USGS
science for a changing world

2018 Minerals Yearbook

RARE EARTHS [ADVANCE RELEASE]

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

August 2022

Rare Earths

By Joseph Gambogi

Domestic survey data and tables were prepared by Annie Hwang, statistical assistant.

In 2018, world rare-earth mine production was about 190,000 metric tons (t) of rare-earth-oxide (REO) equivalent (tables 1, 8). China continued to dominate global production and consumption of rare-earth mineral concentrates, compounds, and metals. The unique properties of rare earths make them useful in a wide variety of applications, such as alloys, batteries, catalysts, magnets, phosphors, and polishing compounds.

The Mountain Pass mine in California was the leading source of mineral concentrates in the United States prior to being idled in 2015. In 2018, mining operations in Mountain Pass, CA, resumed and production was reported to be about 14,000 t of REO equivalent (MP Materials Corp., 2020, p. 90). The total value of U.S. imports of rare-earth compounds and metals was $159 million, and U.S. exports including compounds, metal, and mineral concentrates from Mountain Pass were about $113 million. Prices in 2018 for cerium, lanthanum, neodymium, samarium, and yttrium oxides were relatively unchanged compared with those in 2017. Oxide prices for europium and terbium decreased significantly. In contrast, the price of gadolinium oxide increased significantly (table 3).

The rare earths are a group of moderately abundant elements comprising the 15 lanthanides, scandium (Sc), and yttrium (Y). The lanthanides are the elements with atomic numbers 57 through 71, in order of atomic number: lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb), and lutetium (Lu). In rock-forming minerals, rare earths typically occur in compounds as trivalent cations in carbonates, oxides, phosphates, and silicates (Mason and Moore, 1982, p. 46). The principal economic rare-earth minerals are bastnaesite, loparite, monazite, xenotime, and the lateritic ion-adsorption clays. The percentage distribution of REOs in mineral concentrates varies significantly based on mineral sources and location (table 2).

Excluding scandium, a rare-earth element (REE) can be classified as either a light rare-earth element (LREE) or a heavy rare-earth element (HREE). The LREEs include the lanthanide elements from atomic number 57 (La) through atomic number 64 (Gd), and the HREEs include the lanthanide elements from atomic number 65 (Tb) through atomic number 71 (Lu). The division is based on the LREEs having unpaired electrons in the 4f electron shell and HREEs having paired electrons in the 4f electron shell.

Scandium (atomic number 21), a transition metal, is the lightest REE, but it is not classified as one of the group of LREEs nor one of the HREEs. Scandium is similar in appearance and weight to aluminum. Although its occurrence in crustal rocks is greater than that of lead, mercury, and the precious metals, scandium rarely occurs in concentrated quantities because it does not selectively combine with the common ore-forming anions.

Yttrium (atomic number 39), a transition metal, is chemically similar to the lanthanides and commonly occurs in the same minerals as a result of its similar ionic radius. Yttrium is included as an HREE even though it is not part of the lanthanide series.

The elemental forms of rare earths are iron gray to silvery lustrous metals that are typically soft, malleable, ductile, and usually reactive, especially at elevated temperatures or when finely divided. Melting points range from 798 degrees Celsius (°C) for cerium to 1,663 °C for lutetium.

Legislation and Government Programs

In October, the U.S. Department of Defense, Defense Logistics Agency Strategic Materials announced the fiscal year 2019 (October 1, 2018, through September 30, 2019) Annual Materials Plan (AMP) for the National Defense Stockpile (NDS). The AMP included potential acquisitions of new NDS stocks. In fiscal year 2019, these potential acquisitions included 0.5 t of dysprosium (unspecified form), 35 t of europium (unspecified form), 100 t of rare-earth magnet feedstock, 10 t of yttrium oxide, and 416 t of rare earths (unspecified form) (Defense Logistics Agency Strategic Materials, 2018).

The U.S. Department of Energy (DOE) continued to fund research for cost-effective methods to separate rare earths from coal and coal byproducts (including effluents). In fiscal year 2018, the REE Program budget was approximately $15 million and supported 30 active projects including Small Business Innovative Research (SBIR) projects (Alvin, 2019, p. 2). In fiscal year 2018, the DOE made three $150,000 awards under the SBIR program related to the extraction and recovery of rare earths from coal ash. The Phase 1 award recipients were Anactisis LLC (Pittsburgh, PA), Skyhaven Systems, LLC (Steamboat Springs, CO), and Wyonics LLC (Laramie, WY) (U.S. Small Business Administration, 2021).

Researchers at the Critical Materials Institute (CMI), funded by the DOE, continued their efforts to diversify supply, develop substitutes, and improve reuse and recycling of rare earths. In fiscal year 2018, the funding for CMI was $25 million from the DOE and $0.8 million from CMI collaborators (U.S. Department of Energy, 2019, p. 3).

