

GEMSTONES

By Ronald F. Balazik

Gemstones have been used as symbols of beauty, wealth, and status for more than 10,000 years (Schumann, 1998). Despite its long history, however, “gemstone” has no single, precise definition that is generally accepted. According to Webster’s New International Dictionary (2nd edition), a gemstone is “any jewel, whether stone, pearl or the like, having value and beauty that are intrinsic and not derived from its setting; a precious or, sometimes, a semiprecious stone cut and polished for ornament. A semiprecious stone of value because it is carved or engraved, as a cameo or intaglio.” Additionally, the dictionary states that a gemstone is “any mineral or petrified material which can, when cut and polished, be used in jewelry.”

Natural gemstones are minerals; each type has its own chemical composition and physical attributes. For this report, therefore, “gemstone” means any mineral, organic or inorganic, used for personal adornment, display, or object of art because it possesses beauty, rarity, and durability. Note that shell and cultured pearl are treated as gemstones in this report. In addition, synthetic gems and gemstone simulants are included in this report but are treated separately from natural gemstones. (*See tables 1 and 2.*)

Production

The gemstone industry in the United States consists of several distinct sectors: (1) individuals and organizations that mine gemstones or harvest shell and natural/cultured pearls, (2) companies that manufacture synthetic gemstones, and (3) individuals or firms that process/cut natural and synthetic gemstones. The domestic gemstone industry is focused on the production of colored gemstones and the cutting of large diamonds. Employment in the industry is estimated to range between 1,000 and 1,500 persons (U.S. International Trade Commission, 1997).

Most natural gemstone producers in the United States are small businesses that are widely dispersed and operate independently. It is estimated that the small producers have an average of fewer than three employees, including many who only work part time. The number of gemstone mines operating from year to year fluctuates because the inherent uncertainty associated with the finding and marketing gem-quality minerals makes it difficult to obtain financing for developing and sustaining economically viable deposits (U.S. International Trade Commission, 1997).

The total value of natural gemstones produced in the United States during 1997 was estimated to be at least \$25 million. (*See table 3.*) This production value was less than that of the preceding year primarily because foreign markets for U.S. shell material decreased, particularly in Japan where the operations of cultured pearl producers that use the shell for pearl nuclei were adversely affected by declining markets in Southeast Asia, competition from

China, and high mortality rates among pearl oysters (Jewelers’ Circular Keystone, 1997b). In addition, gemstone output in 1997 declined, in part, because a few of the larger producers halted mine operations and relied on materials stockpiled in previous years.

The estimate of 1997 U.S. gemstone production is based on a survey of approximately 200 domestic gemstone operations conducted by the U.S. Geological Survey (USGS). The survey provides a foundation for projecting the scope and level of domestic gemstone production. The survey, however, does not represent all gemstone activity in the United States, which includes thousands of professional and amateur collectors. Consequently, the USGS supplements its survey with estimates of domestic gemstones production from related published data, contacts with gem dealers and collectors, and analyses of gem and mineral shows.

Natural gem materials indigenous to the United States are collected, produced, and/or marketed in every State. In 1997, five States accounted for more than 70% of the total value of production reported by survey respondents. These States were (in declining order of reported production value) Tennessee, Kentucky, Arizona, California, and Montana. Certain States are best known for the production of a single gem material (for example, Kentucky and Tennessee for freshwater shell). Other States, however, have a wide array of gemstones. For example, Arizona gemstone deposits include agate, amethyst, azurite, chrysocolla, fire agate, garnet, jade, malachite, obsidian, onyx, petrified wood, precious opal, smithsonite, and turquoise. A great variety of gemstones also are found in California, Idaho, Montana, and North Carolina.

Estimated diamond production in the United States reached at least \$1 million during 1997. Late in the year, Redaurum Limited (Toronto) announced that it planned to sell its Kelsey Lake diamond mine near Fort Collins, CO (H. Coopersmith, Colorado Diamond Company, oral commun., 1998). The mine, which opened in 1995, is North America’s first commercial diamond mine in almost a century. The only other significant diamond-bearing area known in the United States is in Crater of Diamonds State Park near Murfreesboro, AR. Testing and evaluation of diamond-bearing rock in the Park was completed in 1997. A final report on the tests and evaluations was presented to the Arkansas Department of Parks and Tourism in late 1997 (U.S. Geological Survey, 1998).

In addition to natural gemstones, synthetic gems and gemstone simulants are produced in the United States. Synthetic gemstones essentially have the same appearance and the same optical, physical, and chemical properties as the natural materials that they represent. Simulants have an appearance similar to that of a natural gem material but have different optical, physical, and

chemical properties. Synthetic gemstones produced in the United States include alexandrite, emerald, ruby, sapphire, turquoise, and zirconia. The major simulants produced in the United States are colored and colorless varieties of cubic zirconia. Coral, lapis lazuli, malachite, and turquoise are also produced. In addition, certain colors of synthetic sapphire and spinel, used to represent other gemstones, are classed as simulants.

