



2011 Minerals Yearbook

GEMSTONES

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In 2011, the estimated value of natural gemstones produced in the United States was more than \$11.0 million, and the estimated value of U.S. laboratory-created gemstone production was more than \$31.9 million. The total estimated value of U.S. gemstone production was about \$43.0 million. The value of U.S. gemstone imports was \$23.5 billion, and the value of combined U.S. gemstone exports and reexports was estimated to be \$18.2 billion. In 2011, world natural diamond production totaled almost 135 million carats, of which an estimated 74.0 million carats was gem quality.

In this report, the terms “gem” and “gemstone” mean any mineral or organic material (such as amber, pearl, petrified wood, and shell) used for personal adornment, display, or object of art because it possesses beauty, durability, and rarity. Of more than 4,000 mineral species, only about 100 possess all these attributes and are considered to be gemstones. Silicates other than quartz are the largest group of gemstones in terms of chemical composition; oxides and quartz are the second largest (table 1). Gemstones are subdivided into diamond and colored gemstones, which in this report designates all natural nondiamond gems. In addition, laboratory-created gemstones, cultured pearls, and gemstone simulants are discussed but are treated separately from natural gemstones (table 2). Trade data in this report are from the U.S. Census Bureau. All percentages in the report were computed using unrounded data. Current information on industrial-grade diamond and industrial-grade garnet can be found in the U.S. Geological Survey (USGS) Minerals Yearbook, volume I, Metals and Minerals, chapters on industrial diamond and industrial garnet, respectively.

Gemstones have fascinated humans since prehistoric times. They have been valued as treasured objects throughout history by all societies in all parts of the world. Amber, amethyst, coral, diamond, emerald, garnet, jade, jasper, lapis lazuli, pearl, rock crystal, ruby, serpentine, and turquoise are some of the first stones known to have been used for making jewelry. These stones served as symbols of wealth and power. Today, gems are worn more for pleasure or in appreciation of their beauty than to demonstrate wealth. In addition to jewelry, gemstones are used for collections, decorative art objects, and exhibits.

Production

U.S. gemstone production data were based on a survey of more than 250 domestic gemstone producers conducted by the USGS. The survey provided a foundation for projecting the scope and level of domestic gemstone production during the year. However, the USGS survey did not represent all gemstone activity in the United States, which includes thousands of professional and amateur collectors. Consequently, the USGS supplemented its survey with estimates of domestic gemstone production from related published data, contacts with gemstone

dealers and collectors, and information gathered at gem and mineral shows.

Commercial mining of gemstones has never been extensive in the United States. More than 60 varieties of gemstones have been produced commercially from domestic mines, but most of the deposits are relatively small compared with those of other mining operations. In the United States, much of the current gemstone mining is conducted by individual collectors, gem clubs, and hobbyists rather than by businesses.

The commercial gemstone industry in the United States consists of individuals and companies that mine gemstones or harvest shell and pearl, firms that manufacture laboratory-created gemstones, and individuals and companies that cut and polish natural and laboratory-created gemstones. The domestic gemstone industry is focused on the production of colored gemstones and on the cutting and polishing of large diamond stones. Industry employment is estimated to be between 1,000 and 1,200.

Most natural gemstone producers in the United States are small businesses that are widely dispersed and operate independently. The small producers probably have an average of less than three employees, including those who only work part time. The number of gemstone mines operating from year to year fluctuates because the uncertainty associated with the discovery and marketing of gem-quality minerals makes it difficult to obtain financing for developing and sustaining economically viable operations.

The total value of natural gemstones produced in the United States was estimated to be about \$11.0 million during 2011 (table 3). This production value was a 10% increase from that of 2010.

Natural gemstone materials indigenous to the United States are collected or produced in every State. During 2011, all 50 States produced at least \$1,390 worth of gemstone materials. There were 11 States that accounted for 90% of the total value, as reported by survey respondents. These States were, in descending order of production value, Arizona, North Carolina, Oregon, Utah, California, Tennessee, Montana, Arkansas, Colorado, Idaho, and Maine. Some States were known for the production of a single gemstone material—Tennessee for freshwater pearls, for example. Other States produced a variety of gemstones; for example, Arizona’s gemstone deposits included agate, amethyst, azurite, chrysocolla, garnet, jade, jasper, malachite, obsidian, onyx, opal, peridot, petrified wood, smithsonite, and turquoise. A wide variety of gemstones also was found and produced in California, Idaho, Montana, and North Carolina.

In 2011, the United States had only one active operation in a known diamond-bearing area in Crater of Diamonds State Park near Murfreesboro in Pike County, AR. The State of Arkansas

maintains a dig-for-fee operation for tourists and rockhounds at the park; Crater of Diamonds is the only diamond mine in the world that is open to the public. The diamonds occur in a lamproite breccia tuff associated with a volcanic pipe and in the soil developed from the lamproite breccia tuff. In 2011, 560 diamond stones with an average weight of 0.267 carat were recovered at the Crater of Diamonds State Park. Of the 560 diamond stones recovered, 30 weighed more than 1 carat. Since the diamond-bearing pipe and the adjoining area became a State park in 1972 through yearend 2011, 29,906 diamond stones with a total carat weight of 5,981.1 have been recovered (Margi Jenks, park interpreter, Crater of Diamonds State Park, written commun., January 22, 2013). Exploration has demonstrated that this diamond deposit contains about 78.5 million metric tons (Mt) of diamond-bearing rock (Howard, 1999, p. 62). An Arkansas law enacted early in 1999 prohibits commercial diamond mining in the park (Diamond Registry Bulletin, 1999).

A few companies have expressed interest in exploration for diamond deposits in areas of Alaska, Colorado, Minnesota, Montana, and Wyoming with geologic settings and terrain that are similar to Canadian diamond mining areas. Even though some exploration has taken place in these States, they remain largely unexplored for diamonds (Iron Range Resources & Rehabilitation Board, 2012). Although exploration and field studies have found many diamond indicators and a number of large diamond deposits, none have attracted long-term investors or been operated commercially.

In addition to natural gemstones, laboratory-created gemstones and gemstone simulants were produced in the United States in 2011. Laboratory-created or synthetic gemstones have the same chemical, optical, and physical properties as natural gemstones. Simulants have an appearance similar to that of a natural gemstone material, but they have different chemical, optical, and physical properties. Laboratory-created gemstones that have been produced in the United States include alexandrite, cubic zirconia, diamond, emerald, garnet, moissanite, ruby, sapphire, spinel, and turquoise. However, during 2011, only cubic zirconia, diamond, moissanite, and turquoise were produced commercially. Simulants of amber, chrysocolla, coral, lapis lazuli, malachite, travertine, and turquoise also were manufactured in the United States. In addition, certain colors of laboratory-created sapphire and spinel, used to represent other gemstones, are classified as simulants.

Laboratory-created gemstone production in the United States was valued at more than \$31.9 million during 2011, which was a 4% increase compared with that of 2010. The value of U.S. simulant gemstone output was estimated to be more than \$100 million. Five companies in five States, representing virtually the entire U.S. laboratory-created gemstone industry, reported production to the USGS. The States with reported laboratory-created gemstone production were, in descending order of production value, Florida, New York, Massachusetts, North Carolina, and Arizona.

Since the 1950s, when scientists manufactured the first laboratory-created bits of diamond grit using a high-pressure, high-temperature (HPHT) method, this method of growing diamonds has become relatively commonplace in the world as a technology for laboratory-created diamonds, so much so

that thousands of small plants throughout China were using the HPHT method and producing laboratory-created diamonds suitable for cutting as gemstones. Gem-quality diamonds of 1 carat or more are harder to manufacture because at that size, it is difficult to consistently produce diamonds of high quality, even in the controlled environment of a laboratory using the HPHT method. After more than 50 years of development, that situation changed, and several laboratory-created diamond companies were able to produce high-quality diamonds that equaled those produced from mines (Park, 2007).

Gemesis Corp. (Sarasota, FL) consistently produced gem-quality laboratory-created diamond and reported production in 2011. The weight of the laboratory-created diamond stones ranges from 1½ to 2 carats, and most of the stones are brownish yellow, colorless, green, and yellow. Gemesis uses diamond-growing machines capable of growing 3-carat rough diamonds by generating HPHT conditions that recreate the conditions in the Earth's mantle where natural diamonds form (Davis, 2003). The prices of the Gemesis laboratory-created diamonds are 30% to 50% lower than those of comparable natural diamond but above the prices of simulated diamond (Gemesis Corp., 2010).

In the early 2000s, Apollo Diamond, Inc., near Boston, MA, developed and patented a method for growing single, extremely pure, gem-quality diamond crystals by chemical vapor deposition (CVD). The CVD technique transforms carbon into plasma, which is then precipitated onto a substrate as diamond. CVD had been used for more than a decade to cover large surfaces with microscopic diamond crystals, but in developing this process, Apollo Diamond discovered the temperature, gas composition, and pressure combination that resulted in the growth of a single diamond crystal. Apollo Diamond produced laboratory-created stones that ranged from 1 to 2 carats. Beginning in 2008, Apollo Diamond increased its production of large stones and sold the diamonds at prices that averaged 15% less than those of comparable natural diamonds (Apollo Diamond, Inc., 2008). Apollo Diamond and Gemesis prefer to call their diamonds "cultured" rather than laboratory-created, referring to the fact that the diamonds are grown much like a cultured pearl is grown.

