

GEMSTONES

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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);

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&useoverride=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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GENERAL SOURCES OF INFORMATION

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- Area Reports: Domestic. Minerals Yearbook, annual.¹
- Gem stones. Ch. in United States Mineral Resources, Professional Paper 820, 1973.
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¹Prior 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.

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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
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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 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		1999	
	Quantity (carats)	Value 2/ (millions)	Quantity (carats)	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/

Kind, range, and country of origin	1998		1999	
	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		1999	
	Quantity (carats)	Value 2/ (millions)	Quantity (carats)	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/

Kind and country	1998		1999	
	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		1999	
	Quantity	Value 2/	Quantity	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.