In 1997, synthetic gem production in the United States reached \$22 million; simulant gemstone output was even greater—estimated to exceed \$100 million. Five firms in four states, representing the U.S. synthetic gem industry, reported production to the USGS in 1997. In descending order of production value, the States with reported output were New York, California, Michigan, and Arizona.

In late 1997, a company in North Carolina announced plans to market the first commercial supplies of moissanite, a gem-like silicon carbide made by the firm. The company will sell the moissanite as a diamond simulant (Jewelers' Circular Keystone, 1997a).

Consumption

Although the United States accounts for less than 1% of total global gem production, it is the world's leading gemstone market. On the basis of such indicators as trade data and income growth rates, it was estimated that U.S. gemstone markets, bolstered by a strong and growing national economy, accounted for at least one-third of world gem demand in 1997.¹ Domestic markets for natural, unset colored gemstones (excluding diamond but including shell, pearl, and coral) totaled approximately \$650 million during the year. The domestic market for unset gem diamonds in 1997 was estimated to exceed \$5 billion, the largest in the world.

Moreover, U.S. diamond jewelry sales in 1997 increased 8% to \$19.3 billion; this was the sixth consecutive year that sales increased (Jewelers' Circular Keystone, 1998b).

Gemstones are used in the United States and elsewhere for jewelry, collections and exhibits, decorative art objects, and certain industrial applications. According to a poll conducted by a U.S. jewelry retailers association, 61% of domestic consumers who were surveyed preferred diamond as their favorite gemstone; others chose emeralds (10%), sapphires (9%), and rubies (7%) (International Colored Gemstone Association, 1996).

Prices

Gemstone prices are governed by many factors and qualitative characteristics, including beauty, clarity, defects, demand, and rarity. Colored gemstone prices are generally influenced by market supply/demand considerations, and diamond prices are supported by producer controls on the quantity and quality of supply. Values and prices of gemstones produced and/or sold in the United States are shown in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported and exported/reexported are shown in tables 6 through 10.

De Beers Consolidated Mines Limited in South Africa is a significant force affecting gem diamond price worldwide because it mines about one-half the diamonds produced each year worldwide and controls about three-fourths of global raw diamond supply through its Central Selling Organization (CSO) which has marketing agreements with other producers (Shor, 1997). The average price of all rough, uncut diamonds sold throughout the world was estimated to be about \$70 per carat in 1997; by country, the average value reported per carat ranged from about \$10 for Australian production to more than \$300 for Namibian output (Financial Times, 1997).

Foreign Trade

As measured by several standards, such as imports, the United States is the world leader in gemstone trade. In 1997, U.S. gemstone exports/reexports were shipped to 86 countries, and imports of gemstones were received from 114 countries. (See tables 6 through 10.) Total U.S. gemstone trade with all countries in 1997 exceeded \$11 billion; diamonds accounted for 89% of the trade.

The American Diamond Industry Association reported that U.S. trade in loose, polished diamonds reached unprecedented levels in 1997; records were set for imports and exports, as well as for quantity and value (Sheung, 1998). The records were attributed to the growing U.S. economy and a strong consumer demand for diamond jewelry.

The value of U.S. gemstone exports and reexports in 1997 totaled \$2.8 billion; diamonds, including \$2.3 billion for cut diamonds, accounted for 84% of the total. Domestic exports and reexports of natural, rough, colored gemstones were valued at \$192 million, and the value of U.S. exports and reexports of natural, cut but unset, colored gemstones was \$187 million. Synthetic gemstone exports and reexports during the year were valued at \$10.6 million and \$17.9 million, respectively. Exports and reexports of natural and cultured pearl were valued at \$3.8 million and \$7.4 million, respectively. Approximately \$15 million of coral and shell was exported/reexported by the United States in 1997.

The United States remained the world's largest importer of gemstones in 1997; imports of natural, unset, colored gemstones, including coral and pearl, reached \$671 million. During the year, U.S. imports of all gemstones, including synthetics and simulants, increased by 16%, to a record high of \$8.38 billion. Diamonds accounted for 91% of the imports.

Also during 1997, the Office of the United States Trade Representative, assisted by the USGS, entered negotiations with 17 Asian and Pacific Rim governments to reduce barriers in gemstone trade. The negotiations, still underway at yearend, focused on tariffs and other barriers to international trade.

World Review

Global gemstone markets primarily are concerned with two distinctly different commodities: (1) diamonds, and (2) colored gemstones; that is, gems other than diamonds. Most diamond supplies are controlled by a few major mining companies; prices

¹The domestic market rose by an average of 14% annually during 1995-1997.

are supported by managing the quantity and quality of the gems relative to demand, a function performed by the CSO. Unlike diamonds, colored gemstones are primarily produced at relatively small, low-cost operations with few dominant producers; prices are influenced more by supply availability and consumer demand.