During 2011, Apollo Diamond ceased manufacture of single-crystal CVD diamond for gemstone and industrial use. On August 31, 2011, SCIO Diamond Technology Corp. acquired the diamond growing machines and the related intellectual property rights from Apollo Diamond and on June 5, 2012, acquired the remainder of the assets including cultured diamond gemstone-related technology, inventory, and various intellectual property rights. SCIO Diamond Technology transferred all diamond growing equipment to their labs in Greenville, SC, and planned to begin manufacturing single-crystal CVD diamonds during 2012 (Yahoo Finance, 2012).

Charles & Colvard, Ltd. in North Carolina was the world's only manufacturer of moissanite, a gem-quality laboratory-created silicon carbide. Moissanite is an excellent diamond simulant, but it is being marketed for its own gem qualities. Moissanite exhibits a higher refractive index (brilliance) and higher luster than diamond. Its hardness is between those of corundum (ruby and sapphire) and diamond, which gives it

durability (Charles & Colvard, Ltd., 2010). Charles & Colvard reported that moissanite sales increased by 26% to just more than \$16 million in 2011 compared with \$12.7 million in 2010 (Bracken, 2012).

U.S. mussel shells are used as a source of mother-of-pearl and as seed material for culturing pearls. U.S. shell production increased slightly in 2011 compared with that of 2010. This increase was in spite of decreased demands for U.S. shell materials caused by the use of manmade seed materials and seed materials from China and other sources by pearl producers in Japan. The popularity of darker and colored pearls and freshwater pearls that do not use U.S. seed material has also contributed decreased demands for U.S. shell materials. In some regions of the United States, shell from mussels was being used more as a gemstone based on its own merit rather than as seed material for pearls. This shell material was being processed into mother-of-pearl and used in beads, jewelry, and watch faces.

Consumption

Historically, diamond gemstones have proven to hold their value despite wars or economic depressions, but this did not hold true during the recent worldwide economic recession. Diamond and colored gemstones value and sales decreased during the economic downturn in 2008 and continued into 2009, but during 2010 and 2011 U.S. gemstone consumption and sales increased.

Although the United States accounted for little of the total global gemstone production, it was the world's leading diamond and nondiamond gemstone market. It was estimated that U.S. gemstone markets accounted for more than 35% of world gemstone demand in 2011. The U.S. market for unset gem-quality diamond during the year was estimated to be about \$22.3 billion, an increase of 20% compared with that of 2010. Domestic markets for natural, unset nondiamond gemstones totaled approximately \$1.19 billion in 2011, which was a 24% increase from that of 2010. These large increases in domestic markets were a reflection of the recovery from the impacts of the global recession on luxury spending.

In the United States, a majority of domestic consumers designate diamond as their favorite gemstone. This popularity of diamonds is evidenced by the U.S. diamond market making up 95% of the total U.S. gemstone market. Colored natural gemstones, colored laboratory-created gemstones, and "fancy" colored diamonds were popular in 2011, with the values of the domestic markets for almost all types of colored natural, unset nondiamond gemstones increased from the 2010 values (table 10), also owing to recovery from the impact of the recession on luxury spending.

The estimated U.S. retail jewelry sales were \$68.3 billion in 2011, an increase of 11% from sales of \$61.5 billion in 2010 (Gassman, 2012). Fifty-nine percent of all U.S. jewelers reported jewelry sales increased during the holiday shopping season from that of the previous year holiday shopping season (Graff, 2012).

Prices

Gemstone prices are governed by many factors and qualitative characteristics, including beauty, clarity, defects, demand, durability, and rarity. Diamond pricing, in particular, is complex; values can vary significantly depending on time, place, and the subjective valuations of buyers and sellers. More than 14,000 categories are used to assess rough diamond and more than 100,000 different combinations of carat, clarity, color, and cut values can be used to assess polished diamond.

Colored gemstone prices are generally influenced by market supply and demand considerations, and diamond prices are supported by producer controls on the quantity and quality of supply. Values and prices of gemstones produced and (or) sold in the United States are listed in tables 3 through 5. In addition, customs values for diamonds and other gemstones imported, exported, or reexported are listed in tables 6 through 10.

De Beers Group companies remain a significant force, influencing the price of gem-quality diamond sales worldwide during 2011 because the companies mine a significant portion of the world's gem-quality diamond produced each year. In 2011, De Beers production from its independently owned and joint-venture operations in Botswana, Canada, Namibia, and South Africa decreased 5% to 31.3 million carats (Mct), compared with that of 2010. De Beers companies also sorted and valued a large portion (by value) of the world's annual supply of rough diamond through De Beers' subsidiary Diamond Trading Co. (DTC). DTC sales of rough diamonds increased 27% during 2011 compared with those of 2010 and totaled \$6.5 billion during 2011. DTC rough diamond average prices increased by 29% from those of 2010. In 2011, De Beers had total diamond and jewelry sales of \$7.4 billion, which was an increase of 26% compared with those of 2010 (DeMarco, 2012).

Foreign Trade

During 2011, total U.S. gemstone trade with all countries and territories was valued at about \$41.7 billion, which was an increase of 24% from that of 2010. Diamond accounted for about 97% of the 2011 gemstone trade total value. In 2011, U.S. exports and reexports of diamond were shipped to 92 countries and territories, and imports of all gemstones were received from 97 countries and territories (tables 6–10). In 2011, U.S. import quantities in cut diamond decreased slightly compared with those of 2010, and their value increased by 20%. U.S. import quantities in rough and unworked diamond increased by 81%, although their value increased by 20% (table 7). The United States remained the world's leading diamond importer and was a significant international diamond transit center as well as the world's leading gem-quality diamond market. In 2011, U.S. export and reexports quantities of gem-grade diamond decreased by 32% compared with those of 2010, and their value increased by 29%. The large volume of reexports revealed the significance of the United States in the world's diamond supply network (table 6).

Import values of laboratory-created gemstone increased by 27% for the United States in 2011 compared with those of 2010 (table 10). This increase in imports was owing to recovery from the impact of the recession on luxury spending.

Laboratory-created gemstone imports from Austria, Belgium, China, Germany, India, and Malaysia, with more than \$33 million in imports, accounted for about 90% (by value) of the total domestic imports of laboratory-created gemstones during the year (table 9). The marketing of imported laboratory-created gemstones and enhanced gemstones as natural gemstones, and the mixing of laboratory-created materials with natural stones in imported parcels, continued to be problems for some domestic producers in 2011. Problems continued with some simulants being marketed as laboratory-created gemstones during the year.

World Review

The gemstone industry worldwide has two distinct sectors—diamond mining and marketing and colored gemstone production and sales. Most diamond supplies are controlled by a few major mining companies; prices are supported by managing the quality and quantity of the gemstones relative to demand, a function performed by De Beers through DTC. Unlike diamond, colored gemstones are primarily produced at relatively small, low-cost operations with few dominant producers; prices are influenced by consumer demand and supply availability.

In 2011, world natural diamond production totaled about 135 Mct—74.0 Mct gem quality and 60.5 Mct industrial grade (table 11). Most production was concentrated in a few regions—Africa [Angola, Botswana, Congo (Kinshasa), Namibia, and South Africa], Asia (northeastern Siberia and Yakutia in Russia), Australia, North America (Northwest Territories in Canada), and South America (Brazil and Venezuela). In 2011, Russia led the world in total natural diamond output quantity (combined gemstone and industrial) with 25% of the estimated world production. Botswana was the world's leading gemstone diamond producer with 34%; followed by Russia, 25%; Canada, 15%; Angola, 11%; Congo (Kinshasa), 5%; South Africa, 4%; Namibia, 2%; and Zimbabwe and Lesotho, with 1% each. These nine countries produced 98% (by quantity) of the world's gemstone diamond output in 2011.

