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2016 Minerals Yearbook

BERYLLIUM [ADVANCE RELEASE]

U.S. Department of the Interior
U.S. Geological Survey

September 2018

Beryllium

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On the basis of estimated beryllium content, U.S. mine shipments of beryllium ore in 2016 decreased by 24% to 155 metric tons (t) from 205 t in 2015, and reported consumption of ore for the production of beryllium hydroxide decreased by 27% (table 1). U.S. shipments and consumption of beryllium ore decreased to their lowest amount since 2009 (fig. 1). On the basis of estimated beryllium content, imports and exports of beryllium materials increased by about 3% and 19%, respectively, in 2016 from those of 2015 (table 3).

In 2016, estimated world beryllium ore production decreased by 18% compared with that of 2015 (table 4). The United States accounted for about 70% of estimated world production and China accounted for about 22%. Beryl, a principal mineral of beryllium mined outside of the United States, is commonly stockpiled for later processing, and sales or exports may not accurately reflect current production. As a result, world production and the U.S. share of world production have a high degree of uncertainty.

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, high melting point relative to other light metals, high specific heat, excellent thermal conductivity, outstanding dimensional stability over a wide range of temperatures, high reflectivity, lowest neutron absorption cross section of any metal and 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 high-strength 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.

The leading use for beryllium, accounting for about 75% of total world consumption, was in copper-base alloys containing from 0.2% to 2.0% beryllium. Beryllium enhances the strength, stiffness, and hardness of copper alloys while retaining relatively good ductility, machinability, and electrical and thermal conductivity. Beryllium-copper alloys are predominantly formed into strip products used as electrical connectors, contacts, relays, shielding, and switches, and as bulk products in the form of bars, plates, rods, and tubes. The second leading use of beryllium, consuming 20% of total world production, was as 99.5%-pure or greater beryllium metal and beryllium-base alloys containing greater than 60% beryllium (primarily alloyed with aluminum). Beryllium metal and alloys are typically used to produce components for high-technology equipment where low weight, low thermal distortion, and good machinability are critical factors. Beryllium oxide ceramics, which accounted for the remaining 5% of beryllium consumption, were used where electrical insulation and heat extraction are essential, such as automotive electrical systems and heat sinks for radar and radio-frequency equipment (Trueman and Sabey, 2014, p. 101–103).

Only two beryllium minerals are of commercial importance for the production of beryllium. Bertrandite, which can contain about 15% beryllium, is the principal beryllium mineral mined in the United States; however, bertrandite ore mined in the United States contained about 0.25% beryllium by weight. Beryl, which can contain up to 5% beryllium, is the principal beryllium mineral mined in the rest of the world from ores typically grading 4% beryllium or less. Commercial beryl contains approximately 12% beryllium oxide, 19% aluminum oxide, 67% silicon dioxide, and 2% other oxides. Artisanal mining of the gemstone varieties of beryl, most notably aquamarine and emerald, is a primary source of byproduct beryl for beryllium extraction. 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

Because beryllium is toxic, 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 and effluent discharges.

Defense Production Act.—To ensure current and future availability of high-quality domestic beryllium to meet critical defense needs, in 2008, the U.S. Department of Defense (DOD), under the Defense Production Act Title III Program, invested in a public-private partnership with Materion Corp. (Mayfield Heights, OH) to build a primary beryllium facility in Elmore, OH. The facility was designed to produce high-purity beryllium metal from beryllium hydroxide sourced from Materion's Delta, UT, operation. 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 beryllium metal. The plant was placed into service in 2012 (Materion Corp., 2017a, p. 55; Metal Bulletin, 2010).

