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# 2012 Minerals Yearbook

## BERYLLIUM

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# Beryllium

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On the basis of estimated beryllium content, U.S. mine shipments of beryllium ore in 2012 decreased by 4% from those of 2011, and ore consumption for the production of beryllium hydroxide decreased by 12% (table 1). The Defense Logistics Agency—Strategic Materials, U.S. Department of Defense (DOD) offered and sold selected beryllium materials from the National Defense Stockpile (NDS). On the basis of estimated beryllium content, total U.S. imports and exports of beryllium materials in 2012 were greater than those of 2011 (table 3).

Beryl, a principal mineral of beryllium, produced outside of the United States is commonly stockpiled for later processing, and sales or exports may not accurately reflect current production. China is thought to be a significant producer, but does not report its beryl production. As a result, world production and the U.S. share of world production have a high degree of uncertainty. In 2012, estimated world beryllium ore production decreased by 6% compared with that of 2011 (table 4). The United States accounted for about 91% of estimated world production.

Beryllium is gray in color and one of the lightest metals. Its physical and mechanical properties—outstanding stiffness-to-weight and strength-to-weight ratios, one of the highest melting points of all light metals, high specific heat, excellent thermal conductivity, outstanding dimensional stability over a wide range of temperatures, high reflectivity, the lowest neutron absorption cross section of any metal and a high neutron-scattering cross section, and transparency to x rays—make it useful for many applications. Beryllium is used primarily in beryllium-copper alloys, beryllium oxide ceramics, and as beryllium metal in a wide variety of products such as bearings and bushings, computer chip heat sinks, contacts and connectors, disc brakes, highly conductive and strong wire, mirrors, protective housings, switches and relays, and x-ray windows. Industries that use beryllium products include aerospace, automotive, computer, defense, electronics, energy, marine, medical, nuclear, and telecommunications.

High-purity beryllium was designated both a strategic and a critical material by the U.S. Department of Defense Strategic Materials Protection Board. The Board found that domestic beryllium production capabilities had abated and required the DOD to continue to take special actions to maintain a long-term domestic supply (U.S. Department of Defense, Office of the Secretary, 2009).

Only two beryllium minerals are of commercial importance for the production of beryllium. Bertrandite, which contains about 15% beryllium, is the principal beryllium mineral mined in the United States. Bertrandite ore, however, contains less than 1% beryllium. Beryl, which contains about 4% beryllium, is the principal mineral mined in the rest of the world. Aquamarine, bixbite, emerald, goshenite, heliodor, and morganite are gem forms of the mineral beryl. More information on gem-quality beryl and chrysoberyl can be found in the Gemstones chapter of the U.S. Geological Survey (USGS) Minerals Yearbook, volume I, Metals and Minerals.

## Legislation and Government Programs

***Defense Production Act.***—In an effort to ensure current and future availability of high-quality domestic beryllium to meet critical defense needs, the DOD, under the Defense Production Act, Title III, invested in a public-private partnership with Materion Corp. to build a $90.4 million primary beryllium facility in Elmore, OH. Approximately two-thirds of the facility's output was to be allocated for defense and Government-related end uses, the remaining output was to go to the private sector. Plant production capacity was designed to be 73 metric tons per year (t/yr) of high-purity beryllium metal. The facility was placed in service during 2012, but did not produce at planned capacity on a consistent basis, although output levels improved by yearend (Materion Corp., 2013a, p. 31).

***National Defense Stockpile.***—The United States maintained a stockpile of strategic materials. As of December 31, 2012, the NDS goal for hot-pressed beryllium metal powder was 45 metric tons (t) (table 2). The Annual Materials Plan for fiscal year 2012, which represented the maximum quantities of beryllium materials that could be sold from October 1, 2011, through September 30, 2012, was unchanged from that of fiscal year 2011 (table 2). NDS calendar yearend inventories of beryllium materials are listed in table 2 (U.S. Department of Defense, 2013, p. 7).

## Production

Domestic production and consumption statistics for beryllium-containing ores, as listed in tables 1 and 4, were based on data collected by the USGS by means of two voluntary surveys of U.S. operations. A small number of unidentified producers may have shipped negligible quantities of byproduct beryl, but these have not been included. In 2012, domestic mine shipments were less than those of 2011.