In 2002, the international rough-diamond certification system, the Kimberley Process Certification Scheme (KPCS), was agreed upon by United Nations (UN) member nations, the diamond industry, and involved nongovernmental organizations to prevent the shipment and sale of conflict diamonds. Conflict diamonds are diamonds that originate from areas controlled by forces or factions opposed to legitimate and internationally recognized governments, and are used to fund military action in opposition to those governments, or in contravention of the decisions of the UN Security Council. The KPCS includes the following key elements: the use of forgery-resistant certificates and tamper-proof containers for shipments of rough diamonds; internal controls and procedures that provide credible assurance that conflict diamonds do not enter the legitimate diamond market; a certification process for all exports of rough diamonds; the gathering, organizing, and sharing of import and export data on rough diamonds with other participants of relevant production; credible monitoring and oversight of

the international certification scheme for rough diamonds; effective enforcement of the provisions of the certification scheme through dissuasive and proportional penalties for violations; self regulation by the diamond industry that fulfills minimum requirements; and sharing information with all other participants on relevant rules, procedures, and legislation as well as examples of national certificates used to accompany shipments of rough diamonds. Congo (Kinshasa) assumed the chair of KPCS for January 1 through December 31, 2011, the ninth country or organization in succession to hold the chair after Israel, Namibia, India, South Africa, Canada, Russia, Botswana, and the European Commission. The 54 participants represented 80 nations (including the 27 member nations of the European Community) plus the rough diamond-trading entity of Taipei. During 2011, Côte d'Ivoire continued to be under UN sanctions and was not trading in rough diamonds, and Venezuela voluntarily suspended exports and imports of rough diamonds until further notice. The participating nations in the KPCS account for approximately 99.8% of the global production and trade of rough diamonds (Kimberley Process, undated).

Globally, the value of production of natural gemstones other than diamond was estimated to be more than \$2.5 billion in 2011. Most nondiamond gemstone mines are small, low-cost, and widely dispersed operations in remote regions of developing nations. Foreign countries with major gemstone deposits other than diamond are Afghanistan (aquamarine, beryl, emerald, kunzite, lapis lazuli, ruby, and tourmaline), Australia (beryl, opal, and sapphire), Brazil (agate, amethyst, beryl, ruby, sapphire, topaz, and tourmaline), Burma (beryl, jade, ruby, sapphire, and topaz), Colombia (beryl, emerald, and sapphire), Kenya (beryl, garnet, and sapphire), Madagascar (beryl, rose quartz, sapphire, and tourmaline), Mexico (agate, opal, and topaz), Sri Lanka (beryl, ruby, sapphire, and topaz), Tanzania (garnet, ruby, sapphire, tanzanite, and tourmaline), and Zambia (amethyst and beryl). In addition, pearls are cultured throughout the South Pacific and in other equatorial waters; Australia, China, French Polynesia, and Japan were key producers in 2011.

Worldwide diamond exploration allocations increased in 2011 after 3 years of declines with 70 companies allocating \$449 million, compared with 99 companies allocating \$357 million during 2010. This made the diamond share of overall worldwide exploration spending 3%. Africa no longer was the most popular diamond exploration location, after 7 years in a row of being the leading exploration spending spot (Metals Economics Group, 2011).

Worldwide in 2011, average diamond values increased 10% to \$97.67 per carat from the 2010 average value of \$88.79 per carat. This increase was reflected in increases in the U.S. markets, which demonstrated increasing quantity and value of diamond imports in 2011 compared with those of 2010, and improved sales in North America overall (Metals Economics Group, 2012).

Despite higher diamond prices, only two new projects were commissioned in 2011. The Kao Mine in Lesotho began operation, and the expansion of the Williamson Mine in Tanzania was commissioned in December 2011 (Metals Economics Group, 2012).

Canada.—Canadian diamond production was about 10.8 Mct during 2011, a decrease of about 8% compared with that of 2010. Diamond exploration continued in Canada, with several commercial diamond projects and additional discoveries in Alberta, British Columbia, the Northwest Territories, the Nunavut Territory, Ontario, and Quebec. In 2011, Canada produced 8% of the world's combined natural gemstone and industrial diamond output.

The Ekati Diamond Mine, Canada's first operating commercial diamond mine, completed its 13th full year of production in 2011. Ekati produced 2.07 Mct of diamond from 4.60 Mt of ore. BHP Billiton Ltd. has an 80% controlling ownership in Ekati, which is in the Northwest Territories. Ekati has estimated remaining reserves of 33.9 Mt of ore in kimberlite pipes that contain 16.2 Mct of diamond. BHP Billiton projected the remaining mine life to be 11 years. Approximately 21% of the Ekati 2011 diamond production is industrial-grade material (Perron, 2011, p. 1; BHP Billiton Ltd., 2012, p. 10).

The Diavik Diamond Mine, Canada's second diamond mine, also located in the Northwest Territories, completed its ninth full year of production. Diavik produces an average of 2 million metric tons per year (Mt/yr), grading an average of 3.1 carats per ton. At yearend 2011, Diavik estimated the mine's remaining proven and probable reserves to be 18.9 Mt of ore in kimberlite pipes containing 58.9 Mct of diamond and projected the total mine life to be 16 to 22 years. Diavik began developing an underground mine and substantially completed construction on the project during 2009. The first ore was produced from the underground mine during the first quarter of 2010, with full production expected in 2013. The mine is an unincorporated joint venture between Diavik Diamond Mine Inc. (60%) and Harry Winston Diamond Mines Ltd. (40%) (Perron, 2011, p. 2; Diavik Diamond Mine Inc., 2012, p. 5).

Canada's third diamond mine, the Jericho Diamond Mine in Nunavut, was originally owned by Tahera Diamond Corp. Tahera estimated the Jericho Diamond Mine's reserves to be about 5.5 Mt of ore grading 0.85 carats per ton. The Jericho Diamond Mine experienced startup problems related to ore mining and processing. The mine also suffered financial problems owing to the cost of transporting supplies to the mine site, high operational costs, high oil prices, and appreciation of the Canadian dollar versus the U.S. dollar. All of these problems combined to force the company to enter into protection under Canada's "Companies' Creditors Arrangement Act" on January 16, 2008, and the mine suspended production on February 6, 2008. At yearend 2009, Tahera was finalizing arrangements to sell all of its Jericho Diamond Mine assets (Perron, 2011, p. 2). In July 2010, Shear Minerals Ltd. (now known as Shear Diamonds Ltd.) announced that it had entered into a purchase agreement with Tahera and Benachee Resources Inc. to acquire a 100% interest in the Jericho Diamond Mine, the mine's processing facilities, and all supporting exploration assets in the Kitikmeot region of Nunavut (Shear Minerals Ltd., 2010). Shear Minerals completed the acquisition of the Jericho Diamond Mine in August 2010 with the intention of bringing the mine back into production during 2012 (Shear Minerals Ltd., 2011).

The Snap Lake Mine, in the Northwest Territories, is wholly owned by De Beers Canada Inc. The Snap Lake deposit is a tabular-shaped kimberlite dyke rather than the typical kimberlite pipe. The dyke is 2.5 meters thick and dips at an angle of 12° to 15°. The deposit was mined using a modified room and pillar underground mining method in 2011. The Snap Lake Mine started mining operations in October 2007, reached commercial production levels in the first quarter of 2008, and officially opened June 25, 2008. The mine was expected to produce 1.4 Mct per year of diamond, and the mine life was expected to be about 20 years. The mine's production for 2011 amounted to 881,000 carats for a recovered grade of 1.2 carats per ton (De Beers Canada Inc., 2011; Perron, 2011, p. 2–3; De Beers Group Inc., 2012).

The Victor Mine, in northern Ontario on the James Bay coast, also is wholly owned by De Beers Canada. The Victor kimberlite consists of two pipes with surface area of 15 hectares. The Victor Mine initiated mining operations at yearend 2007 and was officially opened on July 26, 2008. The Victor reportedly has 27.4 Mt of ore with average ore grade of 0.23 carats per ton estimated minable reserves. At full capacity, the open pit mine was expected to produce 600,000 carats per year, and the mine life was expected to be about 12 years. In 2011, the mine's production was 779,000 carats recovered from 2.67 Mt of ore (Perron, 2011, p. 3; De Beers Group Inc., 2012; De Beers Canada Inc., undated).

Lesotho.—The Kao Mine, owned by Namakwa Batla Diamonds Co., began processing kimberlite ore in late November 2011 and began commercial production in March 2012. Namakwa expected production of 170,000 carats for 2012 (Metals Economics Group, 2012).

Tanzania.—Refurbishing of the plant at the Williamson Mine began in December 2011. The Williamson Mine is 75% owned by Petra Diamond Ltd. and 25% by the Government of Tanzania. Petra began operating the newly rebuilt plant in March 2012, but was waiting for a secure electrical supply before committing to the full expansion to mining 10 Mt/yr of ore (Metals Economics Group, 2012, p. 24).

Outlook

As the domestic and global economy improves, Internet sales of diamonds, gemstones, and jewelry were expected to continue to expand and increase in popularity, as were other forms of e-commerce that emerge to serve the diamond and gemstone industry. Internet sales are expected to add to and partially replace "brick-and-mortar" sales. This is likely to take place as the gemstone industry and its customers become more comfortable with and learn the applications of new e-commerce tools, such as sales Web sites and online social networking Web sites (Dayrit, 2011).

As more independent producers, such as Ekati and Diavik in Canada, come online they will bring a greater measure of competition to global markets that presumably will bring more supplies and lower prices. Further consolidation of diamond producers and larger quantities of rough diamond being sold outside DTC is expected to continue as the diamond industry adjusts to De Beers' reduced influence on the industry.