National Defense Stockpile.—The Defense Logistics Agency Strategic Materials, DOD, offered and sold selected beryllium materials from the National Defense Stockpile (NDS). At yearend 2016, the stockpile contained 75 t of beryllium metal, an excess to the NDS beryllium metal stockpile goal of 47 t. The Annual Materials Plan for fiscal year 2016, which represented the maximum quantities of beryllium metal that could be sold from October 1, 2015, through September 30, 2016, was 14 t, a decrease of 11% from that in fiscal year 2015. In calendar

year 2016, the NDS sold approximately 3 t of beryllium metal. The NDS also upgraded beryllium hot-pressed metal powder into hot isostatic pressing structured metal powder to meet product specification for many modern DOD applications. NDS calendar yearend inventories of beryllium materials are listed in table 2 (U.S. Department of Defense, 2017, p. 8–14).

Production

Domestic production and consumption data for beryllium-containing ores (tables 1, 4) were collected by the USGS from two voluntary surveys of U.S. operations. In 2016, 100% of the canvassed respondents replied to the survey. A small number of unidentified producers may have shipped minimal quantities of byproduct beryl, but these have not been included. In 2016, the only domestic beryllium mine shipped approximately 155 t of contained beryllium, 24% less than that of 2015.

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. Most 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. In 2016, 94% of Materion's beryllium hydroxide was produced from bertrandite, and 6% was produced from imported beryl (Materion Corp., 2017a, p. 29). Very-high-purity beryllium is made exclusively from beryl, as beryl typically has fewer impurities than bertrandite (for example, fluorine and uranium). Beryl-sourced high-purity beryllium is used in nuclear applications, where the absence of uranium in the beryllium allows for safe and timely disposal of nuclear waste containing beryllium, and in foil for use as x-ray windows for medical applications (Keith Smith, Vice President, Technology and Government Business Development, Materion Corp., oral commun., April 4, 2016).

In 2015, based on the expectation that worldwide stockpiles of beryllium concentrate were being depleted, Materion invested $23 million to further develop its bertrandite pits in the Topaz-Spor Mountain region. In 2013, the company increased its capacity to produce beryllium hydroxide at its Delta plant. In 2016, the capacity utilization of the Delta plant was 42%, down from 55% in 2015 (Materion Corp., 2014, p. 37; 2017a, p. 29).

Consumption

In 2016, U.S. reported consumption of bertrandite ore and beryl for the production of beryllium hydroxide was approximately 160 t of contained beryllium, a 27% decrease from that of 2015. U.S. apparent consumption of all beryllium materials in 2016, as calculated from mine shipments, net trade, and changes in Government and industry stocks, was estimated to be about 182 t of contained beryllium, a decrease of 22% from that of 2015. Beryllium mine shipments and net imports decreased in 2016.

Materion produced beryllium hydroxide, beryllium products (including metal, metal-matrix composites, and ceramics), and beryllium strip and bulk products in the Performance Metals unit of its Performance Alloys and Composites segment. Materion produced two types of metal-matrix composites—one made from aluminum and beryllium, and the other made from beryllium and beryllium oxide (BeO or beryllia). Foil, rod, sheet, tube, and a variety of customized shapes were produced at plants in Elmore and in Fremont, CA. Beryllia ceramic products for aerospace, defense, electronics, medical, semiconductor, telecommunications, and wireless applications were produced at its plant in Tucson, AZ, and copper- and nickel-base alloy products, the majority of which contained beryllium, were produced at plants in Elmore and in Shoemakersville, PA. These included 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).

In 2016, sales from the Performance Alloys and Composites segment decreased slightly from that of 2015 owing mostly to lower raw material sales of beryllium hydroxide and lower value-added sales to the industrial components market. Value-added sales to the consumer electronics market increased owing to greater demand for base connector material applications. Value-added sales to the defense market also increased, mostly owing to stronger sales into satellite surveillance and missile projects. In 2016, consumer electronics accounted for 21% of the Performance Alloys and Composites value-added sales, and industrial component applications accounted for 19%. The remaining sales were distributed as follows: automotive electronics, 14%; defense, 11%; telecommunications infrastructure, 9%; energy, 6%; medical, 2%; and other, 18% (Materion Corp., 2017a, p. 20; 2017c, p. A-1).