World diamond output in 1997 totaled 110 million carats with an estimated value of approximately \$7 billion. (See table 11.) Most production was concentrated in a few regions— Africa (Angola, Botswana, Namibia, South Africa, and Zaire); Asia (northeastern Siberia and Yakutia in Russia); Australia; and South America (Brazil and Venezuela).

Sales of rough diamond by the CSO in 1997 reached \$4.6 billion, 4% less than the record sales of 1996 (Mining Journal, 1998). The sales loss reflected reduced demand in Asian markets following the decline of several national economies in the region. Nevertheless, strong market demand in the United States helped compensate for the Asian decline and make the 1997 sales level the second highest on record. It is estimated that U.S. demand for rough diamond alone has been equivalent to about 15% of the De Beers sales in recent years.

During 1997, De Beers took several actions to maintain its influence on global diamond supplies and respond to declining markets in Asia: (1) the company signed a new contractual agreement that returned Russia to the CSO after more than a 2-year absence (Teslenko, 1997); (2) the CSO began to reduce its supply of diamonds available in world markets to stabilize and support prices (Jewelers' Circular Keystone, 1998a); (3) De Beers prepared to increase output from its mines and compete more vigorously against producers outside the CSO (Jewelers' Circular Keystone, 1997c; Shor, 1997); and (4) the company continued planning for new markets, particularly in China, the Middle East, and South America (Diamond Registry Bulletin, 1998).

Construction of Canada's first commercial diamond mine was almost completed by year-end 1997; production was scheduled to begin in 1998. When fully operational, the mine (in Canada's Northwest Territories) will produce 4.5 million carats per year, or about 5% of world output valued from \$350 million to \$490 million, (Hart, 1998; Reuters, 1998). Planning also was underway in 1997 for another significant diamond mine in the Northwest Territories that could be operational within a few years.

It is estimated that annual world production of cut natural gemstones other than diamond and pearl exceeds \$2 billion per year. Most colored gemstone mining consists of small, low-cost, and widely-dispersed operations in remote regions of developing nations. Pearls are cultured throughout the South Pacific and in other seas near the equator. The largest producers are Australia, China, and Japan.

Foreign countries with major gemstone deposits other than diamond are Afghanistan (beryl, ruby, and tourmaline); Australia (beryl, opal, and sapphire); Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline); Burma (beryl, jade, ruby, sapphire, and topaz); Colombia (beryl, emerald, and sapphire); Kenya (beryl, garnet, and sapphire); Madagascar (beryl, rose quartz, sapphire, and tourmaline); Mexico (agate, opal, and topaz); Sri Lanka (beryl, ruby, sapphire, and topaz); Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline); and Zambia (amethyst and beryl).

Like the diamond industry, colored gemstone producers and markets were adversely affected by the economic crisis in Asia during 1997. Mining and sales reportedly were disrupted in many Asian countries. Prices of high-quality colored gemstones, however, did not decline dramatically (Cavey, 1998).

The application of thermal, chemical, and physical treatments to enhance the color and other attributes of natural gemstones received considerable attention in various gem industry publications during 1997. Many business associations and professionals in the industry have proposed or adopted treatment guidelines. Standards for disclosure of treatment practices to consumers also have been an important issue in the industry. The Federal Trade Commission has addressed aspects of the issue in its Guides for the Jewelry Industry (Gemological Institute of America, 1994).

Outlook

All gemstone market forecasts, particularly long-range projections, must focus on the reality that gemstones are essentially luxury merchandise; consequently, consumer demand, and ultimately supply, is determined by personal discretionary income levels and consumer preferences among nonessential goods in the marketplace.² Fortunately for producers of precious gems, long-term economic forecasts anticipate continued growth of discretionary income in the industrialized countries and expect even higher growth rates of personal wealth in certain developing nations as well. In the next decade, for example, China and several Middle Eastern countries where personal wealth is growing, may emerge as major new markets for precious gems, particularly diamonds (Diamond Registry Bulletin, 1998).

If the CSO continues its 1997 restraints on diamond supplies to stabilize prices and restore market confidence, its rough diamond sales will fall significantly. Some market analysts predict that CSO rough diamond sales in 1998 will be the lowest in since 1992 (Jewelers' Circular Keystone, 1998c).

Diamond mining in Canada may prove to be part of a significant trend in world diamond markets. New Canadian mines are expected to produce as much as one-seventh of world diamond output early in the next century (Hart, 1998). Nevertheless, only a limited share of the new production is expected to be marketed through the CSO (Hart, 1998; Reuters, 1998). Thus, Canada with other important independent producers, such as Argyle Diamond Mines (Australia) which withdrew from the CSO in 1996, may bring a greater measure of competition to global diamond markets. Presumably, more competition would bring lower prices for buyers; however, the actual outcome and its significance are uncertain at present.