Rare Resource Recycling Inc. (Houston, TX) was in the second phase of a SBIR project supported by the National Science Foundation to recycle REEs from neodymium magnets. The first phase of the project successfully demonstrated the feasibility of developing a process beyond laboratory scale to pilot scale. The second phase of the project was expected to result in a pilot-scale production plant of rare-earth concentrates. The first and second phases of the project totaled $900,000, and work was expected to be completed in 2019 (National Science Foundation, 2018).

Production

The U.S. Geological Survey developed domestic mine production data for rare-earth minerals from a voluntary canvass of U.S. mining operations and information gathered from publicly available reports. In 2018, rare-earth mineral concentrates were produced domestically by MP Mine Operations LLC doing business as MP Materials Corp. (Las Vegas, NV) and Southern Ionics Minerals LLC (Jacksonville, FL). Bastnaesite mineral concentrates were produced as a primary product by MP Materials at mining and processing operations in Mountain Pass, CA. The Mountain Pass operations were restarted in the first quarter of 2018 after being put on care-and-maintenance status by the former owner in the fourth quarter of 2015. The Mountain Pass operations produced mineral concentrates in 2018; however, the downstream cracking and solvent extraction production capacity at Mountain Pass remained idle. Southern Ionics Minerals produced monazite concentrates recovered as a byproduct of processing heavy-mineral sands from its operations near Offerman, GA. The total domestic production of rare-earth mineral concentrates was estimated to be 14,000 t of REO equivalent.

A variety of specialty alloys and compounds containing rare earths were produced from imported materials. Leading producers of rare-earth-bearing catalysts and chemical intermediates in the United States included Albemarle Corp. (Baton Rouge, LA), BASF Corp. (Florham Park, NJ), Solvay Chemicals, Inc. (Houston, TX), and W.R. Grace & Co. (Columbia, MD). Globe Metallurgical Inc. (Beverly, OH) and CC Metals and Alloys, LLC (Calvert City, KY) produced specialty ferroalloys containing REEs. U.S. producers of rare-earth alloys or magnets included Electron Energy Corp. (Landisville, PA), Eutectix LLC (Troy, MI, and Tolleson, AZ), and TdVib, LLC (Boone, IA). Urban Mining Co. (Austin, TX) was preparing to construct a commercial operation to recycle and produce rare-earth magnets in San Marcos, TX. Rare Earth Salts (Beatrice, NE) was working to commercialize a proprietary process to produce separated rare-earth compounds.

In addition to MP Materials and Southern Ionics, companies with plans to develop domestic resources of rare earths included NioCorp Developments Ltd. at its Elk Creek project in Nebraska, Rare Element Resources Ltd. at its Bear Lodge project in Wyoming, Texas Mineral Resources Corp. (TMRC) at its Round Top project in Texas, and Ucore Rare Metals Inc. at its Bokan Mountain project in Alaska. In addition to the lanthanides and yttrium, several companies were considering scandium recovery in their project plans.

Following the completion of a revised National Instrument 43–101-compliant feasibility study for its Elk Creek polymetallic (niobium-titanium-scandium) project in Nebraska, Niocorp was seeking financing necessary to complete engineering and environmental permitting efforts. According to the company, the indicated resource was 90.9 million metric tons (Mt) containing 70 grams per metric ton (6,300 t) of elemental scandium using a cutoff based on a $180 per ton net smelter return (NSR). The NSR was based on revenue from niobium, titanium, and scandium oxides (NioCorp Developments Ltd., 2017, p. 443; 2019, p. 17).

Rare Element Resources entered into an agreement with Umwelt-und Ingenieurtechnik GmbH Dresden (UIT) to validate its hydrometallurgical recovery and separation technology. UIT, an affiliate of General Atomics Technologies Corp. and Synchron, was expected to complete pilot-plant studies in 2019. Measured and indicated resources at Rare Element Resources' Bear Lodge project were 16.3 Mt containing 3.07% (500,000 t) of REO equivalent using a 1.5%-REO cutoff grade (Rare Element Resources Ltd., 2018, p. 37; 2019, p. 13).

TMRC was partnering with Morzev Pty Ltd., doing business as USA Rare Earth, LLC, to advance its polymetallic Round Top project. In an agreement between the two companies, USA Rare Earth was expected to provide $10 million to assist in the development of the project through to bankable feasibility and could be entitled to up to a 70% interest in the project. Measured and indicated resources for the Round Top project were previously reported to be 480 Mt containing about 300,000 t of REO equivalent (Texas Mineral Resources Corp., 2014, p. 13; 2018). Ucore was proceeding with plans to develop a processing and separation facility to produce rare earths and other metals in Alaska. In 2018, the company was evaluating feedstocks from numerous sources including its own Bokan project and had agreed to purchase land in Ketchikan for the facility. At yearend, Ucore also was working to resolve legal issues in its agreement with IBC Advanced Technologies, Inc. regarding the use of proprietary molecular recognition separation technology. Using a 0.4%-REO cutoff grade, the Bokan Project's indicated resources were estimated to be 4.8 Mt containing about 29,000 t of REO equivalent (Ucore Rare Metals Inc., 2019, p. 6, 16).

