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GEMSTONES [ADVANCE RELEASE]

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Gemstones

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In 2016, the estimated value of natural gemstones produced in the United States was $11.7 million (table 1), and the estimated value of U.S. production of synthetic gemstones was $54.9 million. The total estimated value of U.S. gemstone production was $66.6 million. The value of U.S. gemstone imports was $25.2 billion (table 8), and the value of combined U.S. gemstone exports and reexports was estimated to be $22.7 billion. In 2016, world production of natural diamond totaled 134 million carats, of which an estimated 73.2 million carats were gem quality (table 11). The value of diamond imported into the United States in 2016 exceeded $23.2 billion. This value was the combination of $20.1 billion of cut but unset diamonds more than 0.5 carat, $2.24 billion of cut but unset diamonds less than 0.5 carat, and $860 million of rough or uncut natural diamonds (table 5).

In this chapter, 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 9). Gemstones are subdivided into diamond and colored gemstones, which in this chapter designates all natural nondiamond gems. In addition, synthetic gemstones and gemstone simulants (also known as imitation gemstones) are discussed but are treated separately from natural gemstones (tables 1, 7, 8, 10). Synthetic gemstones have the same chemical, optical, and physical properties as their natural gemstone counterparts. Cultured and laboratory-created are terms also used to refer to synthetic gemstones. Gemstone simulants have appearances like those of natural gemstone materials, but they have different chemical, optical, and physical properties. Trade data in this chapter are from the U.S. Census Bureau. All percentages in the chapter were calculated using unrounded data. Revisions were made to 2015 trade data, which caused some of the 2015 data to be revised from those in the 2015 Gemstones chapter of the U.S. Geological Survey (USGS) Minerals Yearbook, volume I, Metals and Minerals. Information on industrial-grade diamond and industrial-grade garnet can be found in the USGS Minerals Yearbook, volume I, Metals and Minerals, chapters on industrial diamond and industrial garnet, respectively.

Gemstones have captured the attention of 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. 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 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 commercial operations.

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 and polish natural and synthetic 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 $11.7 million during 2016 (table 1). This production value was a 37% increase from that of 2015.

Natural gemstone materials indigenous to the United States are collected or produced in every State. During 2016, each of the 50 States produced at least $1,530 worth of gemstone materials. The leading 11 States accounted for 92% of the total value, as reported by survey respondents. These States were, in descending order of production value, Oregon, Arizona, Idaho, Colorado, California, Montana, North Carolina, Nevada, Utah, Arkansas, and Maine. Some States were known to produce a single gemstone material—Hawaii produced coral and Tennessee produced 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 2016, the United States had only one active operation in a known diamond-bearing area, Crater of Diamonds State Park near Murfreesboro, 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 for collecting diamonds. The diamonds occur in a lamproite breccia tuff associated with a volcanic pipe and in the soil developed from the lamproite breccia tuff. The largest diamond found during the year was a 2.1-carat white diamond (Easterling, 2017). During 2016, 501 diamond stones with an average weight of 0.193 carat were recovered at Crater of Diamonds. Of the 501 diamond stones recovered, 17 weighed more than 1 carat. Since the diamond-bearing pipe and the adjoining area became a State park in 1972, 32,444 diamond stones with a total weight of 6,490.0 carats have been recovered (Waymon Cox, Park Interpreter, Crater of Diamonds State Park, written commun., August 27, 2018). Exploration has demonstrated that this diamond deposit contains about 78.5 million metric tons of diamond-bearing rock (Howard, 1999, p. 62). An Arkansas law prohibits commercial diamond mining in the park.

In addition to natural gemstones, synthetic gemstones and gemstone simulants were produced in the United States in 2016. Synthetic gemstones that have been produced in the United States include alexandrite, cubic zirconia, diamond, emerald, garnet, moissanite, ruby, sapphire, spinel, and turquoise. However, during 2016, only cubic zirconia, diamond, moissanite, and turquoise were produced commercially. Gemstone simulants of amber, chrysocolla, coral, lapis lazuli, malachite, travertine, and turquoise also were manufactured in the United States. In addition, certain colors of synthetic sapphire and spinel, used to represent other gemstones, are classified as gemstone simulants.

Synthetic gemstone production in the United States was valued at $54.9 million in 2016, which was a slight decrease compared with that of 2015 (table 1). Five companies 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, in descending order of production value, North Carolina, New York, California, South Carolina, and Arizona. The value of U.S. gemstone simulant output was estimated to be more than $100 million.

Since the 1950s, when scientists manufactured the first synthetic 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 synthetic diamonds, so much so that thousands of small plants throughout China were using the HPHT method and producing synthetic 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 synthetic diamond companies were able to produce relatively large high-quality diamonds that equaled those produced from mines. The chemical vapor deposition (CVD) method of producing synthetic diamond was also developed and used during the 1950s. The CVD method was only capable of producing diamond films and small polycrystalline diamonds, which were unsuitable for jewelry. CVD has been used for more than a decade to cover large surfaces with microscopic diamond crystals and thereby add hardness to the surface.

In the early 2000s, Apollo Diamond Inc. (Boston, MA) further developed CVD technology as a method for growing single, extremely pure, gem-quality diamond crystals that were large and suitable for use in jewelry. The CVD technique uses high-energy microwaves in a chamber to energize a methane gas into plasma, which then precipitates carbon atoms onto flat diamond wafer seeds as diamond. In developing this process, synthetic diamond producers discovered the temperature, gas composition, and pressure combination that resulted in the growth of a single diamond crystal and were able to produce synthetic stones that ranged from 1 to 2 carats. The size of the diamonds produced was limited only by the size of the diamond seeds and the growing chamber (table 10).

In 2011, Scio Diamond Technology Corp. (Greenville, SC) acquired the diamond growing process patents and equipment from Apollo Diamond (Sim, 2016). During 2015, the average size of synthetic diamond crystals grown by Scio Diamond more than doubled (Scio Diamond Technology Corp., 2015). In 2016, Scio Diamond Technology Corp. increased its capacity to produce colorless single-crystal diamonds at a higher quality and volume than the previous year. In 2016, Scio Diamond used CVD technology to produce synthetic single-crystal diamond stones for finished sizes that averaged from 0.75 to 2 carats for jewelry. These CVD diamonds were also appropriate for industrial uses (Bailey, 2016; Sim, 2016).

Charles & Colvard, Ltd. in North Carolina was the only U.S. manufacturer of moissanite, a gem-quality synthetic silicon carbide and an excellent diamond simulant. The company used a proprietary patented technology. Moissanite was marketed for its own gem qualities; it exhibits a higher refractive index (brilliance) and higher luster than diamond. Its hardness is between that of corundum (ruby and sapphire) and that of diamond, which gives it durability. Charles & Colvard reported that moissanite sales increased by 12% to $29.2 million in 2016 compared with $25.7 million in 2015 (Charles & Colvard, Ltd., 2017, p. 27).