Demand for colored gemstones will continue to rise as diamonds become more expensive and retailers promote the popularity of alternatives. The retail jewelry trade will further consolidate toward fewer companies and more dealers will focus on niche markets and target specific demographic groups. Greater demand for synthetic and simulant gemstones also is anticipated.

²Related economic factors include consumer confidence and interest rates.

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SOURCES OF INFORMATION

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TABLE 1
GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size 1/	Cost 2/	Mohs	Specific gravity	Refraction	Refractive index	May be confused with-	Recognition characters
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0-2.5	1.0-1.1	Single	1.54	Synthetic or pressed plastics	Fossil resin, soft.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	Small to medium	High	6.0-6.5	3.64-3.68	Double	1.76-1.80	Sapphire, tanzanite, blue diamond, blue tourmaline	Strong blue in ultraviolet light.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5-8.0	2.63-2.80	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	do.	Small	Very high	7.5-8.0	2.63-2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald	do.	Green	Medium	do.	7.5	2.63-2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5-8.0	2.63-2.80	do.	1.58	Genuine emerald	Flaws, brilliant, fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5-8.0	2.63-2.80	do.	1.58	Citrine, topaz, glass, doublets	
Goshenite	do.	do.	do.	Low	7.5-8.0	2.63-2.80	do.	1.58	Quartz, glass, white sapphire, white topaz.	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5-8.0	2.63-2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49-1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.6	do.	Banded, translucent.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by day, red by artificial light	Former U.S.S.R. (small), Sri Lanka (medium)	High	8.5	3.50-3.84	Double	1.75	Synthetic	Dichroism, inclusions in synthetic sapphire.
Cats-eye	do.	Greenish to brownish	Small to large	do.	8.5	3.50-3.84	do.	1.75	Synthetic, shell	Gravity and translucence.
Chrysolite	do.	Yellow, green, and/or brown	Medium	Medium	8.5	3.50-3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.
Coral	Calcium carbonate	Orange, red, white, black, or green	Branching, medium	Low	3.5-4.0	2.6-2.7	do.	1.49-1.66	False coral	Dull translucent.

See footnotes at end of table.

TABLE 1--Continued
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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, single refraction hardness, cut, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green	Large	Low	6.0-6.5	2.56	--	1.52	Jade	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play	do.	do.	6.0-6.5	2.56	--	1.56	do.	Do.
Moonstone	do.	White	do.	do.	6.0-6.5	2.77	--	1.52-1.54	Glass or white onyx	Blue sheen, opalescent.
Garnet	Complex silicate	Brown, black, yellow, green, ruby red, or orange	Small to medium	Low to high	6.5-7.5	3.15-4.30	Single strained	1.79-1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Jade:										
Jadeite	do.	Green, yellow, black, white, or mauve	Large	Low to very high	6.5-7.0	3.3-3.5	Cryptocry- stalline	1.65-1.68	Onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent, to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0-6.5	2.96-3.10	do.	1.61-1.63	do.	Do.
Opal	Hydrous silica	Colors flash in white gray, black, red, or yellow	Large	Low to high	5.5-6.5	1.9-2.3	Isotropic	1.45	Glass, synthetics, triplets	Play of color.
Pearl	Calcium carbonate	White, pink, or black	Small	do.	2.5-4.0	2.6-2.85	--	--	Cultured and imitation	Luster, structure, X-ray.
Peridot	Iron magnesium silicate	Yellow and/or green	Any	Medium	6.5-7.0	3.27-3.37	Double (strong)	1.65-1.69	Tourmaline chrysoberyl	Strong double refraction, low dichroism.

See footnotes at end of table.

TABLE 1--Continued
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Quartz:										
Agate	Silica	Any color	Large	Low	7.0	2.58-2.64	--	--	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65-2.66	Double	1.55	do.	Refractive index, double refraction, transparent.
Cairngorm	do.	Smoky	do.	Low	7.0	2.65-2.66	do.	1.55	do.	Do.
Citrine	do.	Yellow	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Do.
Crystal, rock	do.	Colorless	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Do.
Jasper	do.	Uniform or spotted red, yellow, or green	do.	do.	7.0	2.58-2.66	--	--	do.	Opaque, vitreous.
Onyx	do.	Many colors	do.	do.	7.0	2.58-2.64	--	--	do.	Uniformly banded.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65-2.66	do.	1.55	do.	Refractive index, double refraction, translucent.
Spinel	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5-3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5-3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5-7.0	3.13-3.20	do.	1.66	Synthetic spinel	Refractive index.
Kunzite	do.	Pink to lilac	do.	do.	6.5-7.0	3.13-3.20	do.	1.66	Amethyst,morganite	Do.
Tanzanite	Complex silicate	Blue	Small	High	6.0-7.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism.
Topaz	do.	White, blue, green	Medium	Low to medium	8.0	3.4-3.6	do.	1.62	Beryl, quartz	Refractive index.
Tourmaline	do.	All, including mixed	do.	do.	7.0-7.5	2.98-3.20	do.	1.63	Peridot, beryl, corundum, glass	Double refraction, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green	Large	Low	6.0	2.60-2.83	do.	1.63	Glass, plastics	Difficult if matrix not present, matrix usually limonitic.
Zircon	Zirconium silicate	White, blue, or brown, yellow, or green	Small to medium	Low to medium	6.0-7.5	4.0-4.8	Double (strong)	1.79-1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

1/ Small-up to 5 carats; medium-up to 50 carats; large-more than 50 carats.