Consumption

Because of limited data transparency, industry estimates of global consumption of rare earths varied significantly and generally ranged from 140,000 to 160,000 t of REO equivalent (Kingsnorth, 2018, p. 5; Adamas Intelligence, 2019, p. 15; Roskill Information Services Ltd., 2019). Global consumption was led, in descending order of quantity, by magnets, catalysts, polishing, and metallurgical applications. Other end uses included ceramics, glass, phosphors, pigments, and miscellaneous other uses. Based on trade data and excluding stock changes, U.S. apparent consumption of rare earths was estimated to be 6,500 t of REO equivalent in 2018.

Based on an analysis of import data, the estimated domestic use of rare earths in 2018 was primarily in catalysts (60%), with the remainder in ceramics and glass (15%), metallurgical applications and alloys (10%), polishing (10%), and other uses (5%).

The United States consumed primarily LREEs. Because the United States had limited capabilities to produce battery alloys, magnet alloys, and phosphors, most LREE consumption was in the form of cerium and lanthanum compounds used to produce catalysts, ceramics, glass, and polishing compounds; ferrocerium and rare-earth metals were used for alloys and other metallurgical applications. Most HREE consumption was in the form of yttrium compounds primarily used in ceramics. Together, the remaining HREEs (Tb, Dy, Ho, Er, Tm, Yb, and Lu) were estimated to contribute less than 2% to domestic consumption.

The amount of specific REEs used varied significantly by market sector and application. In the catalyst sector, the primary REEs consumed were lanthanum and cerium, with lesser amounts of neodymium. Consumption in the magnet sector varied by the type of permanent magnet. Neodymium-iron-boron magnets primarily used neodymium and praseodymium with lesser amounts of dysprosium, gadolinium, and terbium; samarium-cobalt magnets used samarium and lesser amounts of gadolinium; lanthanum had limited use in certain ferrite magnets. Polishing compounds primarily used cerium with lesser amounts of lanthanum. Batteries primarily used lanthanum and lesser amounts of cerium and other REEs. Ceramics were dominated by yttrium consumption with lesser amounts of cerium and other REEs. Metallurgical applications varied by element. Europium, yttrium, and terbium were the three REEs commonly associated with the phosphors sector, but other REEs were used by that sector as well. The glass sector used lanthanum, cerium, and erbium, in descending order of consumption, as well as other REEs. The HREEs were often used in high-unit-value applications. For example, laser crystals were commonly based on neodymium and yttrium and were doped with HREEs (particularly dysprosium, erbium, thulium, and ytterbium). Among its other uses, lutetium was used in positron emission tomography.

Global consumption of scandium was estimated to be 10 to 20 metric tons per year (t/yr). Although not quantified, the domestic end uses of scandium were primarily for fuel cells and as an additive in aluminum alloys. However, scandium for these applications was thought to be imported in the form of value-added intermediate products rather than imported under the Harmonized Tariff Schedule of the United States (HTS) codes for rare-earth metals (2805.30) and rare-earth compounds (2846). Globally, the leading end uses for scandium were aluminum-scandium alloys, fuel cells, and lasers.

Prices

Prices for rare-earth products are influenced by the overall production of REO and demand for specific elements with a variety of end uses. In 2018, prices for most LREE oxides were relatively unchanged compared with those in 2017. Gadolinium had the largest increase in price and europium had the largest decrease in price (table 3).

Based on information collected by the U.S. Census Bureau on imports, the estimated unit value of REO in rare-earth compounds was $14 per kilogram compared with $12 in 2017. Variations in the purity or mix of specific compounds imported from year to year affect the unit value of imports. The domestic price for scandium oxide quoted by a domestic supplier was unchanged compared with that in 2017.

Foreign Trade

Total exports of rare-earth compounds and metals increased substantially to 19,800 t of REO equivalent, seven times those in 2017, owing primarily to the resumption of production and export of rare-earth mineral concentrates from Mountain Pass. Exports of other rare-earth compounds, including bastnaesite mineral concentrates, were 18,200 t of REO equivalent. Exports of rare-earth metals under HTS code 2805.30, including unalloyed and alloyed metals but excluding ferrocerium, were about one-half of those in 2017. The leading export destinations of rare-earth metals (excluding ferrocerium) were China, Japan, and the United Kingdom. Exports of ferrocerium and other pyrophoric alloys under HTS code 3606.90 were 1,410 t, a 28% increase compared with those in 2017 (tables 1, 4, 5).