U.S. mussel shells are used as a source of mother-of-pearl and as seed material for culturing pearls. The value of U.S. shell production increased 36% to $340,000 in 2016 compared with $250,000 in 2015 (table 1). This mussel shell data includes only freshwater mussel shells. 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 only a small portion of total global gemstone production, it was the world's leading diamond and nondiamond gemstone market, accounting for more than 35% of world gemstone consumption in 2016. In the United States, the majority of domestic consumers designated diamond as their favorite gemstone. This popularity of diamonds is evidenced by the diamond market accounting for 94% of the total value of the U.S. gemstone apparent consumption. The U.S. apparent consumption for unset gem-quality diamond during the year was estimated to be $20.7 billion, a slight increase compared with $20.6 billion in 2015. Domestic markets for natural, unset nondiamond gemstones totaled $1.23 billion in 2016, which was a 9% increase from $1.12 billion in 2015.

U.S. specialty jewelry store retail sales increased to $31.4 billion for the year in 2016, a 3.8% increase compared with retail sales in 2015. There was a sharp increase in sales at the end of the year, with December 2016 sales increasing 6.9% to $6.21 billion compared with sales of December 2015 (Rapaport, 2017).

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. Value of production and prices of gemstones produced and (or) sold in the United States are listed in tables 1, 2, and 3. In addition, customs values for diamonds and other gemstones imported, exported, or reexported are listed in tables 4 through 8.

De Beers Group companies remained a significant force, influencing the price of gem-quality diamond sales worldwide during 2016. De Beers companies produced about 18% of total global quantity and 30% of total global value (De Beers Group UK Ltd., 2017, p. 7).

Since 2000, De Beers' control of world diamond pricing has gradually decreased. Instead, flexible pricing mechanisms have set the stage for new methods of rough diamond sales in addition to rough diamonds being sold through a limited number of sightholder sales, the method used for years by De Beers. Rough diamonds were also sold by auctions, placed sales, tender sales, and term contracts (De Beers Group UK Ltd., 2014, p. 39).

Foreign Trade

During 2016, total U.S. natural gemstone trade with all countries and localities was valued at about $47.9 billion, which was a slight decrease from that of 2015. Total U.S. natural gemstone trade with all countries and localities, excluding reexports, was valued at about $28.6 billion. Diamond accounted for about 89% of the 2016 gemstone trade total value. In 2016, U.S. exports and reexports of diamond were shipped to 93 countries and localities, and imports of all gemstones were received from 79 countries and localities (tables 4–8). In 2016, U.S. import quantities of cut diamond decreased slightly compared with those of 2015, and the value decreased by 3%. U.S. import quantities of rough and unworked diamond in 2016 increased 47% compared with the previous year, and the value increased by 182% compared with that of 2015 (table 8). 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 2016, U.S. export and reexport quantities of gem-grade diamond decreased by 5% compared with those of 2015, and the value increased by 5%. The large quantity of reexports revealed the significance of the United States in the world's diamond supply network (table 4).

Import values of natural gemstones increased slightly to $25.2 billion for the United States in 2016 compared with $25.0 billion in 2015. Import values of synthetic gemstone more than doubled to $74.2 million in 2016 compared with $31.6 million 2015 (tables 7–8). This increase was due to large increases in synthetic gemstone imports from China and India. Synthetic gemstone imports from India, China, Russia, Germany, Hong Kong, Belgium, and Austria had a value of about $66.6 million and accounted for about 94% (by value) of total domestic imports of synthetic gemstones during 2016 (table 7). The marketing of imported synthetic gemstones and enhanced gemstones as natural gemstones and the mixing of synthetic materials with natural stones in imported parcels continued to be an issue for some domestic jewelers and sales companies in 2016. In addition, some simulants were marketed as natural or synthetic gemstones during the year, as in previous years.

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 influenced by consumer demand and supply availability and, to a lesser extent, by managing the quality and quantity of the gemstones relative to demand, a function that has been performed by De Beers sightholder sales. Unlike diamond, colored gemstones are primarily produced at relatively small, low-cost operations with few dominant producers; prices are influenced only by consumer demand and supply availability.

In 2016, world natural rough diamond production increased by 5% to 134 million carats from 127 million carats in 2015. The 134 million carats of rough diamond produced included 73.2 million carats (55% of total diamond production) of gem-quality and 60.8 million carats (45% of total diamond production) of industrial-grade diamond (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). The world's rough diamond producers were as follows: Russia, producing 40.3 million carats or 30% of total world production; Congo (Kinshasa), with 23.2 million carats

(17%); Botswana, with 20.5 million carats (15%); Australia, with 14.0 million carats (10%); Canada, with 13.0 million carats (9.7%); Angola, with 9.02 million carats (6.7%); South Africa, with 8.31 million carats (6.2%); and other countries, with 5.7 million carats (4.3%). During 2016, the value of worldwide rough diamond production decreased by 12% to $15.4 billion from the 2015 value of $17.5 billion (De Beers Group UK Ltd., 2017, p. 7). In 2016, Russia also was the world's leading gemstone diamond producer with 31%; followed by Botswana, 20%; Canada, 18%; Angola, 11%; South Africa, 9%; Congo (Kinshasa), 6%; and Namibia, 2%. These seven countries produced 97% (by quantity) of the world's gemstone diamond output in 2016 (table 11).

During 2016, OJSC ALROSA and De Beers Group remained the two leading diamond producers by quantity and value. ALROSA's production was about 26% of total global quantity and 25% of total global value; De Beers' production was about 18% of total global quantity and 30% of total global value. The third-ranked company was Rio Tinto Ltd., which produced about 12% of total global production quantity and approximately 4% of global production value (De Beers Group UK Ltd., 2017, p. 7).

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 objectives of the UN Security Council. The KPCS monitors rough diamond trade in both gemstone and industrial diamond. 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 Arab Emirates assumed the chair of KPCS from January 1 through December 31, 2016. As of December 31, 2016, the 54 participants represented 81 nations (including the 28 member nations of the European Union counted as a single participant) plus the rough diamond trading entity of Taipei (Taiwan). The participating nations in the KPCS account for approximately 99.8% of the global production and trade of rough diamonds (Kimberley Process, 2018).

Globally, the value of production of natural gemstones other than diamond was estimated to be more than $2.5 billion in 2016. Most nondiamond gemstone mines are small, low-cost, and widely dispersed operations that are often in remote regions. 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 2016.

Worldwide diamond exploration spending decreased by 21% in 2016 with 45 companies allocating $290 million, compared with 52 companies allocating $367 million during 2015. The diamond share of overall worldwide mineral exploration spending remained at 4.2% (SNL Metals & Mining, 2016, p. 1, 12–13).