2/ Low-up to \$25 per carat; medium-up to \$200 per carat; high-more than \$200 per carat.

TABLE 2
SYNTHETIC GEMSTONE PRODUCTION METHODS

Gemstone	Production methods	Company/producer	Date of first production
Alexandrite	Flux	Creative crystals	1970's
Do.	Melt pulling	J.O. Crystal	1990's
Do.	do.	Kyocera	1980's
Do.	Zone melt	Seiko	1980's
Cubic zirconia	Skull melt	Various producers	1970's
Emerald	Flux	Chatham	1930's
Do.	do.	Gilson	1960's
Do.	do.	Kyocera	1970's
Do.	do.	Seiko	1980's
Do.	do.	Lenix	1980's
Do.	do.	Russia	1980's
Do.	Hydrothermal	Lechleitner	1960's
Do.	do.	Regency	1980's
Do.	do.	Biron	1980's
Do.	do.	Russia	1980's
Ruby	Flux	Chatham	1950's
Do.	do.	Kashan	1960's
Do.	do.	J.O. Crystal (Ramaura)	1980's
Do.	do.	Douras	1990's
Do.	Zone melt	Seiko	1980's
Do.	Melt pulling	Kyocera (Inamori)	1970's
Do.	Verneuil	Various producers	1900's
Sapphire	Flux	Chatham	1970's
Do.	Zone melt	Seiko	1980's
Do.	Melt pulling	Kyocera	1980's
Do.	Verneuil	Various producers	1900's
Star ruby	do.	Linde (Div. of Union Carbide)	1940's
Do.	Melt pulling	Kyocera	1980's
Do.	do.	Nakazumi	1980's
Star sapphire	Verneuil	Linde	1940's

TABLE 3
VALUE OF U.S. GEMSTONE PRODUCTION, BY GEMSTONE 1/

(Thousand dollars)

Gem materials	1996	1997
Agate	1,110	218
Beryl	960	901
Coral (all types)	152	65
Diamonds	685	W
Garnet	40	35
Gem feldspar	4,980	579
Geode/nodules	169	100
Obsidian	64 e/	(2/)
Opal	363	341
Petrified wood	54 e/	2 e/
Quartz	1,880	1,130
Sapphire/ruby	1,680 r/	964
Shell	22,800	11,700
Topaz	14	8
Tourmaline	25	16
Turquoise	1,410	976
Other	6,900	7,990
Total	43,300 r/	25,000

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Less than 1/2 unit.

TABLE 4
PRICES OF U.S. CUT DIAMONDS, BY SIZE AND QUALITY 1/

Carat weight	Description, color 2/	Clarity (GIA terms) 3/	Representative prices		
			January 1997 4/	June 1997 5/	December 1997 6/
0.25	G	VS1	\$1,500	\$1,500	\$1,500
.25	G	VS2	1,380	1,380	1,380
.25	G	SI1	1,130	1,130	1,130
.25	H	VS1	1,400	1,400	1,400
.25	H	VS2	1,250	1,250	1,250
.25	H	SI1	1,050	1,050	1,050
.50	G	VS1	3,300	3,300	3,300
.50	G	VS2	2,900	2,900	2,900
.50	G	SI1	2,500	2,500	2,500
.50	H	VS1	2,900	2,900	2,900
.50	H	VS2	2,600	2,600	2,600
.50	H	SI1	2,400	2,400	2,400
.75	G	VS1	3,800	3,800	3,800
.75	G	VS2	3,600	3,600	3,600
.75	G	SI1	3,300	3,300	3,300
.75	H	VS1	3,650	3,650	3,650
.75	H	VS2	3,450	3,450	3,450
.75	H	SI1	3,100	3,100	3,100
1.00	G	VS1	5,400	5,400	5,500
1.00	G	VS2	5,200	5,200	5,200
1.00	G	SI1	4,700	4,700	4,700
1.00	H	VS1	5,000	5,000	5,100
1.00	H	VS2	4,900	4,900	4,900
1.00	H	SI1	4,500	4,500	4,500

1/ Data are rounded to three significant digits.

2/ Gemological Institute of America (GIA) color grades: D--colorless; E--rare white; G - H - I --traces of color.

3/ Clarity: IF--no blemishes; VVS1--very, very slightly included; VS1--very slightly included; VS2--very slightly included, but not visible; SI1--slightly included.