U.S. imports of REO equivalent totaled 10,800 t, a slight decrease compared with those in 2017. Approximately 93% of REO equivalent imports were in the compound form and 7% were metals (tables 6, 7). China continued to dominate most HTS import categories, and most of the rare-earth metals and compounds imported from other countries likely had been derived from China's mineral feedstocks or intermediate compounds. Cerium compounds and lanthanum compounds were the leading import categories for specific rare earths, but most imports were in unspecified HTS categories. Scandium and yttrium compounds were estimated to be less than 2% of total REO equivalent imports.

Imports of rare-earth metals under HTS code 2805.30, including unalloyed and alloyed metals but excluding ferrocerium, were 438 t on a gross-weight basis, whereas imports of ferrocerium and pyrophoric alloys under HTS code 3606.90.30 were 336 t. Imports of unalloyed metals were 209 t and were primarily cerium or lanthanum. Imports of other rare-earth alloys were 230 t on a gross-weight basis (table 7).

World Review

Australia.—Arafura Resources Ltd. continued piloting studies on its Nolan's Bore project in the Northern Territory with the goal of producing rare-earth, phosphate, and uranium products. In November, Arafura announced plans to construct a separation plant onsite pending the outcome of a definitive feasibility study to be completed in 2019. Arafura received $2.1 million from the Government of Australia for research and development. Measured resources at Nolan's Bore were 4.9 Mt containing 3.2% (160,000 t) REO equivalent, and indicated resources were 30 Mt containing 2.7% (810,000 t) REO equivalent, using a 1%-REO cutoff grade. At yearend, an estimate of reserves neared completion (Arafura Resources Ltd., 2020, p. 13, 18).

Alkane Resources Ltd. continued the development of its polymetallic Dubbo Zirconia project in New South Wales with planned production of hafnium, niobium, rare-earths, tantalum, and zirconium products. In 2018, Alkane continued test work and sought financing to advance the development of the project. Proven reserves included 18.9 Mt of polymetallic ore containing 0.87% (164,000 t) REO equivalent. Measured resources were 43 Mt containing 0.74% (320,000 t) REO equivalent (Alkane Resources Ltd., 2017, p. 5; 2019, p. 3–4).

Australian Mines Ltd. completed a bankable feasibility study on the Sconi cobalt-nickel-scandium project in northern Queensland. Proven and probable reserves were 34 Mt containing 42 parts per million (ppm) (1,400 t) scandium. In 2017 and 2018, Australian Mines received about $1.6 million[1] (AUD 2.1 million) in tax rebates from the Government of

[1]Where necessary, values have been converted from Australian dollars (AUD) to U.S. dollars at the rate of AUD 1.340=US$1.00 for 2018.

Australia for its research and development (Australian Mines Ltd., 2018, p. 23; 2019).

Clean TeQ Holdings Ltd. completed a definitive feasibility study for its Sunrise nickel-cobalt-scandium project in New South Wales. The study assumed a scandium-oxide production capacity of 80 t/yr, but assumed sales would be limited to 10 t/yr. The latest mineral resource estimate was reported to be 46 Mt containing 420 ppm (19,000 t) scandium using a cutoff grade of 300 ppm scandium. About 27% of the total resource was classified as measured and indicated (Clean TeQ Holdings Ltd., 2018, p. 18).

Hastings Technology Metals Ltd. updated its reserve and resource estimates for the Yangibana project in Western Australia. Reserves were reported to be 10 Mt containing 1.2% (130,000 t) REO equivalent, and resources were reported to be 22 Mt containing 1.17% (250,000 t) REO equivalent. About 64% of the total resource was classified as measured and indicated (Hastings Technology Metals Ltd., 2019).

Lynas Corp. Ltd., the leading producer of rare-earth mineral concentrates outside of China in 2018, continued to operate its Mt Weld mining operations in Western Australia to support its processing operations in Malaysia. Following a drilling program and analysis, Lynas updated its estimates of reserves and resources. Mt Weld reserves were revised to 20 Mt containing 8.6% (1.7 Mt) REO equivalent. Total resources were revised to 55 Mt containing 5.4% (3.0 Mt) REO equivalent; 69% of the total resource was classified as measured and indicated (Lynas Corp. Ltd., 2018a, p. 1–2).

Northern Minerals Ltd. continued work to develop the Browns Range project in Western Australia and the Northern Territory. In 2018, the company was commissioning pilot plant operations that included beneficiation through hydrometallurgical extraction. About 2.6 t of mixed rare-earth carbonate was produced and exported to China in the fourth quarter. Indicated resources for the Browns Range project were estimated to be 4.69 Mt containing 0.7% (32,900 t) REO equivalent, using a cutoff grade of 0.15% REO. Probable reserves were 3.75 Mt containing 0.7% (26,400 t) REO equivalent (Northern Minerals Ltd., 2015, p. 1–2; 2019, p. 3).