Botswana.—Diamond production in Botswana was 20.5 million carats during 2016, a slight decrease compared with that of 2015, accounting for 15% of total global production.

The Jwaneng diamond mine in the Kalahari Desert of south-central Botswana was wholly owned by Debswana Diamond Co. (Pty.) Ltd. The company began the Cut-8 project during 2016, and production from the project was expected to begin in 2017 (De Beers Group UK Ltd., 2017, p. 7).

Canada.—Diamond production in Canada was 13.0 million carats during 2016, a 12% increase compared with that of 2015, accounting for 9.7% of total global production.

The Diavik Diamond Mine in the Northwest Territories began an extension project of the A21 kimberlite pipe pit during 2016. Diavik is jointly owned by Rio Tinto Group (60%) and Dominion Diamond Corp. (40%). Production from this project was expected to begin in 2018 (De Beers Group UK Ltd., 2017, p. 7).

The Gahcho Kué Mine in the Northwest Territories began production in 2016. The mine is jointly owned by De Beers Canada, Inc. (51%) and Mountain Province Diamonds Inc. (49%). The mine owners anticipated average annual diamond production of 4.5 million carats (De Beers Group UK Ltd., 2017, p. 7).

The Renard Mine in Quebec began production in 2016. The mine is wholly owned by Stornoway Diamond Corp. Stornoway anticipated average annual diamond production of 1.6 million carats (De Beers Group UK Ltd., 2017, p. 7).

Lesotho.—Diamond production in Lesotho was 342,000 carats during 2016, a 13% increase compared with that of 2015, accounting for 0.3% of total global production.

The Liqhobong Diamond Mine in the Maluti Mountains of northern Lesotho began production in 2016. The mine is owned by Firestone Diamonds plc (75%) and the Government of Lesotho (25%). The mine owners anticipated average annual diamond production of 1.0 million carats (De Beers Group UK Ltd., 2017, p. 7).

Russia.—Diamond production in Russia was 40.3 million carats during 2016, a 4% decrease compared with that of 2015, accounting for 30% of total global production. The Verkhne-Munskoe Mine project in Yakutia, Russia, was started during 2016. The mine is owned by OJSC ALROSA. The project completion and mine startup were expected during 2018 (De Beers Group UK Ltd., 2017, p. 7).

Outlook

As domestic and global luxury spending increase, sales of gemstones and jewelry are expected to increase also. As the gemstone and jewelry industries and their consumers become more comfortable with the internet and other forms of e-commerce, sales of diamonds, gemstones, and jewelry over the internet are expected to continue to increase. Internet sales are expected to add to and partially replace "brick-and-mortar" store sales.

Global diamond production is expected to increase during the next few years as a result of new projects coming onstream. By 2020, about 25% of diamond production will come from projects that are currently being developed, but additional increases in output will come from expected expansions at currently operating mines (De Beers Group UK Ltd., 2016, p. 29).

More synthetic gemstones, simulants, and treated gemstones are likely to enter the marketplace and necessitate more transparent industry trade standards to maintain customer confidence.

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TABLE 1
ESTIMATED VALUE OF U.S. GEMSTONE PRODUCTION,
BY GEM TYPE[1]

(Thousand dollars)

Gem materials	Natural gems		Synthetic gems	
	2015	2016	2015	2016
Beryl	177	360	--	--
Coral, all types	101	68	--	--
Cubic zirconia	XX	XX	12,000	12,000
Diamond	72	70	2,250	13,600
Garnet	66	53	10,000	--
Gem feldspar	730	1,730	--	--
Geodes and nodules	51	69	--	--
Moissanite	XX	XX	30,800	29,200
Opal	143	138	--	--
Quartz:			--	--
Macrocrystalline[2]	251	496	--	--
Cryptocrystalline[3]	59	604	--	--
Sapphire and ruby	313	331	--	--
Shell	250	340	--	--
Topaz	3	13	--	--
Tourmaline	177	43	--	--
Turquoise	1,330	2,280	75	75
Other	4,820	5,140	--	--
Total	8,540	11,700	55,100	54,900

XX Not applicable. -- Zero.

[1]Table includes data available through September 21, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Macrocrystalline quartz (crystals recognizable with the naked eye) includes amethyst, aventurine, blue quartz, citrine, hawk's eye, prasiolite, prase, quartz, cat's eye, rock crystal, rose quartz, smoky quartz, and tiger's eye.

[3]Cryptocrystalline quartz (microscopically small crystals) includes agate, carnelian, chalcedony, chrysoprase, fossilized wood, heliotrope, jasper, moss agate, onyx, and sard.

TABLE 2
PRICES PER CARAT OF U.S. CUT ROUND DIAMONDS, BY SIZE AND QUALITY IN 2016

Carat weight	Color[1]	Clarity[2]	Representative prices		
			January[3]	June[4]	December[5]
0.25	G	VS1	$1,650	$1,650	$1,650
Do.	do.	VS2	1,575	1,575	1,575
Do.	do.	SI1	1,250	1,250	1,250
Do.	H	VS1	1,600	1,600	1,600
Do.	do.	VS2	1,500	1,500	1,500
Do.	do.	SI1	1,200	1,200	1,200
0.50	G	VS1	2,600	2,600	2,600
Do.	do.	VS2	2,400	2,400	2,400
Do.	do.	SI1	2,080	2,080	2,080
Do.	H	VS1	2,390	2,390	2,390
Do.	do.	VS2	2,320	2,320	2,320
Do.	do.	SI1	1,910	1,910	1,910
1.00	G	VS1	7,060	7,060	7,060
Do.	do.	VS2	6,600	6,600	6,600
Do.	do.	SI1	6,000	6,000	6,000
Do.	H	VS1	6,450	6,450	6,450
Do.	do.	VS2	6,000	6,000	6,000
Do.	do.	SI1	5,425	5,200	5,200
2.00	G	VS1	13,690	13,690	13,690
Do.	do.	VS2	12,250	12,250	12,250
Do.	do.	SI1	10,660	10,660	10,660
Do.	H	VS1	11,620	11,620	11,620
Do.	do.	VS2	10,450	10,450	10,450
Do.	do.	SI1	9,950	9,950	9,950

Do., do. Ditto.

[1]Gemological Institute of America (GIA) color grades: D—colorless; E—rare white; G, H, I—traces of color.

[2]GIA clarity terms: 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. 35, no. 1, January/February 2016, p. 24–26.

[4]Source: The Gem Guide, v. 35, no. 4, July/August 2016, p. 22–24.

[5]Source: The Gem Guide, v. 35, no. 6, November/December 2016, p. 24–26.

