PRECIOUS AND SEMIPRECIOUS STONES (GEM MINERALS)

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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	2,460,879	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				
Jade	1,200,000		Art jewels (possibly artificial)	6,000,000	1.8
Rock crystal (quartz)	450,000		Coral	4,000,000	1.3
Tourmaline	380,000		Pearl	20,000,000	5.9
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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[8] Lavrov, S. E., Precious and Ornamental Stones of Russia: Econ. Geol., June–July, 1931, pp. 432–436.
[9] An Information Circular on amber awaits publication, and a Bulletin on diamonds is in preparation.

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