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

References Cited

- Apollo Diamond, Inc., 2008, Interested in buying?: Boston, MA, Apollo Diamond, Inc. (Accessed October 19, 2009, at <https://www.shopapollo.com/>.)
- BHP Billiton Ltd., 2012, BHP Billiton production report for the half year ended 31 December 2011: Melbourne, Australia, BHP Billiton Ltd. news release, January 18, 20 p.
- Bracken, David, 2012, Charles & Colvard sees brighter future with new gemstone: NewsObserver.com, June 3. (Accessed January 22, 2013, at <http://www.newsobserver.com/2012/06/03/2107003/charles-colvard-sees-brighter.html>.)
- Charles & Colvard, Ltd., 2010, What is moissanite?: Morrisville, NC, Charles & Colvard, Ltd. (Accessed December 13, 2010, at <http://www.whatismoissanite.com/#>.)
- Davis, Joshua, 2003, The new diamond age: Wired, v. 11, no. 9, September, p. 96–105, 145–146.
- Dayrit, Catherine, 2011, Online retailing continues to gain momentum: National Jeweler, January 26. (Accessed December 14, 2011, at <http://www.nationaljeweler.com/nj/independents/a/~25743-Online-retailing-continues-to-gain>.)
- De Beers Canada Inc., 2011, Snap Lake Mine fast facts: Yellowknife, Northwest Territories, Canada, De Beers Canada Inc. fact sheet, September, 1 p. (Accessed December 9, 2011, at http://www.debeerscanada.com/files_3/pdf_documents/Snap-Lake-Mine_Fast-Facts.pdf.)
- De Beers Canada Inc., [undated], Victor Mine fast facts: Timmins, Ontario, Canada, De Beers Canada Inc. fact sheet, 1 p. (Accessed December 9, 2011, at http://www.debeerscanada.com/files_3/pdf_documents/fast_facts_vm.pdf.)
- De Beers Group Inc., 2012, Operating and financial review 2011: London, United Kingdom, De Beers UK Ltd., February 10, 32 p.
- DeMarco, Anthony, 2012, De Beers 2011 diamond and jewelry sales up 26%: Forbes, February 10. (Accessed January 22, 2013, at <http://www.forbes.com/sites/anthonydemarco/2012/02/10/de-beers-2011-diamond-and-jewelry-sales-up-26/>.)
- Diamond Registry Bulletin, 1999, Verdict in—Crater of Diamonds remains public park: Diamond Registry Bulletin, v. 31, no. 2, February 28, p. 6.
- Diavik Diamond Mine Inc., 2012, 2011 sustainable development report: Yellowknife, Northwest Territories, Canada, Diavik Diamond Mine Inc. media release, July 7, 24 p. (Accessed December 11, 2012, at http://www.diavik.ca/documents/2011_Sustainable_Development_Report.pdf.)
- Gassman, Ken, 2012, IDEX Online research—U.S. jewelry sales hit \$68.3B: IDEX Online S.A., February 2. (Accessed January 22, 2013, at <http://www.nationaljeweler.com/nj/independents/a/~27759-IDEX-Online-Research-Jewelry-sales>.)
- Gemesis Corp., 2010, Gemesis—Transform the way you think of diamonds: Sarasota, FL, Gemesis Corp. (Accessed February 18, 2010, at <http://www.gemesis.com/index.cfm>.)
- Graff, Michelle, 2012, Exclusive report—A strong year for jewelers: National Jeweler, February 6. (Accessed January 22, 2013, at <http://www.nationaljeweler.com/nj/independents/a/~27779-Exclusive-Report-A-strong-year>.)
- Howard, J.M., 1999, Summary of the 1990's exploration and testing of the Prairie Creek diamond-bearing lamproite complex, Pike County, AR, with a field guide, in Howard, J.M., ed., Contributions to the geology of Arkansas: Little Rock, AR, Arkansas Geological Commission Miscellaneous Publication 18D, v. IV, p. 57–73.
- Iron Range Resources & Rehabilitation Board, 2012, Explore Minnesota—Diamonds: Eveleth, MN, Iron Range Resources & Rehabilitation Board, March, 4 p. (Accessed May 16, 2012, at http://www.irrb.org/site_components/files/2012_Diamonds8x11.pdf.)
- Kimberley Process, [undated], The Kimberley Process: New York, NY, Kimberley Process. (Accessed January 22, 2013, via <http://www.kimberleyprocess.com/web/kimberley-process/home>.)
- Metals Economics Group, 2011, Trends in worldwide exploration budgets, 2011: Metals Economics Group Strategic Report, v. 24, no. 6, November/December, p. 1–11.
- Metals Economics Group, 2012, Diamond pipeline, 2012: Metals Economics Group Strategic Report, v. 25, no. 3, May/June, p. 17–29.
- Park, Alice, 2007, Diamonds de novo: TIME, v. 169, no. 7, February 12, p. G1.
- Perron, Louis, 2011, Diamonds, in Canadian minerals yearbook 2009: Ottawa, Ontario, Canada, Natural Resources Canada, March 11, 27 p. (Accessed March 17, 2011, at <http://www.nrcan.gc.ca/mms-smm/busi-indu/cmy-amc/2009cmy-eng.htm>.)
- Shear Minerals Ltd., 2010, Shear Minerals Ltd. to acquire Jericho Diamond Mine, Nunavut: Edmonton, Alberta, Canada, Shear Minerals Ltd. press release, July 19, 5 p.
- Shear Minerals Ltd., 2011, Jericho Diamond Mine, Nunavut: Edmonton, Alberta, Canada, Shear Minerals Ltd. project fact sheet. (Accessed December 16, 2011, at <http://www.shearminerals.com/jericho.html>.)
- Yahoo Finance, 2012, Form 10–Q for SCIO Diamond Technology Corp: Quarterly Report, August 20, [unpaginated]. (Accessed December 27, 2012, at <http://biz.yahoo.com/e/120820/scio10-q.html>.)

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

- Diamond, Industrial. Ch. in Minerals Yearbook, annual.
- Garnet, Industrial. Ch. in Minerals Yearbook, annual.
- Gem Stones. Ch. in United States Mineral Resources, Professional Paper 820, 1973.
- Gemstones. Ch. in Mineral Commodity Summaries, annual.
- Historical Statistics for Mineral and Material Commodities in the United States, Data Series 140.

Other

- Antwerp Confidential.
- Colored Stone Magazine.
- De Beers Consolidated Mines Ltd. annual reports, 1998–2001.
- Directory of Principal U.S. Gemstone Producers in 1995. U.S. Bureau of Mines Mineral Industry Surveys, 1995.
- Gems & Gemology.
- Gemstone Forecaster.
- Lapidary Journal.
- Overview of Production of Specific U.S. Gemstones, An. U.S. Bureau of Mines Special Publication 95–14, 1995.

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

Name	Composition	Color	Practical size ¹	Cost ²	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Amber	Hydrocarbon	Yellow, red, green, blue	Any	Low to medium	2.0–2.5	1.0–1.1	Single	1.54	Synthetic or pressed plastics, kaurigum	Fossil resin, color, low density, soft, insects.
Apatite	Chlorocalcium phosphate	Colorless, pink, yellow, green, blue, violet	Small	Low	5.0	3.16–3.23	Double	1.63–1.65	Amblygonite, andalusite, brazilianite, precious beryl, titanite, topaz, tourmaline	Crystal habit, color, hardness, appearance.
Azurite	Copper carbonate hydroxide	Azure, dark blue, pale blue	Small to medium	do.	3.5–4.0	3.7–3.9	do.	1.72–1.85	Dumortierite, hauynite, lapis lazuli, lazulite, sodalite	Color, softness, crystal habits, associated minerals.
Benitoite	Barium titanium silicate	Blue, purple, pink, colorless	do.	High	6.0–6.5	3.64–3.68	do.	1.76–1.80	Sapphire, tanzanite, blue diamond, blue tourmaline, cordierite	Strong blue in ultraviolet light.
Beryl:										
Aquamarine	Beryllium aluminum silicate	Blue-green to light blue	Any	Medium to high	7.5–8.0	2.63–2.80	do.	1.58	Synthetic spinel, blue topaz	Double refraction, refractive index.
Bixbite	do.	Red	Small	Very high	7.5–8.0	2.63–2.80	do.	1.58	Pressed plastics, tourmaline	Refractive index.
Emerald, natural	do.	Green	Medium	do.	7.5	2.63–2.80	do.	1.58	Fused emerald, glass, tourmaline, peridot, green garnet doublets	Emerald filter, dichroism, refractive index.
Emerald, synthetic	do.	do.	Small	High	7.5–8.0	2.63–2.80	do.	1.58	Genuine emerald	Lack of flaws, brilliant fluorescence in ultraviolet light.
Golden (heliodor)	do.	Yellow to golden	Any	Low to medium	7.5–8.0	2.63–2.80	do.	1.58	Citrine, topaz, glass, doublets	Weak-colored.
Goshenite	do.	Colorless	do.	Low	7.5–8.0	2.63–2.80	do.	1.58	Quartz, glass, white sapphire, white topaz	Refractive index.
Morganite	do.	Pink to rose	do.	do.	7.5–8.0	2.63–2.80	do.	1.58	Kunzite, tourmaline, pink sapphire	Do.
Calcite:										
Marble	Calcium carbonate	White, pink, red, blue, green, or brown	do.	do.	3.0	2.72	Double (strong)	1.49–1.66	Silicates, banded agate, alabaster gypsum	Translucent.
Mexican onyx	do.	do.	do.	do.	3.0	2.72	do.	1.60	do.	Banded, translucent.
Charoite	Hydrated sodium calcium hydroxi-silicate	Lilac, violet, or white	Small to medium	do.	5.0–6.0	2.54–2.78	XX	1.55–1.56	Purple marble	Color, locality.
Chrysoberyl:										
Alexandrite	Beryllium aluminate	Green by direct sunlight, or incandescent light, red by indirect sunlight or fluorescent light	do.	High	8.5	3.50–3.84	Double	1.75	Synthetic	Strong dichroism, color varies from red to green, hardness.
Cat's eye	do.	Greenish to brownish	Small to large	do.	8.5	3.50–3.84	do.	1.75	Synthetic, shell	Density, translucence, chatoyance.
Chrysolite	do.	Yellow, green, and (or) brown	Medium	Medium	8.5	3.50–3.84	do.	1.75	Tourmaline, peridot	Refractive index, silky.

