA	57,500
Total	1,740,000	23,500,000	2,200,000	21,300,000

NA Not available. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Customs value.

[3]Does not include pearls.

Source: U.S. Census Bureau.

TABLE 11
NATURAL DIAMOND: WORLD PRODUCTION, BY COUNTRY AND TYPE[1, 2, 3]

(Thousand carats)

Country and type	2008	2009	2010	2011	2012
Gemstones:					
Angola[e]	8,020 r	8,310 r	7,530 r	7,500 r	7,500
Australia[e]	149 r	156 r	100	78 r	92
Botswana[e]	22,600 r	12,400 r	15,400 r	16,000 r	14,400
Brazil, unspecified[4, 5]	80 r	21	25	46 r	46
Canada, unspecified[4, 5]	14,803	10,946	11,804 r	10,795	10,451
Central African Republic[e]	302	249	241 r	259 r	293
China, unspecified[4, 5]	69 r	46 r	17 r	(6) r	2
Congo (Brazzaville)[4, 5]	22 r	14 r	76 r	15 r	10
Congo (Kinshasa)[e]	33,402	21,298	20,166	19,249	21,524
Ghana, unspecified[4, 5]	643 r	376 r	334 r	302 r	233
Guinea[e]	2,480 r	557	299 r	243 r	213
Guyana, unspecified[4, 5]	193 r	97 r	46 r	51 r	44
India[e]	--	2	5	3	7
Indonesia[e]	24	9	--	--	--
Lesotho, unspecified[4, 5]	253 r	92 r	109 r	224 r	479
Liberia, unspecified[4, 5]	47	28	27	42	42
Namibia, unspecified[4, 5]	2,435	1,192	1,693	1,256 r	1,629
Russia[e]	21,900 r	20,600 r	20,700 r	20,900 r	20,700
Sierra Leone[7]	223	241	263 r	214 r	406
South Africa[e]	5,160 r	2,460 r	3,550 r	2,820 r	2,830
Tanzania[e]	202	155	60 r	35 r	108
Togo, unspecified[4, 5]	9	(6)	(6)	(6)	(6)
Venezuela[e]	4 r	3 r	1 r	-- r	--
Zimbabwe[e]	725 r	876 r	7,670 r	7,730 r	11,000
Total, gem	114,000 r	80,200 r	90,100 r	87,800 r	92,000
Industrial:[e]					
Angola	891 r	924 r	836 r	833 r	833
Australia	14,800 r	15,400 r	9,880 r	7,750 r	9,090
Botswana	9,680 r	5,320 r	6,610 r	6,870 r	6,170
Central African Republic	75 r	62	60 r	65 r	73
Congo (Kinshasa)	88 r	54 r	305 r	61 r	41
Guinea	620 r	139	75 r	61 r	53
India	--	7	13	9	20
Indonesia	6	2	--	--	--
Russia	15,000	14,100 r	14,200 r	14,300 r	14,200
Sierra Leone[8]	149	160	175 r	143 r	135
South Africa	7,740 r	3,680 r	5,320 r	4,230 r	4,246
Tanzania	36	27	11 r	6 r	19
Venezuela	6	5	1	-- r	--
Zimbabwe	73 r	88 r	768 r	774 r	1,100
Total, industrial	49,100 r	40,000 r	38,200 r	35,100 r	36,000
Grand total[9]	163,000 r	120,000 r	128,000 r	123,000 r	128,000

[e]Estimated. [r]Revised. -- Zero.

[1]Estimated data and subtotals are rounded to no more than three significant digits; may not add to unrounded, reported grand totals shown. Source: Kimberley Process Certification Scheme.

[2]Subcategory estimates are based on reported country totals, in carats. Includes data available through June 19, 2014.

[3]In addition to the countries listed, Belarus, Germany, Ireland, Nigeria, the Republic of Korea, and Sweden produced natural diamond, but information is inadequate to formulate reliable estimates of output levels.

[4]Includes near-gem and cheap-gem qualities.

[5]Reported figure.

[6]Less than ½ unit.

TABLE 11—Continued

NATURAL DIAMOND: WORLD PRODUCTION, BY COUNTRY AND TYPE[1, 2, 3]

(Thousand carats)

[7]From 2008 to 2011, production was estimated to be about 60% gem quality. In 2012, production is estimated to be about 75% gem quality.

[8]From 2008 to 2011, production was estimated to be about 40% industrial quality. In 2012, production is estimated to be about 25% industrial quality.

[9]Grand totals are reported and not rounded to three significant digits. Source: Kimberley Process Certification Scheme and United States Geological Survey.