The United States is one of only three countries known to process beryllium ores and concentrates into beryllium products. Materion converted bertrandite from open pit mines in the Topaz-Spor Mountain region of Juab County, UT, into beryllium hydroxide at its operations near Delta, UT. Some of the beryllium hydroxide was shipped to Elmore, where Materion converted it into beryllium-copper master alloy (BCMA), metal, or oxide, and some was sold to NGK Insulators, Ltd. of Japan. Ninety to ninety-five percent of Materion's beryllium hydroxide was produced from bertrandite, while the remainder

was produced from imported beryl. Very high purity beryllium is made exclusively from beryl, as beryl typically has fewer impurities than bertrandite (Stephen Freeman, President, International Business Development, Materion Corp., oral commun., January 10, 2013).

### Environment

Because of the toxic nature of beryllium, various international, national, and State guidelines and regulations have been established to determine and monitor allowable beryllium content in air, water, and other media. Industry regulations require control of the quantity of beryllium dust, fumes, and mists in the workplace. Controlling workplace exposure and effluent discharge adds to the final cost of beryllium products (Rossman and others, 1991, p. 277–281; Smith and others, 2002, p. 11–15, 193–200).

### Consumption

U.S. apparent consumption of all beryllium materials in 2012, as calculated from mine shipments, net trade, and changes in Government and industry stocks, was estimated to be about 265 t of contained beryllium, which was a decrease of 20% from that of 2011. The decrease in apparent consumption was a reflection of decreased shipments of bertrandite by Materion, decreased shipments of beryllium metal from the NDS, and increased exports of beryllium metal.

Since the closure of its previous primary beryllium production facility in Elmore in 2000, Materion has sourced its beryllium metal from the NDS and foreign producers. In 2012, Materion's new primary beryllium facility provided a limited amount of beryllium metal. Materion's Beryllium and Beryllium Composites unit manufactured beryllium metal products and two families of metal-matrix composites—one made from aluminum and beryllium, and the other made from beryllium and beryllium oxide (BeO or beryllia). The products, in the form of foil, rods, sheets, tubes, and a variety of customized shapes, were produced at plants in Elmore and Fremont, CA. Beryllium product sales decreased slightly compared with those of 2011. Defense and science applications, which accounted for 52% of the Beryllium and Beryllium Composites sales, decreased by 6% compared with those of 2011 owing to government funding delays and budget cuts. Industrial component and commercial aerospace applications, which accounted for 26% of Beryllium and Beryllium Composites sales, decreased slightly, reportedly owing to a weak capital equipment market. Sales for energy applications were unchanged in 2012 compared with those of 2011 (Materion Corp., 2013a, p. 30–31; Stephen Freeman, President, International Business Development, Materion Corp., oral commun., January 10, 2013).

Materion's Beryllium and Beryllium Composites unit produced BeO ceramic products for aerospace, defense, electronics, medical, semiconductor, telecommunications, and wireless applications at its plant in Tucson, AZ. Medical applications, which accounted for 8% of the Beryllium and Beryllium Composites unit sales, decreased by 17% compared with those of 2011 owing to lower shipments of beryllia ceramics for medical laser applications. Beryllia ceramic sales for applications within the telecommunications infrastructure market, which accounted for 7% of sales, decreased by 7% compared with those of 2011 (Materion Corp., 2013a, p. 31; Stephen Freeman, President, International Business Development, Materion Corp., oral commun., January 10, 2013).

Materion's Performance Alloys unit produced copper- and nickel-base alloy products, the majority of which contained beryllium. Alloy strip products (which were used as connectors, contacts, relays, shielding, and switches) and alloy bulk products (including bar, plate, rod, tube, and customized forms) were produced at plants in Elmore and in Shoemakersville, PA. In 2012, industrial component and commercial aerospace applications accounted for 32% of the Performance Alloys unit sales; consumer electronics applications, 20%; automotive electronics applications, 14%; energy applications, 12%; telecommunications infrastructure applications, 12%; appliance applications, 8%; and defense and medical applications, 2%. The total shipment volume of alloy strip products decreased 18% compared with that of 2011, owing mainly to decreased demand from the appliance and consumer electronics markets, slightly offset by increased demand from the automotive electronics market. The total shipment volume of bulk alloy products decreased slightly compared with that of 2011, owing to decreased demand from the oil and gas sector of the energy market, offset, however, by increased demand from the industrial component and commercial aerospace market. The industrial component and commercial aerospace market was reported to be the leading growth market for the Performance Alloys unit (Materion Corp., 2013a, p. 29; Stephen Freeman, President, International Business Development, Materion Corp., oral commun., January 10, 2013).