TABLE 3
PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES IN 2016

Gemstone	Price range per carat	
	January[1]	December[2]
Amethyst	$30–35	$30–35
Aquamarine	275–365	325–375
Citrine	13–22	13–22
Emerald	3,250–4,500	3,250–4,500
Opal, fire	375–500	375–500
Opal, white (also jelly opal)	120–180	65–80
Pearl, cultured saltwater[3]	5	5
Peridot	150–200	165–200
Rhodolite garnet	55–80	55–80
Ruby	2,640–3,600	2,640–3,600
Sapphire, blue	1,200–1,900	1,200–1,900
Tanzanite	375–395	375–395
Topaz, blue	7–10	7–10
Topaz, yellow	175–250	175–250
Tourmaline, green	135–200	135–200
Tourmaline, pink	175–200	175–200

[1]Source: The Gem Guide, v. 35, no. 1, January/February 2016, p. 53–54, 57, 61, 66–68, 70, 72–75, and 82. 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. 35, no. 6, November/December 2016, p. 53–54, 57, 61, 66–68, 70, 72–75, and 82. 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 4
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY OR LOCALITY[1]

Country or locality	2015 Quantity (carats)	2015 Value[2] (thousands)	2016 Quantity (carats)	2016 Value[2] (thousands)
Exports:				
Aruba	1,050	$4,320	1,220	$2,350
Australia	30,600	32,900	19,000	20,700
Belgium	187,000	304,000	564,000	407,000
Brazil	10,600	3,080	15,500	5,110
Canada	38,600	70,600	38,300	66,600
China	1,370	4,900	1,290	2,770
Costa Rica	3,530	304	12	11
Dominican Republic	30,800	12,200	7,180	3,540
El Salvador	529	215	427	241
France	67,100	24,600	9,410	26,200
Germany	9,790	9,760	1,590	6,350
Hong Kong	1,660,000	671,000	1,170,000	597,000
India	672,000	238,000	669,000	293,000
Ireland	16,900	90,300	7,950	37,200
Israel	243,000	608,000	184,000	601,000
Italy	75,200	10,000	24,900	14,700
Japan	9,320	8,970	2,610	13,500
Lebanon	1,580	1,230	1,560	1,620
Macau	838	4,240	1,710	8,570
Malaysia	10,000	242	54	184
Mauritius	2,400	765	557	183
Mexico	316,000	71,600	331,000	71,300
New Zealand	2,560	2,300	603	1,160
Panama	883	822	17,600	2,800
Poland	6	23	2,290	154
Singapore	6,780	9,960	5,050	14,100
Sint Maarten	7,320	26,000	12,700	17,400
Sri Lanka	1,540	301	22	87
Switzerland	12,300 r	97,800 r	44,200	58,500
Taiwan	10,500	4,800	5,310	3,110
Thailand	146,000	24,000	148,000	11,300
United Arab Emirates	391,000	153,000	408,000	113,000
United Kingdom	6,670	41,500	49,700	19,900
Vietnam	43,900	33,500	36,900	45,600
Other	6,160 r	19,100 r	6,260	17,800
Total	4,020,000	2,590,000	3,790,000	2,480,000
Reexports:				
Armenia	17,200	4,890	27,500	4,860
Aruba	3,240	6,490	2,530	5,380
Australia	2,950	49,300	7,560	41,900
Belgium	635,000	2,590,000	664,000	2,740,000
Brazil	2,940	1,050	1,190	106
Canada	105,000 r	141,000	99,700	142,000
China	28,100	36,700	45,200	42,100
Costa Rica	12,600	279	776	284
Dominican Republic	--	--	17,200	6,830
Ecuador	274	111	2,680	42
France	3,550	163,000	3,910	217,000
Germany	3,070	5,470	30,800	2,190
Hong Kong	2,470,000	2,310,000	2,300,000	2,440,000
India	2,760,000	3,510,000	2,640,000	4,510,000
Israel	990,000	4,710,000	1,050,000	4,370,000
Italy	72,000	35,100	11,100	34,400
Japan	33,800	61,300	27,700	63,600
Jordan	297	55	1,640	742
Laos	7,970	4,810	8,640	4,780
Lebanon	4,180	9,080	1,180	2,870
Malaysia	85,300	1,510	426	795

See footnotes at end of table.

TABLE 4—Continued
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY OR LOCALITY[1]

Country or locality	2015 Quantity (carats)	2015 Value[2] (thousands)	2016 Quantity (carats)	2016 Value[2] (thousands)
Reexports:—Continued				
Mauritius	778	564	1,650	930
Mexico	3,590	8,050	10,000	10,700
Namibia	12,200	7,820	20,600	10,400
Panama	30,900	12,200	1,350	2,120
Singapore	9,140	44,400	6,780	41,400
Sint Maarten	14,800	41,800	20,600	41,600
South Africa	13,100	141,000	7,740	94,500
Sri Lanka	311	710	1,930	659
Switzerland	158,000	1,180,000	96,300	1,030,000
Taiwan	26,100	6,020	704	4,800
Thailand	172,000	59,300	130,000	88,000
Trinidad and Tobago	251	103	1,300	3
United Arab Emirates	402,000	398,000	432,000	539,000
United Kingdom	54,500	363,000	53,700	454,000
Vietnam	3,910	4,840	7,130	7,530
Other	3,460 r	23,900 r	13,400	9,230
Total	8,140,000 r	15,900,000	7,750,000	17,000,000
Grand total	12,200,000	18,500,000	11,500,000	19,400,000

rRevised. -- Zero.

[1]Table includes data available through September 21, 2018. Data are rounded to no more than three significant digits; may not add to totals shown. Export and reexport data are for Harmonized Tariff Schedule of the United States codes 7102.31.0000, 7102.39.0010, and 7102.39.0050.

[2]Values are free alongside ship.

Source: U.S. Census Bureau.