See footnotes at end of table.

GUIDE TO SELECTED GEMSTONES AND GEM MATERIALS USED IN JEWELRY

Name	Composition	Color	Practical size ¹	Cost ²	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Chrysocolla	Hydrated copper silicate	Green, blue	Any	Low	2.0–4.0	2.0–2.4	XX	1.46–1.57	Azurite, dyed chalcedony, malachite, turquoise, variscite	Lack of crystals, color, fracture, low density, softness.
Coral	Calcium carbonate	Orange, red, white, black, purple, or green	Branching, medium	do.	3.5–4.0	2.6–2.7	Double	1.49–1.66	False coral	Dull translucent.
Corundum:										
Ruby	Aluminum oxide	Rose to deep purplish red	Small	Very high	9.0	3.95–4.10	do.	1.78	Synthetics, including spinel, garnet	Inclusions, fluorescence.
Sapphire, blue	do.	Blue	Medium	High	9.0	3.95–4.10	do.	1.78	do.	Inclusions, double refraction, dichroism.
Sapphire, fancy	do.	Yellow, pink, colorless, orange, green, or violet	Medium to large	Medium	9.0	3.95–4.10	do.	1.78	Synthetics, glass and doublets, morganite	Inclusions, double refraction, refractive index.
Sapphire or ruby, stars	do.	Red, pink, violet, blue, or gray	do.	High to low	9.0	3.95–4.10	do.	1.78	Star quartz, synthetic stars	Shows asterism, color side view.
Sapphire or ruby, synthetic	do.	Yellow, pink, blue, green, orange, violet, or red	Up to 20 carats	Low	9.0	3.95–4.10	do.	1.78	Synthetic spinel, glass	Curved striae, bubble inclusions.
Cubic zirconia	Zirconium and yttrium oxides	Colorless, pink, blue, lavender, yellow	Small	do.	8.25–8.5	5.8	Single	2.17	Diamond, zircon, titania, moissanite	Hardness, density, lack of flaws and inclusions, refractive index.
Diamond	Carbon	White, blue-white, yellow, brown, green, red, pink, blue	Any	Very high	10.0	3.516–3.525	do.	2.42	Zircon, titania, cubic zirconia, moissanite	High index, dispersion, hardness, luster.
Feldspar:										
Amazonite	Alkali aluminum silicate	Green-blue	Large	Low	6.0–6.5	2.56	XX	1.52	Jade, turquoise	Cleavage, sheen, vitreous to pearly, opaque, grid.
Labradorite	do.	Gray with blue and bronze sheen color play (schiller)	do.	do.	6.0–6.5	2.56	XX	1.56	do.	Do.
Moonstone	do.	Colorless, white, gray, or yellow with white, blue, or bronze schiller	do.	do.	6.0–6.5	2.77	XX	1.52–1.54	Glass, chalcedony, opal	Pale sheen, opalescent.
Sunstone	do.	Orange, red brown, colorless with gold or red glittery schiller	Small to medium	do.	6.0–6.5	2.77	XX	1.53–1.55	Aventurine, glass	Red glittery schiller.
Garnet	Complex silicate	Brown, black, yellow, green, red, or orange	do.	Low to high	6.5–7.5	3.15–4.30	Single strained	1.79–1.98	Synthetics, spinel, glass	Single refraction, anomalous strain.
Hematite	Iron oxide	Black, black-gray, brown-red	Medium to large	Low	5.5–6.5	5.12–5.28	XX	2.94–3.22	Davidite, cassiterite, magnetite, neptunite, pyrolusite, wolframite	Crystal habit, streak, hardness.

See footnotes at end of table.

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

Name	Composition	Color	Practical size ¹	Cost ²	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Jade:										
Jadeite	Complex silicate	Green, yellow, black, white, or mauve	Large	Low to very high	6.5–7.0	3.3–3.5	Crypto-crystalline	1.65–1.68	Nephrite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Luster, spectrum, translucent to opaque.
Nephrite	Complex hydrous silicate	do.	do.	do.	6.0–6.5	2.96–3.10	do.	1.61–1.63	Jadeite, chalcedony, onyx, bowenite, vesuvianite, grossularite	Do.
Jet (gagate)	Lignite	Deep black, dark brown	do.	Low	2.5–4.0	1.19–1.35	XX	1.64–1.68	Anthracite, asphalt, cannel coal, onyx, schorl, glass, rubber	Luster, color.
Lapis lazuli	Sodium calcium aluminum silicate	Dark azure-blue to bright indigo blue or even a pale sky blue.	do.	do.	5.0–6.0	2.50–3.0	XX	1.50	Azurite, dumortierite, dyed howlite, lazulite, sodalite, glass	Color, crystal habit, associated minerals, luster, localities.
Malachite	Hydrated copper carbonate	Light to black-green banded	do.	do.	3.5–4.0	3.25–4.10	XX	1.66–1.91	Brochantite, chrysoprase, opaque green gemstones	Color banding, softness, associated minerals.
Moissanite	Silicon carbide	Colorless and pale shades of green, blue, yellow	Small	Low to medium	9.25	3.21	Double	2.65–2.69	Diamond, zircon, titania, cubic zirconia	Hardness, dispersion, lack of flaws and inclusions, refractive index.
Obsidian	Amorphous, variable (usually felsic)	Black, gray, brown, dark green, white, transparent	Large	Low	5.0–5.5	2.35–2.60	XX	1.45–1.55	Aegirine-augite, gadolinite, gagate, hematite, pyrolusite, wolframite	Color, conchoidal fracture, flow bubbles, softness, lack of crystal faces.
Opal	Hydrated silica	Reddish orange, colors flash in white gray, black, red, or yellow	do.	Low to high	5.5–6.5	1.9–2.3	Single	1.45	Glass, synthetics, triplets, chalcedony	Color play (opalescence).
Peridot	Iron magnesium silicate	Yellow and (or) green	Any	Medium	6.5–7.0	3.27–3.37	Double (strong)	1.65–1.69	Tourmaline, chrysoberyl	Strong double refraction, low dichroism.
Quartz:										
Agate	Silicon dioxide	Any	Large	Low	7.0	2.58–2.64	XX	XX	Glass, plastic, Mexican onyx	Cryptocrystalline, irregularly banded, dendritic inclusions.
Amethyst	do.	Purple	do.	Medium	7.0	2.65–2.66	Double	1.55	Glass, plastic, fluorite	Macrocrystalline, color, refractive index, transparent, hardness.
Aventurine	do.	Green, red-brown, gold-brown, with metallic iridescent reflection	do.	Low	7.0	2.64–2.69	do.	1.54–1.55	Iridescent analcime, aventurine feldspar, emerald, aventurine glass	Macrocrystalline, color, metallic iridescent flake reflections, hardness.
Cairngorm	do.	Smoky orange or yellow	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.

See footnotes at end of table.