Materion had a long-term supply arrangement with JSC Ulba Metallurgical Plant (UMP), part of Kazakhstan's National Atomic Company Kazatomprom JSC to purchase a total of 352 t of BCMA from 2010 through 2013. In 2012, Materion purchased beryllium-containing materials valued at $5.2 million (Materion Corp., 2013a, p. 73).

IBC Advanced Alloys Corp. (Vancouver, British Columbia, Canada) manufactured beryllium-copper and beryllium-aluminum alloys at plants located in Franklin, IN, New Madrid, MO, Royersford, PA, and Wilmington, MA. UMP had multi-year agreements to supply IBC with beryllium metal and BCMA. They also agreed to explore mutually beneficial strategic partnerships and to assess the feasibility of a Kazakhstan-based high-volume BeO production facility to support IBC's beryllium-enhanced nuclear fuel initiative (IBC Advanced Alloys Corp., 2013, p. 2–5).

Other domestic producers of beryllium alloy products included NGK Metals Corp. (a subsidiary of NGK Insulators, Ltd.), Sweetwater, TN, and GBC Metals, LLC (doing business as Olin Brass), East Alton, IL. American Beryllia Inc. produced beryllium oxide ceramic products at its plant in Haskell, NJ.

### Recycling

Beryllium was recycled from new scrap generated during the manufacture of beryllium-containing components, as well as from old scrap collected from end users. Detailed data

on the quantities of recycled beryllium are not available but may represent as much as 20% to 25% of U.S. consumption. Beryllium products manufactured by Materion from recycled metal require only 20% of the energy as that of beryllium products manufactured from primary material. Materion, therefore, has established a comprehensive recycling program for its beryllium products and indicated a 40% recovery rate of beryllium new and old scrap (Stephen Freeman, President, International Business Development, Materion Corp., oral commun., August 2, 2012).

## Foreign Trade

U.S. foreign trade in beryllium materials, as reported by the U.S. Census Bureau, is summarized in table 3. On the basis of estimated contained beryllium, total beryllium imports increased by 8% compared with those of 2011. The leading suppliers of beryllium materials to the United States were Japan and Kazakhstan. On the basis of estimated contained beryllium, beryllium exports increased by 159% compared with those of 2011. Canada, China, and India were the major recipients of these materials. The U.S. Census Bureau, however, only reports exported beryllium metal and not exported BCMA and beryllium oxide and hydroxide. BCMA typically comprises about 85% of domestic beryllium exports, while beryllium metal typically comprises less than 15% of exports (Stephen Freeman, President, International Business Development, Materion Corp., oral commun., January 10, 2013).

Net import reliance as a percentage of apparent consumption is one measure of the adequacy of current domestic beryllium production to meet U.S. demand. Net import reliance is defined as imports minus exports plus adjustments for Government and industry stock changes. Included among stock changes are acquisitions or shipments from the NDS, regardless of whether the materials were imported or produced in the United States. For 2012, net import reliance as a percentage of apparent consumption was estimated to be about 15%, a decrease from about 29% in 2011.

## World Review

***China.***—In 2012, China produced an estimated 65 t to 70 t of contained beryllium. Approximately 20 t to 25 t of the contained beryllium was sourced from domestic ore and 45 t was obtained from foreign sources. China imported approximately 40 t of contained beryllium from Kazakhstan's UMP in 2012, and was thought to be UMP's largest customer (Stephen Freeman, President, International Business Development, Materion Corp., oral commun., January 10, 2013).

***Kazakhstan.***—UMP reported producing 109 t of contained beryllium, a slight increase from the 107 t produced in 2011. Production was reportedly from stockpiled beryllium concentrate imported mainly from Russia, which had accumulated before the breakup of the Soviet Union. In July, UMP increased the prices of its beryllium products by 8% to 12% (JSC Ulba Metallurgical Plant, 2012; Kazatomprom JSC, 2013, p. 24).

In 2012, Kazatomprom, which established a joint venture with Toshiba Corp. (Tokyo, Japan) in 2011 for the research, exploration, production, and sale of rare metals, including beryllium, was awarded a contract to supply beryllium blocks for a proton accelerator research complex by Japan's Atomic Energy Agency. Previously, as part of Japan's efforts to reduce its dependence on crude oil imports, Toshiba had reached an agreement with Kazatomprom to secure supplies of rare metals and reactor components for Toshiba's nuclear power business. That agreement expanded on an existing agreement under which Kazatomprom supplied uranium for Toshiba-built nuclear plants (Soble and Gorst, 2008; Kazatomprom JSC, 2013, p. 24).