IBC Advanced Alloys Corp. (Canada) manufactured beryllium-aluminum and beryllium-copper alloys and its proprietary Beralcast® alloys, which were castable beryllium-aluminum products, at plants located in Franklin, IN, New Madrid, MO, Royersford, PA, and Wilmington, MA. IBC had multiyear agreements to purchase beryllium metal and BCMA from the Ulba Metallurgical Plant (UMP) in Kazakhstan. In 2014, IBC entered into a contract with Lockheed Martin Corp. to provide critical cast components for Lockheed Martin's F–35 Lightning II Electro-Optical Targeting System. In 2015, IBC delivered the first component to Lockheed—an azimuth gimbal housing manufactured using IBC's Beralcast® beryllium-aluminum casting alloy. IBC also received a second purchase order from Lockheed to produce critical cast components for the F–35 Lightning II Electro-Optical Targeting System. At yearend 2016, IBC received a third purchase order from Lockheed to produce components for the F–35 Lightning II Electro-Optical Targeting System (IBC Advanced Alloys Corp., 2016, p. 1–4; 2017, p. 2).

Other domestic producers of beryllium alloy products included NGK Metals Corp. (a subsidiary of NGK Insulators, Ltd.) in Sweetwater, TN, and Olin Brass (a business segment of Global Brass and Copper Holdings Inc.) in 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 were not available but may have represented as much as 20% to 25% of U.S. consumption. Beryllium products manufactured by Materion from recycled metal require only 20% of the full-cycle (mine through manufacture) energy as that of beryllium products manufactured from primary material. Materion established a comprehensive recycling program for its beryllium products and indicated a 40% beryllium recovery rate from processed new and old beryllium 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 beryllium content, total beryllium imports increased by 3% compared with those of 2015, primarily owing to increased imports of beryllium metal from Kazakhstan. The leading suppliers of beryllium materials to the United States were, by beryllium content, Kazakhstan, Japan, and Nigeria.

On the basis of estimated contained beryllium, beryllium exports increased by 19% compared with those of 2015, mostly from a 31% increase in exports that went to Canada. Canada was the major recipient of total exported beryllium metal. The U.S. Census Bureau, however, only identifies exported beryllium metal; exported BCMA and beryllium oxide and hydroxide are not identified. According to Materion, BCMA typically accounts for about 85% of domestic beryllium exports, whereas beryllium metal typically accounts for 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 2016, net import reliance as a percentage of apparent consumption was 15%, an increase from 12% in 2015. Net import reliance as a percentage of apparent consumption has decreased since its peak of 61% in 2010 owing, on average, to increased U.S. beryllium metal production and a commensurate decrease in beryllium imports and Government stockpile shipments.

World Review

China.—Two facilities in China process beryllium ores and concentrates into beryllium products—Hunan Shuikoushan Nonferrous Metals Group Co., Ltd. in Xinjiang Uyghur Autonomous Region, and Fuyun Hengsheng Beryllium Industry Co., Ltd. in Guangdong Province. In 2015, the last year with supplied information, China produced approximately 100 t of beryllium contained in beryllium-copper alloys, beryllium oxide ceramics, and beryllium metal. In 2016, China was thought to have produced a similar amount of contained beryllium. Approximately 50 t of the contained beryllium was sourced from domestic ore and 50 t was obtained from Kazakhstan and other foreign sources. In 2015, China consumed about 95 t of beryllium for the production of beryllium-copper alloys, beryllium oxide ceramics, and beryllium metal (China Mining Association, 2016). China is now thought to be the world's second leading beryllium-processing country (after the United States), surpassing Kazakhstan (Ron Gilerman, Managing Director, A&R Merchants, Inc., oral commun., August 10, 2017).