Platina Resources Ltd. completed a definitive feasibility study for its Owendale polymetallic (scandium-cobalt-nickel) project in New South Wales. The company planned for an initial capacity of 20 t/yr of scandium-oxide equivalent and reserves were estimated to be 4.0 Mt containing 570 ppm (3,500 t) scandium using a 450-ppm-scandium cutoff grade. Total resources were 36 Mt containing 405 ppm (14,000 t) scandium using a 300-ppm-scandium cutoff grade; 60% of the total resource was classified as measured and indicated. Platina Resources received about $810,000 (AUD 1.1 million) in tax rebates from the Australian Government for its research and development (Platina Resources Ltd., 2018, p. 1–2; 2019, p. 5).

Scandium International Mining Corp. (Sparks, NV) continued to pursue financing and offtake agreements for its Nyngan scandium project in New South Wales. In 2018, the company was awarded two patents from the United States Patent Office related to its leaching and solvent extraction technology. Reserves at the Nyngan scandium project were reported to be 1.4 Mt containing 409 ppm (589 t) scandium. Measured and indicated resources were reported to be 16.9 Mt containing 235 ppm (3,980 t) scandium using a 100-ppm-scandium cutoff grade (Scandium International Mining Corp., 2019, p. 8–9, 18, 22).

Brazil.—Brazil exported an estimated 1,990 t of REE-bearing monazite concentrate to China in 2018, a decrease from 2,900 t exported in 2017 (IHS Markit Ltd., 2021). Although no production data were available for 2018, according to the Agência Nacional de Mineração, Brazil's prior exports were derived from Indústrias Nucleares do Brasil inventories in Sao Francisco do Itabapoana (Andrade, 2018, p. 164–166).

Burundi.—Rainbow Rare Earths Ltd. continued to commission its mining and beneficiation processing operation at its Gakara project in Bujumbura Rural Province. In December, the company announced a total resource estimate of 1.1 Mt containing 55% (6,900 t) REO equivalent with measured and indicated resources of 0.3 Mt. Although production was limited by operational issues in 2018, the company planned to develop downstream separation capability and signed an agreement with TechMet Ltd. to complete a feasibility study (Rainbow Rare Earths Ltd., 2019, p. 1, 4).

Canada.—Commerce Resources Corp. continued prefeasibility work on its Ashram project in northern Quebec. In 2018, Commerce Resources was collaborating with Université Laval to conduct process modeling and bench and pilot plant studies. Ashram's measured and indicated resources were estimated to be 29.3 Mt containing 1.9% (557,000 t) REO equivalent, using a 1.25%-REO cutoff grade. Inferred resources were 220 Mt containing 1.8% (4.1 Mt) REO equivalent. The project was based on a proposed production of 16,900 t/yr of REO equivalent primarily derived from monazite and to a lesser degree bastnaesite and xenotime (Commerce Resources Corp., 2019, p. 3–5).

Canada Strategic Metals Inc. merged with Matamec Explorations Inc. and was renamed Quebec Precious Metals Corp. In southwestern Quebec, the new company held joint ownership of the Kipawa project with Investissement Québec and 100% ownership of the Zeus project. In 2018, development activities at both of these adjacent projects were on hold and the company was seeking partners to further develop the projects. In 2013, the Kipawa project reserves were estimated to be 20 Mt containing 0.41% (81,000 t) REO equivalent using a cutoff value of $48.96 per ton of ore. Resources were estimated to be 28 Mt containing 0.40% (110,000 t) REO equivalent using a 0.2%-REO cutoff grade, and 88% of the total resources were classified as measured and indicated. Most of the rare-earth mineralization occurred in eudialyte (a silicate mineral) (Matamec Explorations Inc., 2013, p. 6–7; Quebec Precious Metals Corp., 2018, p. 14–15).

Medallion Resources Ltd. continued with plans to develop a processing facility to produce mixed rare-earth compounds from monazite. Medallion's proposed facility would purchase monazite byproduct from heavy-mineral-sand operations and produce rare-earth compounds. In 2018, the company continued its process development through collaborations with the Saskatchewan Research Council and Rare Earth Salts Separations and Refining, LLC (Des Moines, IA) (Medallion Resources Ltd., 2019, p. 1, 10).

Search Minerals Inc. was conducting a drilling program and environmental assessments on its Foxtrot project in southeastern Labrador. According to the company, most of the rare-earth mineralization occurred in allanite (a silicate mineral) and fergusonite (an oxide mineral). The company's project plan was based on a combined open pit and underground mine followed by processing to produce a mixed rare-earth concentrate. The company reported that indicated resources were 7.4 Mt containing 1.09% (81,000 t) REO equivalent, and inferred resources were 2.0 Mt containing 1.2% (23,000 t) REO equivalent (Roscoe Associates Inc., 2016, p. 14–1; Search Minerals Inc., 2019, p. 1–2).