***Russia.***—East Siberian Metals Corp. (a subsidiary of Metropol Group) and UMP completed the predesign phase for resuming mining at the Yermakovsky beryllium deposit in the Siberian Republic of Buryatia and the technical design of the processing plant. The new plant would produce beryllium hydroxide, which was expected to be exported to China, Japan, and Kazakhstan for processing into beryllium metal and beryllium alloys. Financing of the project was to be shared by Metropol and Russia's state-owned corporation Rusnano. Yermakovsky was thought to be the largest known beryllium deposit in Russia. Metropol projected annual mining and processing capacity of 25,000 t/yr of ore and beryllium hydroxide production capacity of 130 t/yr. Construction of the complex was to commence in 2013 and the plant was expected to reach its projected annual capacity by 2017 (MBC Corp., 2009, 2011).

## Outlook

The United States is expected to remain self-sufficient with respect to most of its beryllium requirements. At yearend 2012, Materion reported proven bertrandite reserves in Juab County, UT, of 5.67 million dry metric tons having an average grade of 0.264% beryllium and containing about 15,000 t of contained beryllium. Materion owned approximately 95% of its proven mineral reserves and leased the remainder (Materion Corp., 2013a, p. 41).

It was expected that the 2013 sales of beryllium-copper strip products and beryllium bulk products would increase slightly from those of 2012 owing to increased demand from the automotive electronics, consumer electronics, and energy markets. Sales for appliance, industrial components, and telecommunications infrastructure markets, however, were expected to decrease slightly from those of 2012. Slightly decreased shipments of beryllium-based metals and metal matrix composites to defense and nuclear science applications were anticipated owing to government funding delays (Materion Corp., 2013b).

Research and consulting firm Global Industry Analysts, Inc. predicted that purchases from the worldwide beryllium market would increase to 506 t of contained beryllium by 2017 owing to sustained consumption from the computer and telecommunications infrastructure markets and increasing use by the automotive electronics market. Rapidly increasing beryllium consumption by developing markets in Asia and Latin America was also expected (Global Industry Analysts, Inc., 2012).

Materion forecast that the overall beryllium market would increase between 3% and 6% per year, and anticipated

BCMA growth to be higher, at approximately 10% per year. The company, consequently, began to expand its BCMA production capacity. The physical size of many beryllium-containing components, however, has decreased over time owing to improvements in technology. Therefore, despite the continued growth of beryllium applications, growth in beryllium consumption may lag behind the growth in application demand (Stephen Freeman, President, International Business Development, Materion Corp., oral commun., January 10, 2013).

### References Cited


Global Industry Analysts, Inc., 2012, Global beryllium market to reach 505.6 metric tons by 2017, according to new report by Global Industry Analysts, Inc.: San Jose, CA, Global Industry Analysts, Inc. press release, March 5. (Accessed March 5, 2012, at http://www.strategyr.com/pressMCP-2629.asp.)

IBC Advanced Alloys Corp., 2013, Management's discussion and analysis—Six months ended December 31, 2012: Vancouver, British Columbia, Canada, IBC Advanced Alloys Corp., February 26, 17 p. (Accessed March 15, 2013, at http://www.ibcadvancedalloys.com/clientuploads/Financial_Statement_PDFs/IBC_MDA_2012-12vFINAL.pdf.)

JSC Ulba Metallurgical Plant, 2012, Since June 30, 2012 ULBA raises prices for all beryllium-containing products: Ust-Kamenogorsk, Kazakhstan, Ulba Metallurgical Plant JSC press release, May 3. (Accessed July 6, 2012, at http://www.ulba.kz/en/news.htm?id=000014.)

Kazatomprom JSC, 2013, Annual report—2012: Almaty, Kazakhstan, Kazatomprom JSC, 180 p.

Materion Corp., 2013a, Annual report—2012: Mayfield Heights, OH, Materion Corp., 119 p.

Materion Corp., 2013b, Materion Corporation reports third quarter financial results: Mayfield Heights, OH, Materion Corp. press release, October 24. (Accessed October 26, 2013, at http://investor.shareholder.com/materion/releasedetail.cfm?ReleaseID=799732.)