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

Name	Composition	Color	Practical size ¹	Cost ²	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Carnelian	Silicon dioxide	Flesh red to brown red	Large	Low	6.5–7.0	2.58–2.64	Double	1.53–1.54	Jasper	Cryptocrystalline, color, hardness.
Chalcedony	do.	Bluish, white, gray	do.	do.	6.5–7.0	2.58–2.64	do.	1.53–1.54	Tanzanite	Do.
Chrysoprase	do.	Green, apple-green	do.	do.	6.5–7.0	2.58–2.64	do.	1.53–1.54	Chrome chalcedony, jade, prase opal, prehnite, smithsonite, variscite, artificially colored green chalcedony	Do.
Citrine	do.	Yellow	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Jasper	do.	Any, striped, spotted, or sometimes uniform	do.	do.	7.0	2.58–2.66	XX	XX	do.	Cryptocrystalline, opaque, vitreous luster, hardness.
Onyx	do.	Many colors	do.	do.	7.0	2.58–2.64	XX	XX	do.	Cryptocrystalline, uniformly banded, hardness.
Petrified wood	do.	Brown, gray, red, yellow	do.	do.	6.5–7.0	2.58–2.91	Double	1.54	Agate, jasper	Color, hardness, wood grain.
Rock crystal	do.	Colorless	do.	do.	7.0	2.65–2.66	do.	1.55	Topaz, colorless sapphire	Do.
Rose	do.	Pink, rose red	do.	do.	7.0	2.65–2.66	do.	1.55	do.	Macrocrystalline, color, refractive index, transparent, hardness.
Tiger's eye	do.	Golden yellow, brown, red, blue-black	do.	do.	6.5–7.0	2.58–2.64	XX	1.53–1.54	XX	Macrocrystalline, color, hardness, chatoyancy.
Rhodochrosite	Manganese carbonate	Rose-red to yellowish, stripped	do.	do.	4.0	3.45–3.7	Double	1.6–1.82	Fire opal, rhodonite, tugrupite, tourmaline	Color, crystal habit, reaction to acid, perfect rhombohedral cleavage.
Rhodonite	Manganese iron calcium silicate	Dark red, flesh red, with dendritic inclusions of black manganese oxide	do.	do.	5.5–6.5	3.40–3.74	do.	1.72–1.75	Rhodochrosite, thulite, hessonite, spinel, pyroxmangite, spessartine, tourmaline	Color, black inclusions, lack of reaction to acid, hardness.
Shell:										
Mother-of-pearl	Calcium carbonate	White, cream, green, blue-green, with iridescent play of color	Small	do.	3.5	2.6–2.85	XX	XX	Glass and plastic imitation	Luster, iridescent play of color.
Pearl	do.	White, cream to black, sometimes with hint of pink, green, purple	do.	Low to high	2.5–4.5	2.6–2.85	XX	XX	Cultured and glass or plastic imitation	Luster, iridescence, x-structure, ray.

See footnotes at end of table.

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

Name	Composition	Color	Practical size ¹	Cost ²	Mohs	Specific gravity	Refraction	Refractive index	May be confused with	Recognition characteristics
Spinel, natural	Magnesium aluminum oxide	Any	Small to medium	Medium	8.0	3.5–3.7	Single	1.72	Synthetic, garnet	Refractive index, single refraction, inclusions.
Spinel, synthetic	do.	do.	Up to 40 carats	Low	8.0	3.5–3.7	Double	1.73	Spinel, corundum, beryl, topaz, alexandrite	Weak double refraction, curved striae, bubbles.
Spodumene:										
Hiddenite	Lithium aluminum silicate	Yellow to green	Medium	Medium	6.5–7.0	3.13–3.20	do.	1.66	Synthetic spinel	Refractive index, color, pleochroism.
Kunzite	do.	Pink to lilac	do.	do.	6.5–7.0	3.13–3.20	do.	1.66	Amethyst, morganite	Do.
Tanzanite	Complex silicate	Blue to lavender	Small	High	6.0–7.0	3.30	do.	1.69	Sapphire, synthetics	Strong trichroism, color.
Topaz	do.	White, blue, green, pink, yellow, gold	Medium	Low to medium	8.0	3.4–3.6	do.	1.62	Beryl, quartz	Color, density, hardness, refractive index, perfect in basal cleavage.
Tourmaline	do.	Any, including mixed	do.	do.	7.0–7.5	2.98–3.20	do.	1.63	Peridot, beryl, garnet corundum, glass	Double refraction, color, refractive index.
Turquoise	Copper aluminum phosphate	Blue to green with black, brown-red inclusions	Large	Low	6.0	2.60–2.83	do.	1.63	Chrysocolla, dyed howlite, dumortierite, glass, plastics, variscite	Difficult if matrix not present, matrix usually limonitic.
Unakite	Granitic rock, feldspar, epidote, quartz	Olive green, pink, and blue-gray	do.	do.	6.0–7.0	2.60–3.20	XX	XX	XX	Olive green, pink, gray-blue colors.
Zircon	Zirconium silicate	White, blue, brown, yellow, or green	Small to medium	Low to medium	6.0–7.5	4.0–4.8	Double (strong)	1.79–1.98	Diamond, synthetics, topaz, aquamarine	Double refraction, strongly dichroic, wear on facet edges.

Do., do. Ditto. XX Not applicable.

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

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

TABLE 2
LABORATORY-CREATED GEMSTONE PRODUCTION METHODS

Gemstone	Production method	Company/producer	Date of first production
Alexandrite	Flux	Creative Crystals Inc.	1970s.
Do.	Melt pulling	J.O. Crystal Co., Inc.	1990s.
Do.	do.	Kyocera Corp.	1980s.
Do.	Zone melt	Seiko Corp.	Do.
Cubic zirconia	Skull melt	Various producers	1970s.
Emerald	Flux	Chatham Created Gems	1930s.
Do.	do.	Gilson	1960s.
Do.	do.	Kyocera Corp.	1970s.
Do.	do.	Lennix	1980s.
Do.	do.	Russia	Do.
Do.	do.	Seiko Corp.	Do.
Do.	Hydrothermal	Biron Corp.	Do.
Do.	do.	Lechleitner	1960s.
Do.	do.	Regency	1980s.
Do.	do.	Russia	Do.
Ruby	Flux	Chatham Created Gems	1950s.
Do.	do.	Douras	1990s.
Do.	do.	J.O. Crystal Co., Inc.	1980s.
Do.	do.	Kashan Created Ruby	1960s.
Do.	Melt pulling	Kyocera Corp.	1970s.
Do.	Verneuil	Various producers	1900s.
Do.	Zone melt	Seiko Corp.	1980s.
Sapphire	Flux	Chatham Created Gems	1970s.
Do.	Melt pulling	Kyocera Corp.	1980s.
Do.	Verneuil	Various producers	1900s.
Do.	Zone melt	Seiko Corp.	1980s.
Star ruby	Melt pulling	Kyocera Corp.	Do.
Do.	do.	Nakazumi Earth Crystals Co.	Do.
Do.	Verneuil	Linde Air Products Co.	1940s.
Star sapphire	do.	do.	Do.

Do., do. Ditto.

TABLE 3
ESTIMATED VALUE OF U.S. NATURAL GEMSTONE PRODUCTION,
BY GEM TYPE¹

(Thousand dollars)

Gem materials	2010	2011
Beryl	1,700	1,740
Coral, all types	150	150
Diamond	(2)	(2)
Garnet	149	110
Gem feldspar	693	756
Geode/nodules	110	110
Opal	189	71
Quartz:		
Macrocrystalline ³	273	333
Cryptocrystalline ⁴	208	248
Sapphire/ruby	344	343
Shell	821	832
Topaz	(2)	(2)
Tourmaline	95	73
Turquoise	449	1,330
Other	4,840	4,950
Total	10,000	11,000

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Less than ½ unit.

³Macrocrystalline quartz (crystals recognizable with the naked eye) includes amethyst, aventurine, blue quartz, citrine, hawk's eye, pasiolite, prase, quartz cat's eye, rock crystal, rose quartz, smoky quartz, and tiger's eye.

⁴Cryptocrystalline quartz (microscopically small crystals) includes agate, carnelian, chalcedony, chrysoprase, fossilized wood, heliotrope, jasper, moss agate, onyx, and sard.

TABLE 4
PRICES PER CARAT OF U.S. CUT ROUND DIAMONDS, BY SIZE AND QUALITY IN 2011

Carat weight	Description, color ¹	Clarity ² (GIA terms)	Representative prices		
			January ³	June ⁴	December ⁵
0.25	G	VS1	\$1,400	\$1,650	\$1,650
Do.	G	VS2	1,300	1,600	1,600
Do.	G	SII	1,200	1,250	1,250
Do.	H	VS1	1,350	1,600	1,600
Do.	H	VS2	1,250	1,500	1,500
Do.	H	SII	1,150	1,200	1,200
0.50	G	VS1	2,650	3,600	3,600
Do.	G	VS2	2,200	3,100	3,100
Do.	G	SII	1,900	2,500	2,500
Do.	H	VS1	2,350	3,170	3,170
Do.	H	VS2	2,150	2,750	2,750
Do.	H	SII	1,800	2,250	2,250
1.00	G	VS1	6,400	8,500	8,500
Do.	G	VS2	5,450	8,000	8,000
Do.	G	SII	4,650	6,500	6,500
Do.	H	VS1	5,300	7,700	7,700
Do.	H	VS2	4,800	7,200	7,200
Do.	H	SII	4,225	5,900	5,900
2.00	G	VS1	12,100	15,500	15,500
Do.	G	VS2	11,500	13,200	13,200
Do.	G	SII	9,100	11,200	11,200
Do.	H	VS1	9,500	13,300	13,300
Do.	H	VS2	9,100	11,700	11,700
Do.	H	SII	8,250	10,300	10,300

Do. Ditto.