China.—China dominated the global production of rare-earth minerals, separated compounds, and metals. Based on China's production quota, China accounted for more than 60% of global mine production in 2018. China was reported to have continued efforts to prohibit illegal production and increase environmental inspections. China's Ministry of Land and Resources (CMLR) production quotas for rare-earth mine production were 120,000 t of REO equivalent, of which 100,850 t was for light rare earths and 19,150 t was for medium and heavy rare earths. CMLR classifications for light, medium, and heavy were not defined. The production quotas for smelting and separation were 115,000 t. Nearly all mine, smelting, and separation quotas were allocated to the state-owned enterprises (Asian Metal Inc., 2019).

China's imports of rare-earth compounds under the Harmonized System (HS) code 2846 were 69,600 t (gross weight) in 2018 compared with 34,300 t in 2017. Increased imports from Burma and the United States were the primary reason for the significant increase. China's imports of rare-earth metals (HS code 2805.30) were reported to be 6 t. Imports of thorium ores and concentrates (HS code 2612.20) containing REEs were 13,400 t, primarily from, in descending order of quantity, Madagascar, Brazil, Thailand, and Vietnam (IHS Markit Ltd., 2021).

China's exports of rare-earth compounds (HS code 2846) were 45,800 t (gross weight), nearly unchanged compared with those in 2017. The top four destinations of these exports were, in descending order, the United States (31%), Japan (28%), the Netherlands (17%), and the Republic of Korea (6%). China's exports of rare-earth metals (HS code 2805.30) were 7,390 t, and Japan (69%) was the leading destination (IHS Markit Ltd., 2021).

Greenland (Denmark).—Greenland Minerals and Energy Ltd. (GMEL) continued work on its polymetallic (REE-uranium-zinc) Kvanefjeld project in southern Greenland. In 2018, the company worked to improve its technical designs and submitted environmental and social impact assessments to the government of Greenland. GMEL was working with several companies based in China [Baotou Meng Rong Fine Materials Co. Ltd., China Communications Construction Co., and Shenghe Resources Holding Co. Ltd. (Shenghe)] and North America (Nuna Logistics, PND Engineers, Inc., and Tetra Tech, Inc.) on the commercial development of the project. Shenghe was a major shareholder in GMEL. The Kvanefjeld project's reserves were reported to be 108 Mt containing 1.43% (1.54 Mt) REO equivalent using a uranium-oxide cutoff grade of 150 ppm. Measured and indicated resources were reported to be 451 Mt containing about 1.14% (5.14 Mt) REO equivalent. Measured and indicated resources were less than one-half of the total resources (Greenland Minerals and Energy Ltd., 2016, p. 8, 16; 2019, p. 4–10).

India.—India's producers of rare-earth-bearing heavy-mineral concentrates included Indian Rare Earths Ltd. (IREL) and Kerala Metals & Minerals Ltd. India's monazite production capacity was reported by the Indian Bureau of Mines to be 6,240 t/yr. At Aluva, in the State of Kerala, IREL operations had the capacity to produce mixed rare-earth chlorides and separated compounds from monazite concentrates. At Chatrapur, in the State of Odisha, IREL was operating a processing plant that used monazite as a feedstock to produce up to 11,200 t/yr of mixed rare-earth chlorides. In the fiscal years 2018–19 (April 1, 2018, through March 31, 2019) and 2017–18 (April 1, 2017, through March 31, 2018), rare-earth chloride production was reported to be 4,215 t and 2,724 t, respectively (Indian Bureau of Mines, 2020, p. 24–3—24–4).

Japan.—Japan's Society of Newer Metals estimated the 2018 consumption of rare earths in Japan to be 18,600 t, a slight increase compared with 18,100 t in 2017. Consumption included cerium (6,350 t), neodymium and praseodymium (4,900 t), mixed rare-earth metals (3,700 t), lanthanum (1,960 t), yttrium (1,010 t), samarium (80 t), europium (11 t), and other (539 t) (Japan Society of Newer Metals, 2019).

Kazakhstan.—In October, Kazakhstan's National Mining Co. Tau-Ken Samruk JSC acquired the Summit Atom Rare Earth Co. LLP (SARECO) from Kazakhstan's National Atomic Co. Kazatomprom JSC. The SARECO operations in Stepnogorsk were reported to have a capacity of 1,500 t/yr of REO equivalent, although the company described the production as insignificant in 2018. SARECO's REO was a byproduct of uranium mining and processing (National Atomic Co. Kazatomprom JSC, 2019, p. 32).

Madagascar.—In 2018, QIT Madagascar Minerals (QMM) produced 16,000 t of monazite concentrates as a byproduct of processing heavy-mineral sands to produce ilmenite and zircon-sillimanite concentrates. QMM was owned by the Government of Madagascar (20%) and Rio Tinto plc (80%) (Rio Tinto plc, undated). In 2018, China imported 8,000 t of monazite concentrates from Madagascar (IHS Markit Ltd., 2021).