TABLE 5
U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY OR LOCALITY[1]

Kind, weight, and country or locality	2015 Quantity (carats)	2015 Value[2] (thousands)	2016 Quantity (carats)	2016 Value[2] (thousands)
Rough or uncut, natural:[3]				
Angola	23,400	$70,500	34,000	$232,000
Australia	2,710	1,120	18,500	1,540
Botswana	55,100	61,300	63,700	318,000
Brazil	4,170	3,970	5,830	20,600
Canada	105,000	7,380	112,000	26,400
Congo (Brazzaville)	947	413	2,210	25
Congo (Kinshasa)	11,900	456	1,340	6,390
Guyana	969	433	7,510	1,950
India	1,520	484	4,470	3,260
Lesotho	1,760	27,900	407	13,400
Namibia	2,810	5,040	18,300	23,100
Russia	64,200	23,100	173,000	21,800
South Africa	141,000	97,000	173,000	139,000
Tanzania	1,060	403	147	50,200
Other	1,300 r	5,120 r	1,080	2,740
Total	418,000	305,000	616,000	860,000
Cut but unset, not more than 0.5 carat:[4]				
Armenia	3,400	2,380	6,850	3,390
Australia	1,240	1,100	1,300	1,860
Belgium	190,000	101,000	154,000	99,800
Botswana	6,600	22,900	5,610	14,400
Brazil	940	611	1,050	866
Cambodia	7,030	6,280	22,200	17,300
Canada	12,600	10,600	20,200	12,600
China	37,100	44,600	34,500	29,300
Dominican Republic	3,680	436	1,090	176
France	2,370	803	533	1,030
Germany	3,720	981	5,110	1,640
Hong Kong	121,000	35,500	164,000	28,800
India	5,240,000	1,600,000	5,070,000	1,560,000
Israel	641,000	260,000	761,000	285,000
Italy	7,290	2,080	19,600	4,170
Japan	1,840	888	1,290	579
Laos	2,230	2,610	8,030	9,290
Mauritius	15,800	49,100	16,100	30,400
Mexico	83,400	20,500	70,600	15,400
Namibia	4,200	14,100	2,120	6,060
Panama	1,140	409	--	--
Singapore	2,610	1,600	4,000	3,600
South Africa	20,500	90,300	28,100	40,600
Spain	2,050	441	531	189
Sri Lanka	3,830	3,710	3,480	3,660
Switzerland	1,310	5,900	572	335
Thailand	40,200	12,100	44,600	11,300
United Arab Emirates	5,700	2,710	16,100	3,670
United Kingdom	22,400	4,450	24,300	2,960
Vietnam	58,800	68,700	49,500	44,500
Other	1,880	2,610 r	7,950	2,930
Total	6,540,000	2,370,000	6,540,000	2,240,000
Cut but unset, more than 0.5 carat:[5]				
Armenia	3,870	2,630	2,210	1,600
Australia	3,460	59,300	3,570	95,800
Belgium	591,000	3,600,000	479,000	3,180,000
Botswana	28,300	118,000	24,900	94,800
Brazil	726	6,670	658	3,700
Canada	40,700	114,000	34,000	129,000
China	50,800	233,000	25,100	181,000
France	1,910	79,300	1,520	58,200

See footnotes at end of table.

TABLE 5—Continued
U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY OR LOCALITY[1]

Kind, weight, and country or locality	2015 Quantity (carats)	2015 Value[2] (thousands)	2016 Quantity (carats)	2016 Value[2] (thousands)
Cut but unset, more than 0.5 carat:[5]—Continued				
Germany	2,440	5,730	1,480	3,580
Hong Kong	62,900	262,000	29,100	149,000
India	2,200,000	6,180,000	2,430,000	7,510,000
Israel	1,530,000	8,410,000	1,350,000	7,150,000
Italy	1,480	11,700	815	14,100
Japan	2,000	5,820	3,430	6,760
Lebanon	1,280	6,900	57	401
Mauritius	9,140	53,900	7,450	28,200
Mexico	6,880	2,480	735	769
Namibia	12,000	47,000	10,300	31,700
Russia	10,100	90,500	14,600	61,500
Singapore	11,400	24,700	11,000	20,300
South Africa	37,000	583,000	27,500	692,000
Spain	1,270	2,540	696	2,500
Switzerland	8,100	403,000	9,050	409,000
Thailand	24,200	34,300	8,730	39,100
United Arab Emirates	8,880	56,700	7,720	62,400
United Kingdom	4,260	145,000	6,730	78,700
Vietnam	531	2,790	2,410	7,270
Other	2,960 r	15,300 r	8,250	93,300
Total	4,650,000	20,600,000	4,500,000	20,100,000

rRevised. -- Zero.
[1]Table includes data available through September 21, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Harmonized Tariff Schedule of the United States (HTS) code 7102.31.0000.
[4]HTS code 7102.39.0010.
[5]HTS code 7102.39.0050.

Source: U.S. Census Bureau.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY OR LOCALITY[1]

Kind and country or locality	2015		2016	
	Quantity (carats)	Value[2] (thousands)	Quantity (carats)	Value[2] (thousands)
Emerald:[3]				
Belgium	825	$3,490	1,220	$4,530
Brazil	234,000	16,800	113,000	17,000
Canada	2,210	198	1,140	414
China	9,570	906	22,100	464
Colombia	393,000	248,000	285,000	233,000
France	2,180	16,900	4,480	33,800
Germany	4,290	1,710	14,000	1,300
Hong Kong	92,300	30,200	217,000	29,700
India	1,910,000	137,000	1,090,000	134,000
Israel	188,000	56,300	180,000	60,000
Italy	815	3,710	5,790	13,000
Japan	1,180	31	1,070	117
Lebanon	59	9	1,450	235
Malaysia	5,170	198	6,500	27
Mozambique	661	347	4,320	1,150
South Africa	9,670	1,790	8,830	1,790
Sri Lanka	2,410	1,150	7,500	3,270
Switzerland	5,030	20,500	8,550	30,100
Thailand	406,000	15,300	525,000	17,500
United Arab Emirates	13,100	13,200	12,200	1,650
United Kingdom	794	4,490	2,170	7,510
Zambia	361,000	43,800	291,000	35,700
Zimbabwe	--	--	3,400	300
Other	6,930 r	1,110 r	1,590	3,180
Total	3,650,000	617,000	2,810,000	630,000
Ruby:[4]				
Afghanistan	3,180	250	1,280	1,730
Belgium	89	1,450	348	1,320
Brazil	6,930	24	1,960	14
Burma	--	--	1,750	6,630
Canada	113	45	1,790	61
China	7,070	91	8,950	118
France	857	3,470	1,010	2,990
Germany	14,900	1,640	6,260	357
Hong Kong	16,800	11,400	357,000	11,000
India	1,310,000	14,800	1,570,000	21,000
Israel	3,660	5,180	1,190	4,070
Italy	317	1,520	1,770	1,690
Kenya	7,840	53	7,860	81
Madagascar	174,000	6,510	127,000	6,470
Malaysia	1,230	15	11,500	12
Mozambique	70,100	25,400	95,000	36,700
South Africa	13,000	4,450	11,300	1,450
Sri Lanka	2,200	1,290	2,680	1,810
Switzerland	678	1,310	6,320	4,320
Tanzania	30,800	290	954	5,510
Thailand	2,000,000	63,900	1,980,000	70,300
United Kingdom	2,020	1,670	200	897
Vietnam	1,400	1,490	85	152
Zambia	1,150	284	737	362
Other	3,610 r	2,500 r	628	1,330
Total	3,680,000	149,000	4,200,000	180,000
Sapphire:[5]				
Australia	4,520	591	1,570	186
Belgium	2,610	3,090	716	5,050
Brazil	35,100	63	16,600	463
Burma	64	1,120	20,400	6,730

See footnotes at end of table.