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

²Clarity: IF—no blemishes; VVS1—very, very slightly included; VS1—very slightly included; VS2—very slightly included, but not visible; SII—slightly included.

³Source: The Gem Guide, v. 30, no. 1, January/February 2011, p. 20–22.

⁴Source: The Gem Guide, v. 30, no. 4, July/August 2011, p. 20–22.

⁵Source: The Gem Guide, v. 30, no. 6, November/December 2011, p. 20–22.

TABLE 5
PRICES PER CARAT OF U.S. CUT COLORED GEMSTONES IN 2011

Gemstone	Price range per carat	
	January ¹	December ²
Amethyst	\$10–25	\$10–25
Blue sapphire	950–1,800	950–1,900
Blue topaz	5–10	5–10
Emerald	2,400–4,000	2,600–4,400
Green tourmaline	50–70	50–70
Cultured saltwater pearl ³	5	5
Pink tourmaline	70–150	65–170
Rhodolite garnet	22–45	22–45
Ruby	1,850–2,200	2,200–2,600
Tanzanite	300–375	300–375

¹Source: The Gem Guide, v. 30, no. 1, January/February 2011, p. 50, 53, 57, 61, 63, 65, and 68–71. These figures are approximate wholesale purchase prices paid by retail jewelers on a per stone basis for 1-to-less than 1 carat, fine-quality stones.

²Source: The Gem Guide, v. 30, no. 6, November/December 2011, p. 50, 53, 57, 61, 63, 65, and 68–71. These figures are approximate wholesale purchase prices paid by retail jewelers on a per-stone basis for 1-to-less than 1 carat, fine-quality stones.

³Prices are per 4.5 to 5-millimeter pearl.

TABLE 6
U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL
DIAMOND), BY COUNTRY¹

Country	2010		2011	
	Quantity (carats)	Value ² (millions)	Quantity (carats)	Value ² (millions)
Exports:				
Aruba	5,460	\$9	3,390	\$11
Australia	33,000	34	11,700	25
Austria	440	2	544	1
Bahamas, The	870	3	852	5
Belgium	346,000	396	269,000	370
Belize	371	1	142	(3)
Brazil	20,200	3	7,130	2
Canada	52,000	87	52,400	96
Cayman Islands	1,240	5	1,190	6
China	23,300	34	13,900	39
Costa Rica	9,430	2	7,760	1
Curacao	--	--	6,150	17
Denmark	368	1	190	(3)
Dominican Republic	1,680,000	10	44,300	11
France	33,000	94	1,200	34
Germany	3,720	4	22,500	4
Honduras	300	1	113	(3)
Hong Kong	1,910,000	448	2,320,000	522
India	1,300,000	825	768,000	579
Ireland	10,000	39	895	5
Israel	419,000	365	293,000	756
Italy	1,600	3	3,020	15
Jamaica	179	(3)	440	2
Japan	3,400	9	6,830	3
Lebanon	1,410	2	4,800	5
Malaysia	505	2	255	(3)
Mexico	561,000	84	604,000	97
Netherlands	1,150	9	474	1
Netherlands Antilles (former)	12,700	34	5,860	15
New Zealand	630	2	429	2
Panama	443	(3)	609	2
Qatar	4,370	7	--	--
Russia	460,000	2	639	3
Singapore	8,690	10	6,050	3
South Africa	636	7	510	4
Sweden	145	(3)	2,510	7
Switzerland	147,000	177	190,000	257
Taiwan	9,080	4	497	2
Thailand	92,500	14	168,000	22
United Arab Emirates	193,000	68	131,000	66
United Kingdom	325,000	58	492,000	76
Vietnam	2,610	2	564	(3)
Other	27,500 ^r	7 ^r	12,500	5
Total	7,710,000	2,860	5,450,000	3,070
Reexports:				
Armenia	1,880	(3)	11,000	5
Aruba	3,320	3	2,290	4
Australia	16,300	16	2,980	18
Austria	4,500	(3)	301	3
Belgium	2,410,000	1,600	956,000	2,240
Botswana	370	2	7	(3)
Canada	143,000	144	129,000	150
China	28,700	18	32,900	43
France	47,900	78	6,560	126
Germany	5,820	2	2,230	3
Guatemala	46,000	5	52,600	4
Hong Kong	4,340,000	1,820	2,830,000	2,470
India	2,730,000	1,900	3,510,000	2,940

See footnotes at end of table.

TABLE 6—Continued
 U.S. EXPORTS AND REEXPORTS OF DIAMOND (EXCLUSIVE OF INDUSTRIAL
 DIAMOND), BY COUNTRY¹

Country	2010		2011	
	Quantity (carats)	Value ² (millions)	Quantity (carats)	Value ² (millions)
Israel	4,390,000	\$4,110	2,000,000	\$5,140
Italy	24,900	5	7,270	3
Japan	98,200	32	47,200	34
Laos	4,260	1	4,850	3
Lebanon	7,860	5	3,040	5
Malaysia	2,480	2	376	4
Mexico	5,780	1	2,900	3
Namibia	6,180	10	4,450	11
Netherlands	458,000	304	108,000	365
Netherlands Antilles (former)	16,100	38	4,360	16
Saint Kitts and Nevis	424	1	333	(3)
Singapore	65,500	24	5,080	41
South Africa	29,300	45	8,040	76
Spain	2,600	3	207	(3)
Switzerland	429,000	565	83,500	604
Taiwan	17,900	6	18,000	15
Thailand	160,000	31	178,000	60
United Arab Emirates	338,000	188	511,000	322
United Kingdom	166,000	269	31,500	399
Other	27,300 ^r	10 ^r	17,300	24
Total	16,000,000	11,200	10,600,000	15,100
Grand total	23,700,000	14,100	16,000,000	18,200

^rRevised. -- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Customs value.

³Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY¹

Kind, range, and country of origin	2010		2011	
	Quantity (carats)	Value ² (millions)	Quantity (carats)	Value ² (millions)
Rough or uncut, natural:³				
Angola	67,000	\$132	26,700	\$168
Belgium	114	(4)	2,640	4
Botswana	81,500	68	84,100	159
Brazil	--	--	110	2
Canada	35,300	43	20,100	37
Central African Republic	669	3	394	(4)
Congo (Kinshasa)	6,650	7	6,460	8
India	12,900	1	170,000	2
Israel	10,000	2	1,030	2
Lesotho	488	18	932	40
Namibia	7,450	9	3,820	4
Russia	37,500	8	118,000	18
Sierra Leone	4,100	4	3,180	10
South Africa	102,000	223	199,000	173
Other	22,700 ^r	27 ^r	68,200	3
Total	389,000	524^r	704,000	630
Cut but unset, not more than 0.5 carat:				
Australia	5,690	3	4,110	4
Belgium	281,000	106	277,000	102
Botswana	8,240	13	6,890	18
Brazil	238	(4)	4,470	1
Canada	13,000	9	23,600	8
China	37,500	21	34,300	31
Dominican Republic	7,250	2	3,430	1
Hong Kong	180,000	25	197,000	30
India	7,310,000	1,560	6,990,000	1,850
Israel	433,000	207	414,000	236
Mauritius	5,780	15	6,220	17
Mexico	92,300	21	76,300	21
Namibia	3,220	7	2,060	5
Russia	2,470	2	585	1
South Africa	9,440	13	4,910	7
Sri Lanka	1,020	(4)	2,980	1
Switzerland	807	(4)	40,600	2
Thailand	93,400	14	93,000	13
United Arab Emirates	77,100	17	112,000	42
United Kingdom	2,790	1	24,700	4
Vietnam	27,100	21	30,400	29
Other	12,400 ^r	2 ^r	11,600	3
Total	8,610,000	2,060	8,360,000	2,430
Cut but unset, more than 0.5 carat:				
Armenia	430	(4)	3,170	3
Australia	6,600	37	4,710	41
Belgium	706,000	2,900	733,000	3,550
Botswana	12,500	54	11,200	63
Brazil	424	4	294	7
Canada	23,300	83	16,200	67
Central African Republic	4	(4)	35	2
China	19,300	60	35,000	102
Costa Rica	31	1	5	(4)
France	1,650	26	1,240	23
Germany	662	8	3,050	13
Hong Kong	42,200	102	48,500	107
India	1,900,000	3,610	1,970,000	4,410
Indonesia	44	3	41	1
Israel	2,000,000	7,530	1,970,000	8,950
Italy	5,260	16	3,320	11
Japan	595	2	1,380	2
Lebanon	1,150	2	1,470	3

See footnotes at end of table.