Malaysia.—Lynas continued to increase production of rare-earth compounds at its Lynas Advanced Material Plant (LAMP) near the Port of Kuantan in the State of Pahang. Production of REO from the LAMP operations in 2018 was 18,100 t, a 7% increase compared with production in 2017. Lynas continued efforts to increase its capacity to produce separated neodymium and praseodymium compounds. In December, Malaysia's Ministry for Energy, Science, Technology, Environment and Climate Change (MESTECC) added preconditions for the LAMP operations license renewal. The MESTECC preconditions included the removal from Malaysia of residues containing radioactive materials and an action plan for the disposal of "neutralization underflow" residues. Lynas reported that previously it had submitted an action plan and would consider all options to achieve a resolution prior to the September 2019 deadline (Lynas Corp. Ltd., 2018a, p. 7; 2018b; 2019).

Philippines.—At yearend, Japan's Sumitomo Metal Mining Co., Ltd. (SMM) was preparing to begin commercial-scale

production of a scandium intermediate product at its subsidiary Taganito HPAL Nickel Corp. on Palawan Island. The plant was expected to recover up to 7.5 t/yr of scandium-oxide equivalent from a process stream following the leaching of nickel laterite for nickel-cobalt sulfide. Processing of the intermediate product into scandium oxide was performed at SMM's Harima operation in Japan (Sumitomo Metal Mining Co., Ltd., 2018, p. 15, 26; 2019, p. 66).

Russia.—Imports of rare-earth compounds (HS code 2846) into Russia were 972 t in 2018, and exports were 6,150 t. Rare-earth-metal (HS code 2805.30) imports and exports were 98 t and 3 t, respectively. China was Russia's leading import source and Estonia was the leading export destination of rare-earth compounds (IHS Markit Ltd., 2021).

PJSC Acron continued to operate a 200-t/yr pilot plant to produce REEs in the form of mixed and separated rare-earth compounds at its Veliky Novgorod facility. The feed for the operation was a byproduct apatite mineral concentrate sourced from the company's Oleniy Ruchey phosphate mine in the Murmansk Region. In 2018, Acron produced 87 t of REO equivalent (Cotting and others, 2019).

JSC Dalur continued to recover an unknown quantity of scandium-oxide equivalent at the Dalmatovskoye uranium mining and processing operation in the Kurgan Region. In 2018, the company commissioned a pilot plant to produce aluminum-scandium master alloys (JSC Atomredmetzoloto, 2019, p. 59).

JSC Solikamsk Magnesium Works (SMW) in Perm Krai reported consumption of about 9,200 t of loparite concentrates sourced from mining operations near Revda in the Murmansk Region. SMW reported that shipments of rare-earth compounds were 2,600 t of REO equivalent in 2018. SMW was capable of processing up to 13,000 t/yr of loparite concentrate and producing compounds with up to 3,600 t/yr of REO equivalent (JSC Solikamsk Magnesium Works, 2020, p. 4–15).

United Company RUSAL Plc, one of the world's leading aluminum producers, was conducting pilot-plant studies in the Ural Mountains to recover scandium concentrate from red mud, a residue from the processing of bauxite. RUSAL was reported to have produced scandium oxide with greater than 99% purity (United Company RUSAL Plc, 2018).

South Africa.—Steenkampskraal Holdings Ltd. continued plans to reopen the Steenkampskraal (SKK) monazite mine that was active from 1952 to 1963. The company expected to produce up to 2,700 t/yr of REO equivalent in mixed carbonates. Using a 1%-REO cutoff grade, SKK's measured and indicated resources were reported to be 605,000 t containing 14.4% (86,900 t) REO equivalent (Steenkampskraal Holdings Ltd., 2018, p. i, iii).

Sweden.—The Swedish Mines Inspectorate notified Leading Edge Materials Corp. that it had extended the exploration license for the Norra Karr project in southern Sweden through 2019. In 2018, the Geological Survey of Finland performed a beneficiation study focused on removing iron impurities on bulk samples from Norra Karr. Probable reserves for the project were previously reported to be 23.6 Mt containing 0.592% (140,000 t) REO equivalent. Using a 0.4%-REO cutoff grade, indicated resources were 31.1 Mt containing 0.61% (190,000 t) REO equivalent. The predominate REE mineralization was eudialyte. A prefeasibility study was based on production of 5,000 t/yr of mixed REO and a 20-year mine life, using the 0.4%-REO cutoff grade (Tasman Metals Ltd., 2015, p. 42–43, 45; Leading Edge Materials Corp., 2019, p. 6–7).

Tanzania.—Peak Resources Ltd. continued the development of its Ngualla project with plans for mining operations in southwest Tanzania. As of June 2018, reserves were reported to be 18.5 Mt containing 4.8% (887,000 t) REO equivalent using a 1%-REO cutoff grade. Resources were reported to be 210 Mt containing 2.2% (4.6 Mt) REO equivalent, and 93% of the resources were classified as measured and indicated. Peak Resources expected the Ngualla operations to produce up to 32,700 t/yr of mineral concentrate containing 45% (14,700 t/yr) REO equivalent. At yearend, a special mining license was pending approval by Tanzania's Minister of Minerals (Peak Resources Ltd., 2018, p. 69–71; 2019, p. 3).