Kazakhstan.—It was estimated that UMP produced about 90 t of beryllium contained in beryllium-copper alloys, beryllium oxide ceramics, and beryllium metal in 2016, about the same as that produced in 2015 (based on 2013 data—the last year with supplied information) (Kazatomprom JSC, 2014, p. 33). Since the early 1990s, UMP's production was sourced from beryllium concentrate stockpiled in Kazakhstan, which had accumulated prior to the breakup of the Soviet Union. The beryllium concentrate stockpile in Kazakhstan is still present but is thought to be nearly depleted. UMP's current primary source of beryllium concentrate is from a Soviet-era stockpile located in Russia. The Russian stockpile has about 20 years of reserves available based on UMP's current rate of consumption (Ron Gilerman, Managing Director, A&R Merchants, Inc., oral commun., August 10, 2017).

Russia.—As of 2012, the last year with reported information, MBC Corp. (a subsidiary of Metropol Investment Group), Russia's state-owned Rusnano Corp., and technology specialists from a number of research institutions began work on reopening the Ermakovskoe bertrandite operation in the Siberian Republic of Buryatiya. Ermakovskoe was thought to be the largest identified beryllium deposit in Russia. The mining was to be carried out in two stages: open pit mining of 764,000 t of reserves followed by underground mining of the remaining 630,000 t of reserves (MBC Corp., 2009, 2011; Rusnano Corp., 2012). Recently, however, Russia's reopening of the Ermakovskoe operation has been reported to be on hold owing to a 2014 financial downturn in Russia. Kazakhstan's UMP was expected to continue supplying Russia with beryllium products (Ron Gilerman, Managing Director, A&R Merchants, Inc., oral commun., August 10, 2017).

In an effort to augment the beryllium metal imported by Russia, Russia's Industry and Trade Ministry financed research on beryllium metal production. At yearend 2015, Tomsk Polytechnic University and the Rare Metals of Siberia Research and Production Association jointly produced a total of 1 kilogram of beryllium metal. The Priargunsky Industrial Mining and Chemical Union in Krasnokamensk, Transbaikal Territory, was being considered for a concentrator, and the Siberian Chemical Combine in Seversk, Tomsk Region, was being considered for the beryllium hydrometallurgical plant. Commercial production of beryllium metal was expected to begin 2019, with a planned production capacity of 30 t/yr of beryllium (Dragomanovich, 2015; Tass, 2015; Tomsk Polytechnic University, 2017).

Outlook

The United States is expected to remain self-sufficient with respect to most of its beryllium requirements. At yearend 2016,

Materion reported proven reserves in Juab County, UT, of 7.25 million dry metric tons of bertrandite having an average grade of 0.249% beryllium and containing about 18,100 t of beryllium. Materion owned approximately 90% of its proven mineral reserves and leased the remainder from the State (Materion Corp., 2017a, p. 29).

In the first quarter of 2017, value-added sales for Materion's beryllium-rich Performance Alloys and Composites segment increased slightly from that in the first quarter of 2016 owing to stronger demand in the consumer electronics and industrial components markets (Materion Corp., 2017b, p. 20).

In 2013, Materion forecast worldwide beryllium consumption to increase between 3% and 6% per year and anticipated BCMA consumption growth to be higher, at approximately 10% per year. The physical size of many beryllium-containing components, however, has decreased over time owing to improved technology. Therefore, growth in beryllium consumption may lag behind the expected continued growth in applications (Stephen Freeman, President, International Business Development, Materion Corp., oral commun., January 10, 2013).

References Cited

China Mining Association, 2016, Three rare resources survey report—Rare earth metals, rare metals, scattered metals: China Mining Association, December 20. (Accessed January 23, 2018, at http://www.chinamining.org.cn/index.php?m=content&c=index&a=show&catid=6&id=19002.)

Dragomanovich, Vanya, 2015, Russia plans industrial beryllium production by 2020: Metal-Pages, February 23. (Accessed March 31, 2015, via https://metal-pages.com/.)

IBC Advanced Alloys Corp., 2016, Management's discussion and analysis—Six months ended December 31, 2015: Vancouver, British Columbia, Canada, IBC Advanced Alloys Corp., February 25, 13 p. (Accessed March 14, 2016, at http://ibcadvancedalloys.com/wp-content/uploads/2017/12/IBC-MDA-2015-12.pdf.)