MBC Corp., 2009, Yermakovsky Mining and Smelting Company: Moscow, Russia, MBC Corp. (Accessed December 20, 2012, at http://www.mbc-corp.com/eng/activity/gorsector/ermak/index.wbp.)

MBC Corp., 2011, A plant for beryllium ore hydrometallurgical concentrating is to be built in Buryatia: Moscow, Russia, MBC Corp. press release, August 12. (Accessed October 2, 2011, at http://www.mbc-corp.com/eng/presscenter/news/article.wbp?article_id=b86ebe1c-d684-4b90-9ea4-634570938ad2.)

Rossman, M.D., Preuss, O.P., and Powers, M.B., 1991, Beryllium—Biomedical and environmental aspects: Baltimore, MD, Williams & Wilkins, 319 p.

Smith, Cassandra, Ingerman, Lisa, and Amata, Richard, 2002, Toxicological profile for beryllium: Agency for Toxic Substances and Disease Registry, 247 p. (Accessed May 24, 2007, at http://www.atsdr.cdc.gov/toxprofiles/tp4.pdf.)

Soble, Jonathan, and Gorst, Isabel, 2008, Toshiba agrees to metals deal with Kazatomprom: The Financial Times Ltd., June 23, 1 p. (Accessed February 10, 2009, via http://www.ft.com/home/us/.)

U.S. Department of Defense, Office of the Secretary, 2009, Initial analysis of national security issues associated with strategic materials: Federal Register, v. 74, no. 34, February 23, p. 8061–8064.

U.S. Department of Defense, 2013, Strategic and critical materials operations report to Congress—Operations under the Strategic and Critical Materials Stockpiling Act during fiscal year 2012: Washington, DC, U.S. Department of Defense, February, 69 p.


## GENERAL SOURCES OF INFORMATION

### U.S. Geological Survey Publications

Beryllium. Ch. in Mineral Commodity Summaries, annual.

Beryllium. Ch. in United States Mineral Resources, Professional Paper 820, 1973.

Beryllium (Be). Ch. in Metal Prices in the United States Through 2010, Scientific Investigations Report 2012–5188, 2013.

Beryllium Recycling in the United States in 2000. Circular 1196–P, 2004.

Historical Statistics for Mineral and Material Commodities in the United States. Data Series 140.

### Other

Beryllium. Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.

Defense National Stockpile Center reports and news releases.

Roskill Information Services Ltd.

Strategic and Critical Materials Operations Report to Congress, U.S. Department of Defense.

TABLE 1
SALIENT BERYLLIUM MINERAL STATISTICS

(Metric tons of beryllium content)

| | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|
| United States, beryllium-containing ores: | | | | | |
| Mine shipments[1] | 175 | 120 | 180 | 235 | 225 |
| Imports for consumption, beryl[2] | -- | 1 | 5 | 6 | 12 |
| Consumption, reported[3] | 220 | 150 | 200 | 250 | 220 |
| Stocks, December 31: | | | | | |
| Industry[1] | 60 | 30 | 15 | 10 | 15 |
| U.S. Government, beryl[2, 4] | (5) | (5) | (5) | (5) | (5) |
| World, production[e, 2] | 197 | 144 | 204 | 262 [r] | 246 |

[e]Estimated. [r]Revised. -- Zero.
[1]Data are rounded to the nearest 5 metric tons.
[2]Based on a beryllium content of 4%.
[3]Data are rounded to the nearest 10 metric tons.
[4]Defense Logistics Agency, DLA Strategic Materials. Data are uncommitted beryl.
[5]Less than ½ unit.

TABLE 2
U.S. GOVERNMENT NATIONAL DEFENSE STOCKPILE BERYLLIUM STATISTICS IN 2012[1]

(Metric tons of beryllium content)

| Material | Stockpile goal[2] | Disposal authority[3] | Annual Materials Plan[4] | Uncommitted inventory, December 31 |
|---|---|---|---|---|
| Beryl ore | -- | (5) | -- | (5) |
| Beryllium metal: | | | | |
| Hot-pressed powder | 45 | 38 | -- | 83 [6] |
| Vacuum-cast | -- | 6 | 47 | 6 |
| Total | 45 | 44 | 47 | 89 |
| Grand total | 45 | 44 | 47 | 89 |

-- Zero.
[1]Data were converted from gross weights reported in short tons; may not add to totals shown.
[2]Goal effective as of December 28, 2001.
[3]Total quantity of material that can be disposed.
[4]Maximum quantity of material that can be disposed during 12-month period ending September 30, 2012.
[5]Less than ½ unit.
[6]Held for goal.