TABLE 7—Continued
 U.S. IMPORTS FOR CONSUMPTION OF DIAMOND, BY KIND, WEIGHT, AND COUNTRY¹

Kind, range, and country of origin	2010		2011	
	Quantity (carats)	Value ² (millions)	Quantity (carats)	Value ² (millions)
Lesotho	--	--	136	\$28
Madagascar	55	\$1	--	--
Mauritius	3,220	18	2,720	16
Mexico	1,250	1	465	2
Namibia	9,620	35	16,800	89
Netherlands	244	3	284	5
Philippines	868	1	145	1
Russia	25,300	98	17,100	100
Singapore	1,710	2	245	1
South Africa	63,000	892	42,700	900
Sri Lanka	1,130	8	3,920	4
Switzerland	11,300	391	18,900	541
Tanzania	66	1	--	--
Thailand	5,910	13	11,200	26
United Arab Emirates	10,100	42	38,400	100
United Kingdom	3,550	53	3,880	85
Vietnam	3,410	4	1,920	2
Other	1,260 [†]	137 [†]	1,750	7
Total	4,860,000	16,000	4,970,000	19,300

[†]Revised. -- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Customs value.

³Includes some natural advanced diamond.

⁴Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES, OTHER THAN
DIAMOND, BY KIND AND COUNTRY¹

Kind and country	2010		2011	
	Quantity (carats)	Value ² (millions)	Quantity (carats)	Value ² (millions)
Emerald:				
Belgium	1,340	(3)	737	\$1
Brazil	120,000	\$7	186,000	9
Canada	4	(3)	1,390	--
China	13,800	1	34,100	--
Colombia	406,000	131	365,000	161
France	1,480	2	152	2
Germany	54,000	2	9,940	3
Hong Kong	246,000	17	118,000	11
India	1,810,000	37	1,400,000	57
Israel	172,000	17	138,000	15
Italy	2,880	(3)	9,050	6
Switzerland	6,290	13	71,900	61
Thailand	487,000	10	374,000	11
United Kingdom	1,550	2	760	1
Other	89,400	15	43,400	10
Total	3,410,000	254	2,760,000	348
Ruby:				
Belgium	16	(3)	41	(3)
China	19,200	(3)	730	(3)
France	1,730	(3)	15	1
Germany	10,900	(3)	14,000	(3)
Hong Kong	201,000	1	137,000	4
India	2,310,000	6	2,020,000	4
Israel	22,300	(3)	4,570	(3)
Italy	4,300	(3)	9,910	1
Kenya	1,810	(3)	1,050	(3)
Sri Lanka	3,800	(3)	633	(3)
Switzerland	129	2	55,900	4
Thailand	1,880,000	22	1,640,000	23
United Arab Emirates	210	(3)	--	--
Other	168,000	11 ^r	45,100	7
Total	4,630,000	42	3,920,000	45
Sapphire:				
Belgium	2,420	1	1,720	2
China	56,700	3	163,000	5
France	1,160	2	2,460	2
Germany	123,000	4	32,200	11
Hong Kong	536,000	9	237,000	15
India	2,570,000	20	2,970,000	18
Israel	19,300	2	13,000	3
Italy	5,440	1	93,200	6
Madagascar	2,940	4	31,700	3
South Africa	33,700	1	3,680	1
Sri Lanka	309,000	66	256,000	77
Switzerland	13,700	20	91,800	26
Thailand	2,630,000	78	3,050,000	109
United Kingdom	610	1	1,040	3
Other	11,900 ^r	2 ^r	40,500	1
Total	6,320,000	214	6,980,000	282
Other:				
Rough, uncut, all countries	NA	15	NA	23
Cut, set and unset, all countries	NA	32	NA	37

^r Revised. NA Not available. -- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Customs value.

³Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 9
VALUE OF U.S. IMPORTS OF LABORATORY-CREATED
AND IMITATION GEMSTONES, BY COUNTRY^{1,2}

(Thousand dollars)

Country	2010	2011
Laboratory-created, cut but unset:		
Austria	1,950	2,340
Belgium	1,320	882
China	5,700	4,770
Germany	10,100	9,970
India	9,870	11,900
Malaysia	(3)	3,120
Other	3,350 ^r	3,710
Total	32,300	36,700
Imitation:⁴		
Austria	51,400	48,300
China	13,300	19,500
Czech Republic	5,070	5,540
Other	1,920 ^r	2,010
Total	71,700	75,400

^rRevised.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Customs value.

³Less than ½ unit.

⁴Includes pearls.

Source: U.S. Census Bureau.

TABLE 10
U.S. IMPORTS FOR CONSUMPTION OF GEMSTONES¹

(Thousand carats and thousand dollars)

Stones	2010		2011	
	Quantity	Value ²	Quantity	Value ²
Coral and similar materials, unworked	5,760	12,000	5,370	11,800
Diamonds:				
Cut but unset	13,500	18,100,000	13,300	21,700,000
Rough or uncut	389	524,000	704	630,000
Emeralds, cut but unset	3,140	254,000	2,760	348,000
Pearls:				
Cultured	NA	15,800	NA	27,300
Imitation	NA	5,100	NA	5,930
Natural	NA	22,900	NA	18,600
Rubies and sapphires, cut but unset	10,900	256,000	10,900	328,000
Other precious and semiprecious stones:				
Rough, uncut	1,400,000	30,700	1,670,000	15,000
Cut, set and unset	NA	276,000	NA	301,000
Other	78,100	11,300	33,600	7,240
Laboratory-created:				
Cut but unset	6,800	32,300	6,230	36,700
Other	NA	14,600	NA	22,800
Imitation gemstone ³	NA	66,600	NA	69,400
Total	1,520,000	19,600,000	1,740,000	23,500,000

NA Not available.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Customs value.

³Does not include pearls.

Source: U.S. Census Bureau.

TABLE 11
NATURAL DIAMOND: WORLD PRODUCTION, BY COUNTRY AND TYPE^{1,2,3}

(Thousand carats)

Country and type ⁴	2007	2008	2009	2010	2011
Gemstones:					
Angola	8,732	8,016	12,445	7,600 ^r	8,100
Armenia	123	101	50	50 ^e	80
Australia	231	273	220 ^e	100 ^e	86
Botswana ^e	25,000	25,000	24,000	25,000	25,000
Brazil	182 ^e	71 ^r	21 ^r	25 ^r	25 ^p
Canada	17,144	14,803	10,946	11,773	10,795
Central African Republic ^e	370	302 ⁵	249 ⁵	240 ^r	250
China ^e	100	100	100	100	100
Congo (Kinshasa)	5,700	4,200	3,700	3,400 ^r	3,900
Ghana	671	478	301	267 ^r	300 ^e
Guinea	815	2,500	557	280 ^r	300 ^e
Guyana	269	169 ^r	144	50 ^e	50
Lesotho ^e	454 ⁵	450	450	460	450
Namibia	2,266	2,435	1,192	1,693 ^r	1,700 ^e
Russia ^e	23,300	21,925 ⁵	17,791 ⁵	17,800	18,500
Sierra Leone	362	223	241	306 ^r	280 ^e
South Africa ^e	6,100	5,200	2,500	3,500	2,800
Tanzania ^e	239	202	155	77	51
Venezuela ^e	45	45	45	45	45
Zimbabwe ^e	100	100	100	900 ^r	1,000
Other ⁶	75	121	79	221 ^r	221
Total	92,300	86,700^r	75,300^r	73,900^r	74,000
Industrial:					
Angola ^e	970	900	1,383 ⁵	900 ^r	900
Australia	18,960	15,397	10,700	9,900 ^e	7,500 ^e
Botswana ^e	8,000	8,000	7,000	7,000	7,000
Brazil ^e	600	600	600	600	600
Central African Republic ^e	93	74 ⁵	62 ⁵	62 ^r	62
China ^e	970	1,000	1,000	1,000	1,000
Congo (Kinshasa)	22,600	16,700	14,600	13,400 ^r	15,600
Ghana	168	120	75	67 ^r	67 ^e
Guinea	200	600	139	94 ^r	95 ^e
Russia ^e	15,000	15,000	15,000	15,000	15,000
Sierra Leone	241	149	160	131 ^r	120 ^e
South Africa ^e	9,100	7,700	3,600	5,400	4,200
Tanzania ^e	44	36	27	14	9
Venezuela ^e	70	70	70	70	70
Zimbabwe ^e	600	700	850	7,500	8,000
Other ⁷	84	145	115	285 ^r	285
Total	77,700	67,200	55,400	61,400^r	60,500
Grand total	170,000	154,000	131,000	135,000^r	135,000

^eEstimated. ^pPreliminary. ^rRevised.

¹World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Table includes data available through June 2, 2012.

³In addition to the countries listed, Nigeria and the Republic of Korea produce natural diamond, but information is inadequate to formulate reliable estimates of output levels.

⁴Includes near-gem and cheap-gem qualities.

⁵Reported figure.

⁶Includes Cameroon, Congo (Brazzaville), Gabon (unspecified), India, Indonesia, Liberia, and Togo (unspecified).

⁷Includes Congo (Brazzaville), India, Indonesia, and Liberia.