4/ Jewelers' Circular-Keystone. v. 168, no. 2, Feb. 1997, p. 316.

5/ Jewelers' Circular-Keystone. v. 168, no. 7, July 1997, p. 210.

6/ Jewelers' Circular-Keystone. v. 169, no. 1, Jan. 1998, p. 314.

TABLE 5
PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES 1/

Gemstone	Price range per carat	
	January 1997 2/	December 1997 2/
Amethyst	\$7 - \$16	\$7 - \$16
Aquamarine	75 - 190	75 - 190
Emerald	1,580 - 2,900	800 - 2,000
Garnet, tsavorite	600 - 900	600 - 900
Rhodolite	20 - 30	20 - 30
Ruby	2,450 - 3,900	1,800 - 2,900
Sapphire	800 - 1,800	800 - 1,800
Tanzanite	120 - 210	120 - 190

1/ Fine quality.

2/ Jewelers' Circular-Keystone. v. 168, no. 2, Feb. 1997, p. 316; and v. 169, no. 1, Jan. 1998, p. 314. These figures represent a sampling of net prices that wholesale colored stone dealers in various U.S. cities charged their cash customers during the month for fine-quality stones.

TABLE 6
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL DIAMOND), BY COUNTRY 1/

Country	1996		1997	
	Quantity (carats)	Value 2/ (millions)	Quantity (carats)	Value 2/ (millions)
Belgium	576,000	\$547	843,000	\$614
Canada	135,000	50	151,000	61
France	24,000	43	26,200	31
Hong Kong	324,000	400	578,000	401
India	137,000	21	189,000	24
Israel	546,000	558	776,000	734
Japan	106,000	139	79,500	70
Russia	569	4	577	(3/)
Singapore	18,100	55	18,000	44
Switzerland	50,500	234	62,300	185
Thailand	95,000	42	101,000	24
United Arab Emirates	6,320	7	59,700	13
United Kingdom	31,900	94	27,200	87
Other	40,900	32	41,500	33
Total	2,090,000	2,230	2,950,000	2,320

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Customs value.

3/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY 1/

Kind, range, and country of origin	1996		1997	
	Quantity (carat)	Value 2/ (millions)	Quantity (carat)	Value 2/ (millions)
Rough or uncut, natural: 3/				
Australia	74,600	\$1	1,320	(4/)
Belgium	277,000	149	585,000	\$110
Brazil	38,500	5	26,000	11
Congo (Brazzaville)	13,100	18	11,600	13
Congo (Kinshasa) 5/	92,000	84	87,100	88
Ghana	157,000	105	195,000	97
Guinea	1,220	2	8,170	10
India	11,100	(4/)	110,000	4
Israel	33,600	34	60,500	47
Russia	34	(4/)	29,800	1
Sierra Leone	15,000	19	13,900	16
South Africa	21,900	33	120,000	40
Switzerland	20,900	44	7,360	12
United Kingdom	658,000	200	652,000	186
Venezuela	11,300	2	13,300	3
Other	22,200 r/	36 r/	17,300	9
Total	1,450,000	731	1,940,000	646
Cut but unset, not more than 0.5 carat:				
Belgium	841,000	232	779,000	213
Brazil	9,490	3	2,960	2
Canada	18,000	4	5,050	1
Germany	6,240	1	5,370	4
Hong Kong	358,000	68	419,000	77
India	7,140,000	1,250	7,790,000	1,320
Israel	890,000	387	1,010,000	568
Japan	7,980	2	7,000	4
South Africa	5,350	7	4,480	4
Switzerland	7,420	2	23,600	6
Thailand	54,600	8	57,100	11
United Kingdom	1,450	1	1,200	1
Other	49,400 r/	20 r/	51,100	12
Total	9,390,000	1,980	10,200,000	2,230
Cut but unset, over 0.5 carat:				
Belgium	833,000	1,190	989,000	1,470
Botswana	14,300	8	15,200	9
Canada	4,220	6	2,660	7
France	2,680	10	1,760	8
Hong Kong	48,300	60	62,900	83
India	259,000	151	375,000	260
Israel	1,580,000	2,020	1,690,000	2,390
Japan	1,270	2	5,800	17
Russia	39,400	53	44,100	41
Singapore	1,660	9	575	4
South Africa	15,800	52	25,200	106
Switzerland	16,100	163	30,400	235
Thailand	15,200	29	11,000	11
United Kingdom	6,820	53	12,300	32
Other	30,200 r/	47 r/	22,300	37
Total	2,870,000	3,850	3,280,000	4,720

r/ Revised.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Customs value.

3/ Includes some natural advanced diamond.

4/ Less than 1/2 unit.

5/ Formerly Zaire.