Source: Defense Logistics Agency, DLA Strategic Materials.

TABLE 3
U.S. FOREIGN TRADE OF BERYLLIUM MATERIALS, BY TYPE[1]

| Type and material | 2011 Gross weight (kilograms) | 2011 Content[2] (kilograms) | 2011 Value (thousands) | 2012 Gross weight (kilograms) | 2012 Content[2] (kilograms) | 2012 Value (thousands) | Principal destinations or sources, 2012[3] |
|---|---|---|---|---|---|---|---|
| Exports: | | | | | | | |
| Beryllium, unwrought[4] | 2,880 | 2,880 | $116 | 23,300 | 23,300 | $1,030 | China, 73%; Germany, 9%; France, 6%. |
| Beryllium waste and scrap | 2,200 | 2,200 | 184 | 9,990 | 9,990 | 1,520 | India, 94%; Germany, 3%. |
| Beryllium, other[5] | 16,100 | 16,100 | 14,600 | 21,600 | 21,600 | 20,300 | Canada, 53%; Singapore, 8%; France, 7%; United Kingdom, 7%. |
| Total | 21,200 | 21,200 | 14,900 | 55,000 | 55,000 | 22,800 | China, 31%; Canada, 21%; India, 17%; Germany, 6%; France, 5%. |
| Imports for consumption: | | | | | | | |
| Beryllium ores and concentrates | 142,000 | 5,680 | 180 | 301,000 | 12,000 | 584 | Nigeria, 74%; Brazil, 26%. |
| Beryllium oxide and hydroxide | 531 | 191 | 9 | 49,600 | 17,900 | 549 | China, 100%. |
| Beryllium, unwrought[4] | -- | -- | -- | 2,660 | 2,660 | 539 | Kazakhstan, 97%; Canada, 3%. |
| Beryllium waste and scrap | 13,200 | 13,200 | 245 | 11,200 | 11,200 | 343 | United Kingdom, 46%; Canada, 43%; France, 8%. |
| Beryllium, other[5] | 33,600 | 33,600 | 4,490 | 28,100 | 28,100 | 2,640 | Kazakhstan, 84%; Ukraine, 8%; Canada, 6%. |
| Beryllium-copper master alloy | 792,000 | 31,700 | 14,200 | 485,000 | 19,400 | 8,740 | Kazakhstan, 80%; Germany, 16%. |
| Beryllium-copper plates, sheets, and strip | 511,000 | 7,660 | 7,010 | 558,000 | 8,370 | 9,570 | Japan, 100%. |
| Total | 1,490,000 | 92,000 | 26,100 | 1,440,000 | 99,700 | 23,000 | Japan, 39%; Kazakhstan, 29%; Nigeria, 15%. |

-- Zero.

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

[2]Estimated from gross weights.

[3]Principal destination or source percentages based on beryllium content data.

[4]Includes powders.

[5]Includes articles not elsewhere specified.

Source: U.S. Census Bureau.

TABLE 4
BERYL: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Metric tons of gross weight)

| Country[3] | 2008 | 2009 | 2010 | 2011 | 2012[e] |
|---|---|---|---|---|---|
| China[e] | 500 | 500 | 550 | 550 | 500 |
| Madagascar[e, 4] | 12 | 12 | 12 | 12 | 16 |
| Mozambique | 8 | 45 | 57 | 58 [r] | 58 |
| Portugal[e] | 5 | 5 | 5 | 5 | 5 |
| United States, mine shipments[5] | 4,410 | 3,030 | 4,460 | 5,920 | 5,570 [6] |
| Total | 4,940 | 3,590 | 5,090 | 6,540 [r] | 6,150 |

[e]Estimated. [r]Revised.

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

[2]Includes data available through December 13, 2013. Unless otherwise noted, figures represent beryl ore for the production of beryllium and exclude gem-quality beryl.

[3]In addition to the countries listed, Brazil, Kazakhstan, Nigeria, and Russia may also have produced beryl ore, but information is inadequate to make reliable estimates of production. Other nations that produced gemstone beryl ore may also have produced some industrial beryl ore.

[4]Includes ornamental and industrial products.

[5]Includes bertrandite ore, calculated as equivalent to beryl containing 11% beryllium oxide.

[6]Reported figure.