IBC Advanced Alloys Corp., 2017, Management's discussion and analysis—Six months ended December 31, 2016: Franklin, IN, IBC Advanced Alloys Corp., February 24, 15 p. (Accessed June 3, 2017, at http://ibcadvancedalloys.com/wp-content/uploads/2017/12/IBC-MDA-2016-12.pdf.)

Kazatomprom JSC, 2014, Integrated annual report—2013: Almaty, Kazakhstan, Kazatomprom JSC, 197 p. (Accessed June 8, 2017, at http://www.kazatomprom.kz/sites/default/files/corpfiles/ar_kap_en_2014_light.pdf.)

Materion Corp., 2014, Annual report—2013: Mayfield Heights, OH, Materion Corp., 122 p. (Accessed June 8, 2017, at https://investor.materion.com/static-files/6617e6b4-8dc1-4ff4-a5ab-b9451702ccfe.)

Materion Corp., 2017a, Annual report—2016: Mayfield Heights, OH, Materion Corp., 92 p. (Accessed June 8, 2017, at http://eproxymaterials.com/interactive/mtrn2016/.)

Materion Corp., 2017b, Form 10–Q—For the quarterly period ended March 31, 2017: U.S. Securities and Exchange Commission, 27 p. plus exhibits. (Accessed May 20, 2017, via https://investor.materion.com/.)

Materion Corp., 2017c, Investor presentation: Mayfield Heights, OH, Materion Corp. presentation, April, 30 p. (Accessed May 20, 2017, at http://files.shareholder.com/downloads/BW/4610627335x0x914783/45AB84A1-D848-43E8-9F9C-077526181F54/Materion_Investor_Presentation.pdf.)

MBC Corp., 2009, Ermakovskoe deposit: 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.)

Metal Bulletin, 2010, Brush Wellman set to commission beryllium plant: Metal Bulletin, August 6. (Accessed September 20, 2010, via http://www.metalbulletin.com/.)

Rusnano Corp., 2012, Rusnano and East-Siberian Metals invest in high-tech materials of beryllium: Moscow, Russia, Rusnano Corp. press release, February 22. (Accessed March 15, 2012, at http://www.en.rusnano.com/press-centre/news/88611.)

Tass, 2015, Russia to design its first beryllium production in 2016: Tass, December 17. (Accessed December 18, 2015, at http://www.tass.ru/en/economy/844711.)

Tomsk Polytechnic University, 2017, Beryllium production based on TPU technology will be launched in 2019: Tomsk, Russia, Tomsk Polytechnic University news release, January 26. (Accessed June 3, 2017, at https://tpu.ru/en/about/tpu_today/news/view?id=1161.)

Trueman, D.L., and Sabey, Phillip, 2014, Beryllium, chap. 5 *of* Gunn, Gus, ed., Critical metals handbook: Oxford, United Kingdom, John Wiley & Sons, Ltd. Publishers, p. 99–121.

U.S. Department of Defense, Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, 2017, Strategic and critical materials operations report to Congress—Operations under the Strategic and Critical Materials Stockpiling Act during fiscal year 2016: Fort Belvoir, VA, U.S. Department of Defense, January, 73 p. (Accessed June 10, 2017, at http://www.dla.mil/Portals/104/Documents/StrategicMaterials/Reports/Operations%20Report/FY16%20Operations%20Report_FINAL_Website%20Version.pdf?ver=2017-03-29-080514-340.)

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

Beryllium. Ch. in Critical Mineral Resources of the United States—Economic and Environmental Geology and Prospects for Future Supply, Professional Paper 1802, 2017.

Beryllium. Ch. in Mineral Commodity Summaries, annual.

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.

DLA Strategic Materials, Defense Logistics Agency.

Roskill Information Services Ltd.