Source: Bureau of the Census.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY 1/

Kind and country	1996		1997	
	Quantity (carats)	Value 2/ (millions)	Quantity (carats)	Value 2/ (millions)
Emerald:				
Belgium	13,900	\$2	10,500	\$3
Brazil	4,340,000	7	493,000	6
Canada	15,600	1	1,950	(3/)
China	1,550	(3/)	32	(3/)
Colombia	968,000	74	1,430,000	80
France	3,340	2	4,380	1
Germany	13,900	2	30,500	3
Hong Kong	304,000	17	356,000	18
India	3,280,000	39	2,830,000	45
Israel	401,000	26	162,000	23
Japan	3,020	1	4,590	(3/)
South Africa	1,370	(3/)	17,700	(3/)
Switzerland	89,800	18	71,300	25
Taiwan	207	(3/)	247	(3/)
Thailand	358,000	8	448,000	7
United Kingdom	2,330	3	3,600	2
Other	145,000 r/	4 r/	96,900	3
Total	9,930,000	203	5,960,000	217
Ruby:				
Belgium	11,000	1	2,100	1
Brazil	11,300	(3/)	5,550	(3/)
Burma	189	1	29,700	3
Canada	9,540	(3/)	1,010	(3/)
China	9,020	(3/)	14,200	(3/)
Colombia	423	(3/)	613	(3/)
France	1,260	1	366	(3/)
Germany	31,000	1	71,000	2
Hong Kong	377,000	7	404,000	11
India	2,340,000	6	1,480,000	8
Israel	25,400	1	218,000	1
Japan	2,240	(3/)	1,140	(3/)
Switzerland	14,900	17	69,400	30
Thailand	3,010,000	44	2,830,000	48
United Kingdom	3,370	4	5,780	4
Other	57,000 r/	2 r/	233,000	2
Total	5,910,000	86	5,360,000	111
Sapphire:				
Australia	9,190	(3/)	103,000	2
Belgium	25,900	1	3,480	(3/)
Brazil	8,190	(3/)	5,470	(3/)
Burma	539	1	331	1
Canada	4,840	(3/)	1,680	(3/)
China	506,000	1	64,100	(3/)
Colombia	395	(3/)	3,690	(3/)
France	738	1	337	(3/)
Germany	64,500	2	101,000	2
Hong Kong	298,000	6	246,000	7
India	682,000	2	354,000	3
Israel	67,800	3	99,600	2
Japan	1,640	(3/)	6,220	(3/)
Singapore	84	1	36	(3/)
Sri Lanka (ceylon)	864,000	10	616,000	12
Switzerland	23,100	10	349,000	20
Tanzania	3,010	(3/)	--	--
Thailand	5,920,000	55	4,450,000	64
United Kingdom	8,030	3	8,990	6

See footnotes at end of table.

TABLE 8--Continued
 U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN DIAMOND, BY KIND AND COUNTRY 1/

Kind and country	1996		1997	
	Quantity (carats)	Value 2/ (millions)	Quantity (carats)	Value 2/ (millions)
Sapphire: (continued)				
Other	37,700 r/	\$1 r/	243,000	\$3
Total	8,530,000	95	6,660,000	124
Other:				
Rough, uncut:				
Australia	NA	4	NA	3
Brazil	NA	21	NA	23
China	NA	1	NA	8
Colombia	NA	1	NA	1
Fiji	NA	1	NA	1
Hong Kong	NA	1	NA	1
India	NA	1	NA	1
Kenya	NA	2	NA	1
Nigeria	NA	(3/)	NA	(3/)
Pakistan	NA	(3/)	NA	1
Philippines	NA	1	NA	1
Russia	NA	(3/)	NA	(3/)
South Africa	NA	(3/)	NA	1
Switzerland	NA	(3/)	NA	1
Taiwan	NA	4	NA	12
Tanzania	NA	1	NA	2
Thailand	NA	1	NA	1
United Kingdom	NA	1	NA	1
Zambia	NA	2	NA	3
Other	NA	7 r/	NA	8
Total	NA	50	NA	70
Cut, set and unset:				
Australia	NA	5	NA	8
Brazil	NA	8	NA	10
Canada	NA	(3/)	NA	(3/)
China	NA	5	NA	7
French Polynesia	NA	4	NA	5
Germany	NA	11	NA	9
Hong Kong	NA	24	NA	31
India	NA	18	NA	26
Israel	NA	5	NA	5
Japan	NA	20	NA	10
Kenya	NA	1	NA	2
Sri Lanka (ceylon)	NA	3	NA	3
Switzerland	NA	2	NA	2
Taiwan	NA	2	NA	2
Tanzania	NA	2	NA	3
Thailand	NA	25	NA	28
United Kingdom	NA	1	NA	2
Other	NA	4	NA	4
Total	NA	138	NA	155

r/ Revised. NA Not available.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Customs value.