TABLE 6—Continued
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY OR LOCALITY[1]

Kind and country or locality	2015 Quantity (carats)	2015 Value[2] (thousands)	2016 Quantity (carats)	2016 Value[2] (thousands)
Sapphire:[5]—Continued				
Canada	881	370	1,520	224
China	16,800	968	120,000	1,400
France	3,100	19,900	5,080	37,300
Germany	39,100	3,140	42,400	1,440
Hong Kong	251,000	77,800	173,000	42,400
India	1,880,000	49,800	1,550,000	38,300
Israel	15,500	7,880	13,500	8,640
Italy	3,930	5,370	5,870	8,370
Japan	1,380	209	2,060	160
Kenya	3	2	3,690	102
Madagascar	288,000	6,730	220,000	6,080
Mozambique	7,600	1,260	11,800	663
Pakistan	316	37	4,100	988
South Africa	7,940	281	10,400	1,820
Sri Lanka	361,000	89,800	1,080,000	96,300
Switzerland	16,000	78,900	7,920	52,900
Thailand	3,690,000	104,000	4,060,000	111,000
Turkey	4,410	76	928	95
United Arab Emirates	3,880	275	270	705
United Kingdom	3,470	11,000	995	11,900
Zambia	1,720	126	220	88
Other	1,620 r	1,080 r	2,450	1,470
Total	6,640,000	464,000	7,360,000	435,000
Other:				
Rough, uncut, all countries and (or) localities[6]	137,000,000 r	1,350 r	224,000,000	2,180
Cut, set and unset, all countries and (or) localities[7]	NA	472,000 r	NA	516,000

rRevised. NA Not available. -- Zero.
[1]Table includes data available through September 21, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Harmonized Tariff Schedule of the United States (HTS) code 7103.91.0030.
[4]HTS code 7103.91.0010.
[5]HTS code 7103.91.0020.
[6]HTS code 7103.10.4080.
[7]HTS code 7103.99.1080.

Source: U.S. Census Bureau.

TABLE 7
VALUE OF U.S. IMPORTS OF SYNTHETIC
AND IMITATION GEMSTONES, BY COUNTRY OR LOCALITY[1, 2]

(Thousand dollars)

Country or locality	2015	2016
Synthetic, cut but unset:[3]		
Austria	1,410	1,370
Belgium	281	1,780
Brazil	131 r	12
China	5,190	15,600
Czechia	115	51
France	423	403
Germany	9,080	8,180
Hong Kong	281	2,850
India	6,650	24,900
Israel	64	950
Mexico	63	240
Netherlands	106	330
Russia	892	11,800
Singapore	1,580	489
South Africa	243	--
Sri Lanka	308	431
Switzerland	146	68
Taiwan	54	41
Thailand	882	735
United Arab Emirates	4	423
Other	475 r	452
Total	28,400 r	71,200
Gemstone simulants:[4]		
Brazil	1	25
Canada	83	26
China	20,000	18,500
Germany	33	4
Hong Kong	90	34
India	44	7
Italy	40	1
Japan	2	47
Korea, Republic of	232	199
Netherlands	--	19
Pakistan	97	106
Spain	30	2
Taiwan	1,290	1,040
Thailand	194	122
United Kingdom	57	10
Other	18	80
Total	22,200	20,200

rRevised. -- Zero.
[1]Table includes data available through September 21, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Harmonized Tariff Schedule of the United States (HTS) code 7104.90.1000.
[4]Does not include pearls; HTS code 3926.90.4000.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES[1]

(Thousand carats and thousand dollars)

Stones	2015		2016	
	Quantity	Value[2]	Quantity	Value[2]
Coral and similar materials, unworked[3]	8,190	16,500	7,480	15,100
Diamonds:				
Cut but unset[4]	11,200	22,900,000	11,000	22,300,000
Rough or uncut[5]	418	305,000	616	860,000
Emeralds, cut but unset[6]	3,650	617,000	2,810	630,000
Pearls:				
Cultured[7]	NA	22,100	NA	23,500
Simulant[8]	NA	43,200	NA	39,500
Natural	NA	23,700	NA	41,400
Rubies, cut but unset[9]	3,680	149,000	4,200	180,000
Sapphires, cut but unset[10]	6,640	464,000	7,360	435,000
Other precious and semiprecious stones:				
Rough, uncut[11]	2,520,000	38,600	1,820,000	49,300
Cut, set and unset[12]	NA	472,000 r	NA	516,000
Other[13]	NA	11,300 r	NA	15,600
Synthetic:				
Cut but unset[14]	50,400	28,400 r	41,000	71,200
Other[15]	NA	3,270 r	NA	2,960
Gemstone simulants[16]	NA	22,200	NA	20,200
Total	2,600,000	25,100,000	1,890,000	25,200,000

rRevised. NA Not available.
[1]Table includes data available through September 21, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Customs value.
[3]Harmonized Tariff Schedule of the United States (HTS) code 0508.00.0000.
[4]HTS codes 7102.39.0010 and 7102.39.0050.
[5]HTS code 7102.31.0000.
[6]HTS code 7103.91.0030.
[7]HTS code 7101.21.0000.
[8]HTS codes 7018.10.1000 and 7018.10.2000.
[9]HTS code 7103.91.0010.
[10]HTS code 7103.91.0020.
[11]HTS codes 7103.10.2020 and 7103.10.2080.
[12]HTS code 7103.99.1080.
[13]HTS code 7103.99.5080.
[14]HTS code 7104.90.1000.
[15]HTS code 7104.90.5000.
[16]Does not include simulant pearls; HTS code 3926.90.4000.

Source: U.S. Census Bureau.

TABLE 9
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	2.5–2.0	1.1–1.0	Single	1.54	Synthetic or pressed plastics, kauri gum	Fossil resin, color, low density, soft, insects.
Apatite	Chlorocalcium phosphate	Colorless, pink, yellow, green, blue, violet	Small	Low	5.0	3.23–3.16	Double	1.65–1.63	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.	4.0–3.5	3.9–3.7	do.	1.85–1.72	Dumortierite, hauynite, lapis lazuli, lazulite, sodalite	Color, softness, crystal habits, associated minerals.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	do.	High	6.5–6.0	3.68–3.64	do.	1.80–1.76	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	8.0–7.5	2.80–2.63	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	Red	Small	Very high	8.0–7.5	2.80–2.63	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald, natural	do.	Green	Medium	do.	7.5	2.80–2.63	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	8.0–7.5	2.80–2.63	do.	1.58	Genuine emerald	Lack of flaws, brilliant fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	8.0–7.5	2.80–2.63	do.	1.58	Citrine, topaz, glass, doublets	Weak-colored.
Goshenite	do.	Colorless	do.	Low	8.0–7.5	2.80–2.63	do.	1.58	Quartz, glass, white sapphire, white topaz	Refractive index.
Morganite	do.	Pink to rose	do.	do.	8.0–7.5	2.80–2.63	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, brown	do.	do.	3.0	2.72	Double (strong)	1.66–1.49	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, white	Small to medium	do.	6.0–5.0	2.78–2.54	XX	1.56–1.55	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	3.84–3.50	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	3.84–3.50	do.	1.75	Synthetic, shell	Density, translucence, chatoyance.
Chrysolite	do.	Yellow, green, brown	Medium	Medium	8.5	3.84–3.50	do.	1.75	Tourmaline, peridot	Refractive index, silky.