Strategic and Critical Materials Report to the Congress, U.S. Department of Defense, Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics.

TABLE 1
SALIENT BERYLLIUM STATISTICS

(Metric tons, beryllium content)

	2012	2013	2014	2015	2016
United States, beryllium-containing ores:					
Mine shipments[1]	225	235	270	205	155
Imports for consumption, beryl[2]	12	8	9	18	12
Consumption, reported[3]	220	250	280	220	160
Stocks, December 31:					
Industry[1]	15	20	15	25	35
U.S. Government, beryl[2, 4]	(5)	(5)	(5)	(5)	(5)
World, production[e, 2]	297 r	296 r	337 r	269 r	220

[e]Estimated. [r]Revised.
[1]Table includes data available through February 1, 2018. 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]Data from Defense Logistics Agency Strategic Materials.
[5]Less than ½ unit.

TABLE 2
U.S. GOVERNMENT NATIONAL DEFENSE STOCKPILE
BERYLLIUM STATISTICS IN 2016[1]

(Metric tons, beryllium content)

Material	Stockpile goal[2]	Annual Materials Plan[3]	Inventory, December 31
Beryl ore	--	--	(4)
Beryllium metal:			
Hot-pressed powder	(5)	(5)	63
Rods	--	--	(4)
Structured powder	--	--	6
Vacuum-cast	(5)	(5)	6
Total	47	14	75
Grand total	47	14	75

-- Zero.
[1]Table includes data available through February 1, 2018. Data were converted from gross weight reported in short tons; may not add to totals shown.
[2]2013 Biennial Report on Stockpile Requirements. Goal is for beryllium metal, excluding beryllium structured powder.
[3]Maximum quantity of material that can be disposed during the 12-month period ending September 30, 2016.
[4]Less than ½ unit.
[5]Stockpile goal and Annual Materials Plan for beryllium metal included under "Total."

Source: Defense Logistics Agency Strategic Materials.

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

Type and material	2015 Gross weight (kilograms)	2015 Be content[2] (kilograms)	2015 Value (thousands)	2016 Gross weight (kilograms)	2016 Be content[2] (kilograms)	2016 Value (thousands)	Principal destinations or sources, 2016[3]
Exports:							
Beryllium, unwrought[4]	7,210	7,210	$300	6,450	6,450	$272	China, 82%; United Kingdom, 4%.
Beryllium waste and scrap	37	37	10	--	--	--	
Beryllium, other[5]	21,700	21,700	15,000	28,000	28,000	20,700	Canada, 63%; France, 10%; Germany, 7%; Japan, 5%.
Total	28,900	28,900	15,300	34,400	34,400	20,900	Canada, 52%; China, 16%; France, 8%; Germany, 7%; Japan, 4%.
Imports for consumption:							
Beryllium ores and concentrates	452,000	18,100	1,270	292,000	11,700	837	Nigeria, 48%; Brazil, 41%; Rwanda, 11%.
Beryllium oxide and hydroxide	20,700	7,460 r	129	12,400	4,460	63	Republic of Korea, 67%; Canada, 31%.
Beryllium, unwrought[4]	8,660	8,660	1,720	69	69	21	Germany, 100%.
Beryllium waste and scrap	406	406	133	224	224	11	Japan, 100%.
Beryllium, other[5]	13,800	13,800	1,160	39,600	39,600	2,140	Kazakhstan, 90%; Canada, 5%; China, 5%.
Beryllium-copper master alloy	151,000	6,030	2,920	90,200	3,610	1,850	Kazakhstan, 85%; Germany, 11%; Japan, 4%.
Beryllium-copper plates, sheets, and strip	781,000 r	11,700	11,900	561,000	8,420	6,920	Japan, 99%.
Total	1,430,000	66,100 r	19,300	995,000	68,100	11,800	Japan, 56%; Nigeria, 14%; Brazil, 12%; Kazakhstan, 11%.

rRevised. -- Zero.
[1]Table includes daata available through February 1, 2018. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Estimated from gross weight.
[3]Principal destination or source percentages based on beryllium gross weight data.
[4]Includes powders.
[5]Includes articles not elsewhere specified.