3/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 9
VALUE OF U.S. IMPORTS OF SYNTHETIC AND IMITATION
GEMSTONES, BY COUNTRY 1/

(Thousand dollars) 2/

Country	1996	1997
Synthetic, cut but unset:		
Australia	768	386
Austria	5,320	6,250
Brazil	116	176
China	4,880	10,100
France	1,090	1,120
Germany	12,100	11,500
Hong Kong	2,060	2,010
India	1,000	1,130
Italy	318	123
Japan	93	138
Korea, Republic of	1,440	1,710
Spain	83	123
Sri Lanka (ceylon)	649	674
Switzerland	3,780	4,930
Taiwan	376	519
Thailand	6,410	6,100
Other	280 r/	475
Total	40,700	47,400
Imitation: 3/		
Austria	46,200	40,000
China	414	609
Czech Republic	17,300	10,500
Germany	2,360	2,430
Japan	788	1,190
Spain	175	317
Taiwan	214	304
Other	1,090 r/	1,240
Total	68,500	56,600

r/ Revised.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Customs value.

3/ Includes pearls.

Source: Bureau of the Census.

TABLE 10
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES 1/

(Thousand carats and thousand dollars)

Stones	1996		1997	
	Quantity	Value 2/	Quantity	Value 2/
Diamonds:				
Rough or uncut	1,450	731,000	1,940	646,000
Cut but unset	12,300	5,830,000	13,400	6,950,000
Emeralds, cut but unset	9,930	203,000	5,960	217,000
Coral and similar materials, unworked	NA	6,340	NA	6,080
Rubies and sapphires, cut but unset	14,400	181,000	12,000	235,000
Pearls:				
Natural	NA	1,100	NA	785
Cultured	NA	31,800	NA	34,000
Imitation	NA	1,740	NA	2,210
Other precious and semiprecious stones:				
Rough, uncut	1,610,000	37,400	1,180,000	57,900
Cut, set and unset	NA	105,000	NA	120,000
Other	NA	6,320	NA	5,640
Synthetic:				
Cut but unset	174,000	40,700	230,000	47,400
Other	NA	3,800	NA	6,040
Imitation gemstone 3/	NA	66,800	NA	54,400
Total	XX	7,240,000	XX	8,380,000

NA Not available. XX Not applicable.

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Customs value.

3/ Does not include pearls.

TABLE 11
NATURAL DIAMOND: ESTIMATED WORLD PRODUCTION, BY TYPE AND COUNTRY 1/ 2/

(Thousand carats)

Country	1993	1994	1995	1996	1997
Gemstones: 3/					
Angola	130	270	2,600 r/	2,250 r/	1,110
Australia	18,800	19,500	18,300	18,897 4/	18,100
Botswana	10,300	10,550 4/	11,500	12,700 r/	13,000
Brazil	1,000	300	676 r/ 4/	200 r/	300
Central African Republic	370 4/	401 r/	400	350	400
China	230	230	230	230	230
Congo (Kinshasa) 5/	2,010	4,000	4,000	3,600 r/	2,500
Ghana	106 4/	118 4/	126	142 r/	140
Guinea	134	306	274	165	160
Liberia	60	40	60	60	60
Namibia	1,120	1,312 4/	1,382 4/	1,420 r/	1,500
Russia	8,000	8,500	9,000	9,250	9,550
Sierra Leone	90	155	113	162 4/	110
South Africa	4,600	5,050	5,070	4,280 r/	4,380
Venezuela	267 r/	380 r/	125 r/	105 r/	100
Zimbabwe	26	104	114	300 r/	350
Other	101 r/	180 r/	183 r/	231 r/	235
Total	47,400 r/	51,400	54,200 r/	54,400 r/	52,200
Industrial:					
Angola	15	30	300	250 r/	124
Australia	23,000	23,800	22,400	23,096 4/	22,100
Botswana	4,420	5,000	5,300	5,000	5,000
Brazil	600	600	600	600	600
Central African Republic	125	131	130	120	100
China	850	850	900	900	900
Congo (Kinshasa) 5/	13,600	13,000	13,000	17,000 r/	12,500
Ghana	484 4/	473 4/	505	573 r/	560
Guinea	33	75	91	40	40
Liberia	90	60	90	90	90
Russia	8,000	8,500	9,000	9,250	9,550
Sierra Leone	68	100	101	108	90
South Africa	5,700	5,800	5,880	5,670 r/	5,790
Venezuela	144 r/	203 r/	66 r/	55 r/	50
Zimbabwe	18	69	90	137 r/	100
Other	117 r/	96 r/	127 r/	149 r/	151
Total	57,300 r/	58,800 r/	58,600	63,000 r/	57,700
Grand total	105,000	110,000	113,000	117,000	110,000

r/ Revised.

1/ World totals and estimated data are rounded to three significant digits; may not add to totals shown.

2/ Table includes data available through May 27, 1998.

3/ Includes near-gem and cheap-gem qualities.

4/ Reported figure.

5/ Formerly Zaire.