See footnotes at end of table.

TABLE 9—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	4.0–2.0	2.4–2.0	XX	1.57–1.46	Azurite, dyed chalcedony, malachite, turquoise, variscite	Lack of crystals, color, fracture, low density, softness.
Coral	Calcium carbonate	Orange, red, white, black, purple, green	Branching, medium	do.	4.0–3.5	2.7–2.6	Double	1.66–1.49	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	4.10–3.95	do.	1.78	Synthetics, including spinel, garnet	Inclusions, fluorescence.
Sapphire, blue	do.	Blue	Medium	High	9.0	4.10–3.95	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, colorless, orange, green, violet	Medium to large	Medium	9.0	4.10–3.95	do.	1.78	Synthetics, glass and doublets, morganite	Inclusions, double refraction, refractive index.
Sapphire or ruby, stars	do.	Red, pink, violet, blue, gray	do.	High to low	9.0	4.10–3.95	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.
Sapphire or ruby, synthetic	do.	Yellow, pink, blue, green, orange, violet, red	Up to 20 carats	Low	9.0	4.10–3.95	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Cubic zirconia	Zirconium and yttrium oxides	Colorless, pink, blue, lavender, yellow	Small	do.	8.5–8.25	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	3.525–3.516	do.	2.42	Zircon, titania, cubic zirconia, moissanite	High index, dispersion, hardness, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green-blue	Large	Low	6.5–6.0	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.	6.5–6.0	2.56	XX	1.56	do.	Do.
Moonstone	do.	Colorless, white, gray, yellow with white, blue, or bronze schiller	do.	do.	6.5–6.0	2.77	XX	1.54–1.52	Glass, chalcedony, opal	Pale sheen, opalescent.
Sunstone	do.	Orange, red brown, colorless with gold or red glittery schiller	Small to medium	do.	6.5–6.0	2.77	XX	1.55–1.53	Aventurine, glass	Red glittery schiller.
Garnet	Complex silicate	Brown, black, yellow, green, red, orange	do.	Low to high	7.5–6.5	4.30–3.15	Single strained	1.98–1.79	Synthetics, spinel, glass	Single refraction, anomalous strain.
Hematite	Iron oxide	Black, black-gray, brown-red	Medium to large	Low	6.5–5.5	5.28–5.12	XX	3.22–2.94	Davidite, cassiterite, magnetite, neptunite, pyrolusite, wolframite	Crystal habit, streak, hardness.

See footnotes at end of table.

TABLE 9—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, mauve	Large	Low to very high	7.0–6.5	3.5–3.3	Crypto-crystalline	1.68–1.65	Nephrite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.5–6.0	3.10–2.96	do.	1.63–1.61	Jadeite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Do.
Jet (gagate)	Lignite	Deep black, dark brown	do.	Low	4.0–2.5	1.35–1.19	XX	1.68–1.64	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.	6.0–5.0	3.0–2.50	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.	4.0–3.5	4.10–3.25	XX	1.91–1.66	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	2.69–2.65	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	5.5–5.0	2.60–2.35	XX	1.55–1.45	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, yellow	do.	Low to high	6.5–5.5	2.3–1.9	Single	1.45	Glass, synthetics, triplets, chalcedony	Color play (opalescence).
Peridot	Iron magnesium silicate	Yellow, green	Any	Medium	7.0–6.5	3.37–3.27	Double (strong)	1.69–1.65	Tourmaline, chrysoberyl	Strong double refraction, low dichroism.
Quartz:										
Agate	Silicon dioxide	Any	Large	Low	7.0	2.64–2.58	XX	XX	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.66–2.65	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	2.69–2.64	do.	1.55–1.54	Iridescent analcime, aventurine feldspar, emerald, aventurine glass	Macrocrystalline, color, metallic iridescent flake reflections, hardness.
Cairngorm	do.	Smoky orange, yellow	do.	do.	7.0	2.66–2.65	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.

See footnotes at end of table.

TABLE 9—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										
Carnelian	Silicon dioxide	Flesh red to brown red	Large	Low	7.0–6.5	2.64–2.58	Double	1.54–1.53	Jasper	Cryptocrystalline, color, hardness.
Chalcedony	do.	Bluish, white, gray	do.	do.	7.0–6.5	2.64–2.58	do.	1.54–1.53	Tanzanite	Do.
Chrysoprase	do.	Green, apple-green	do.	do.	7.0–6.5	2.64–2.58	do.	1.54–1.53	Chrome chalcedony, jade, prase opal, prehnite, smithsonite, variscite, artificially colored green chalcedony	Do.
Citrine	do.	Yellow	do.	do.	7.0	2.66–2.65	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Jasper	do.	Any, striped, spotted, sometimes uniform	do.	do.	7.0	2.66–2.58	XX	XX	do.	Cryptocrystalline, opaque, vitreous luster, hardness.
Onyx	do.	Many colors	do.	do.	7.0	2.64–2.58	XX	XX	do.	Cryptocrystalline, uniformly banded, hardness.
Petrified wood	do.	Brown, gray, red, yellow	do.	do.	7.0–6.5	2.91–2.58	Double	1.54	Agate, jasper	Color, hardness, wood grain.
Rock crystal	do.	Colorless	do.	do.	7.0	2.66–2.65	do.	1.55	Topaz, colorless sapphire	Do.
Rose	do.	Pink, rose red	do.	do.	7.0	2.66–2.65	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Tiger's eye	do.	Golden yellow, brown, red, blue-black	do.	do.	7.0–6.5	2.64–2.58	XX	1.54–1.53	XX	Macrocrystalline, color, hardness, chatoyancy.
Rhodochrosite	Manganese carbonate	Rose-red to yellowish, striped	do.	Low	4.0	3.7–3.45	Double	1.82–1.6	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.	6.5–5.5	3.74–3.40	do.	1.75–1.72	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	2.85–2.6	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	4.5–2.5	2.85–2.6	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	3.7–3.5	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.

See footnotes at end of table.