Source: U.S. Census Bureau.

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

(Metric tons, gross weight)

Country or locality[3]	2012	2013	2014	2015	2016
Brazil[e]	80	110	160	100	120
China[e]	1,000 [r]	1,100 [r]	1,200 [r]	1,200 [r]	1,200
Madagascar[e, 4]	16	85	135	140 [r]	140
Mozambique	532 [5]	103 [e]	--	--	--
Nigeria[e]	220	90	40	120	--
Rwanda	--	--	--	70 [e]	30 [e]
United States, mine shipments[6]	5,570	5,910	6,900	5,100	3,870
Total	7,410 [r]	7,400 [r]	8,430 [r]	6,730 [r]	5,500

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

[1]Includes data available through June 9, 2017. All data are reported unless otherwise noted. Totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Unless otherwise noted, figures represent beryl ore for the production of beryllium and exclude gem-quality beryl.

[3]In addition to the countries and (or) localities listed, Kazakhstan, Portugal, Russia, and Uganda may also have produced beryl ore, but information was inadequate to make reliable estimates of production. Other nations that produced gemstone beryl ore may also have produced some industrial beryl ore.

[4]Beryl in quartz concentrates.

[5]Mozambique reported significantly higher beryl ore production in 2012. The accuracy of the reported data could not be confirmed.

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

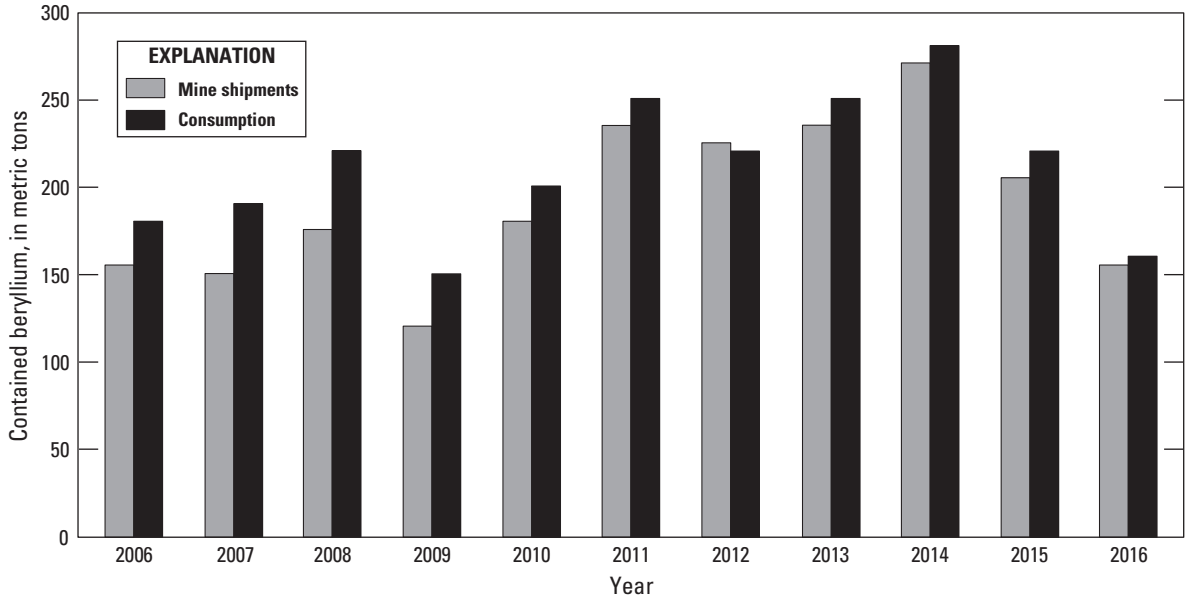

Figure 1. U.S. mine shipments and consumption of beryllium from 2006 through 2016.