TABLE 9—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, synthetic	Magnesium aluminum oxide	Any	Up to 40 carats	Low	8.0	3.7–3.5	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	7.0–6.5	3.20–3.13	do.	1.66	Synthetic spinel	Refractive index, color, pleochroism.
Kunzite	do.	Pink to lilac	do.	do.	7.0–6.5	3.20–3.13	do.	1.66	Amethyst, morganite	Do.
Tanzanite	Complex silicate	Blue to lavender	Small	High	7.0–6.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism, color.
Topaz	do.	White, blue, green, pink, yellow, gold	Medium	Low to medium	8.0	3.6–3.4	do.	1.62	Beryl, quartz	Color, density, hardness, refractive index, perfect in basal cleavage.
Tourmaline	do.	Any, including mixed	do.	do.	7.5–7.0	3.20–2.98	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	2.83–2.60	do.	1.63	Chrysocolla, dyed howlite, dumortierite, glass, plastics, variscite	Difficult if matrix not present, matrix usually limonitic.
Unakite	Granitic rock, feldspar, epidote,	Olive green, pink, blue-gray	do.	do.	7.0–6.0	3.20–2.60	XX	XX	XX	Olive green, pink, gray-blue colors.

TABLE 10
SYNTHETIC GEMSTONE PRODUCTION METHODS[1]

Gemstone	Production method	Company or 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.
Diamond	HPHT[2]	General Electric Co.	1950s.
Do.	CVD[3]	Apollo Diamond Inc.	2000s.
Do.	MPCVD[4]	CIW & UA[5]	2000s.
Emerald	Flux	Chatham Created Gems, Inc.	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.
Moissanite	Sublimation	Cree Research	1980s.
Ruby	Flux	Chatham Created Gems, Inc.	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, Inc.	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.

[1]Gemstones that are also synthesized, but for which the production methods are proprietary, include gems such as garnet, opal, and turquoise. Gemstone amethyst, citrine, and other quartz minerals are produced by the hydrothermal method.

[2]High-pressure, high-temperature (HPHT).

[3]Chemical vapor deposition (CVD).

[4]Microwave plasma chemical vapor deposition (MPCVD).

[5]The Carnegie Institution of Washington Geophysical Laboratory and the University of Alabama.

TABLE 11
NATURAL DIAMOND: WORLD PRODUCTION, BY TYPE AND COUNTRY OR LOCALITY[1]

(Thousand carats)

Type and country or locality[2]	2012	2013	2014	2015	2016
Gemstones:					
Angola[e, 3]	7,500	7,740	7,910	8,120	8,120
Australia[e, 4]	184	235	186	271	279
Botswana[e, 5]	14,400	16,200	17,300	14,500	14,400
Brazil, gem, unspecified[6]	46 [r]	49	57	32	184
Cameroon, gem, unspecified[7]	1	3	4	2	--
Canada, gem, unspecified	10,451	10,600	12,012	11,677	13,036
Central African Republic[e, 8]	293	65 [9]	-- [9]	-- [9]	9 [9]
China, gem, unspecified	2	1	--	--	(10)
Congo (Brazzaville), gem, unspecified	52	56	53	40	12
Congo (Kinshasa)[e, 11]	4,310 [r]	3,140	3,130	3,200	4,640
Côte d'Ivoire, gem, unspecified	-- [12]	-- [12]	1	15	20
Ghana, gem, unspecified	233	169	242	174	142
Guinea, gemstones[e, 8]	213	162	131	134	90
Guyana, gem, unspecified	44	60	100	118	140
India[e, 13]	7	10	10	9	9
Lesotho, gem, unspecified	479	414	346	304	342
Liberia[e, 14]	25	32	39	41	63
Namibia, gem, unspecified	1,629	1,689	1,918	2,053	1,718
Russia[e, 15]	19,600	21,200	21,500	23,500	22,600
Sierra Leone[e, 8]	433	487	496	400	439
South Africa[e, 8]	5,660	6,520	5,950	5,780	6,650
Tanzania[e, 16]	108	153	215	184	205
Togo, gem, unspecified	(10)	(10)	(10)	(10)	(10)
Zimbabwe[e, 17]	1,210	1,040	477	349	210
Total[e]	66,800	70,100	72,000	70,900	73,200
Industrial:[e]					
Angola[3]	833	860	879	902	902
Australia[4]	9,000	11,500	9,100	13,300	13,700
Botswana[5]	6,170	6,960	7,400	6,230	6,150
Central African Republic[8]	73	16 [9]	-- [9]	-- [9]	2 [9]
Congo (Kinshasa)[11]	17,200	12,500	12,500	12,800	18,600
Guinea[8]	53	40	33	33	23
India[13]	20	27	27	24	24
Liberia[14]	17	21	26	27	42
Russia[15]	15,400	16,700	16,900	18,400	17,700
Sierra Leone[8]	108	122	124	100	110
South Africa[8]	1,420	1,630	1,490	1,440	1,660
Tanzania[16]	19	27	38	33	37
Zimbabwe[17]	10,900	9,370	4,290	3,140	2,000
Total	61,200 [r]	59,800	52,800	56,500	60,800
Grand total	128,000 [r]	130,000 [r]	125,000 [r]	127,000 [r]	134,000

[e]Estimated. [r]Revised. -- Zero.

[1]Table includes data available through November 22, 2017. All data are reported unless otherwise noted. Totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown. Estimated gem and industrial diamond quantities are calculated from reported country or locality totals using percentages noted.

[2]In addition to the countries and (or) localities listed, Nigeria produced natural diamond, but information was inadequate to make reliable estimates of output levels.

[3]About 90% gem quality and 10% industrial quality.

[4]About 2% gem quality and 98% industrial quality.

[5]About 70% gem and near-gem quality and 30% industrial quality.

[6]Private sector and artisanal mining. Includes near-gem and cheap-gem qualities.

[7]From artisanal mining.

[8]About 80% gem quality and 20% industrial quality.

[9]From May 2013–15, the Central African Republic was under a temporary suspension from the Kimberley Process Certification Scheme and was not trading in rough diamond.

[10]Less than ½ unit.

[11]About 20% gem quality and 80% industrial quality; the majority of production was from artisanal mining.

TABLE 11—Continued
NATURAL DIAMOND: WORLD PRODUCTION, BY TYPE AND COUNTRY OR LOCALITY[1]

(Thousand carats)

[12]From 2011–13, Côte d'Ivoire was under United Nations sanctions and was not trading in rough diamond.
[13]About 27% gem quality and 73% industrial quality.
[14]About 60% gem quality and 40% industrial quality.
[15]About 56% gem quality and 44% industrial quality.
[16]About 85% gem quality and 15% industrial quality.
[17]About 10% gem quality and 90% industrial quality.

Source: Kimberley Process Certification Scheme.