United Kingdom.—In September, Peak Resources was granted an environmental permit for its Teesside extraction and separation operations located in the Wilton industrial area near Middleborough. The company expected that the Teesside operation would process up to 32,700 t/yr of concentrates from its Ngualla mining operations and produce mixed and separated REO compounds (Peak Resources Ltd., 2019, p. 3–4).

Outlook

The annual average growth rate of REE consumption is expected to range from 5% to 10% through 2025 (Kingsnorth, 2018, p. 5; Adamas Intelligence, 2019, p. 15; Roskill Information Services Ltd., 2019). The leading end uses of rare earths are expected to be magnets, catalysts, and polishing compounds, in descending order of quantity. The magnet materials sector is expected to have higher than average growth, and the catalyst, ceramics, and phosphor sectors are expected to have lower than average growth. As the leading producer and consumer of rare-earth minerals and most downstream products, China is expected to continue to shape the global markets for rare-earth compounds and metal alloys. China's imports of mineral concentrates are expected to continue to significantly increase.

References Cited

Adamas Intelligence, 2019, Rare earth pricing outlook to 2030: Sudbury, Ontario, Canada, Adamas Intelligence, April 23, 46 p.

Alkane Resources Ltd., 2017, Dubbo project resource and reserve statements FY17: Burswood, Western Australia, Australia, Alkane Resources Ltd. press release, September 19, 21 p. (Accessed January 21, 2021, at http://investors.alkane.com.au/site/PDF/1033_0/DubboProjectResourceandReserveStatementsFY17.)

Alkane Resources Ltd., 2019, Interim financial report for the half-year ended 31 December 2018: Burswood, Western Australia, Australia, Alkane Resources Ltd., February 27, 29 p. (Accessed January 21, 2021, at https://investors.alkane.com.au/site/PDF/2322_0/HalfYearAccounts.)

Alvin, M.A., 2019, Feasibility of recovering rare earth elements: National Energy Technology Laboratory 2019 REE Annual Review Meeting presentation, Pittsburgh, PA, April 9–10, 13 p. (Accessed January 11, 2021, at https://netl.doe.gov/sites/default/files/2019-05/2019_Annual_Reports/Tuesday/ree/1%20-%20MAA%20REE%20Program%20Overview.pdf.)

Andrade, R.H.P., 2018, Terras raras [Rare earths], *in* Sumário mineral 2017: Brasilia, Brazil, Agência Nacional de Mineração, 201 p. (Accessed January 21, 2021, at https://www.gov.br/anm/pt-br/centrais-de-conteudo/publicacoes/serie-estatisticas-e-economia-mineral/sumario-mineral/sumariomineral_2017.) [In Portuguese.]

Arafura Resources Ltd., 2020, 2019 annual report: Perth, Western Australia, Australia, Arafura Resources Ltd., January 17, 77 p. (Accessed January 15, 2021, at https://www.arultd.com/images/20200117_Arafura_AR_2019-INCL_FINS-WEB-FINAL_reduced.pdf.)

Asian Metal Inc., 2019, Rare earth industry annual 2018: Beijing, China, Asian Metal Inc., February 20, 20 p. (Accessed February 25, 2019, via http://www.asianmetal.com/.)

Australian Mines Ltd., 2018, Investor presentation—November 2018: Brisbane, Queensland, Australia, Australian Mines Ltd., January 31, 35 p. (Accessed January 21, 2021, at https://cdn-api.markitdigital.com/apiman-gateway/ASX/asx-research/1.0/file/2995-02049947-6A910055?access_token=83ff96335c2d45a094df02a206a39ff4.)

Australian Mines Ltd., 2019, $1.9 million received from Commonwealth Government: Brisbane, Queensland, Australia, Australian Mines Ltd. press release, January 15, 2 p. (Accessed January 21, 2021, at https://cdn-api.markitdigital.com/apiman-gateway/ASX/asx-research/1.0/file/2995-02066755-6A916311?access_token=83ff96335c2d45a094df02a206a39ff4.)

Clean TeQ Holdings Ltd., 2018, Annual report 2018: Notting Hill, Victoria, Australia, Clean TeQ Holdings Ltd., August 27, 98 p. (Accessed January 21, 2021, at https://clients3.weblink.com.au/clients/cleanteq/headline.aspx?headlineid=3499311.)

Commerce Resources Corp., 2019, Management discussion & analysis for three months ended January 31, 2019: Vancouver, British Columbia, Canada, Commerce Resources Corp., March 13, 12 p. (Accessed January 22, 2021, at https://www.commerceresources.com/assets/docs/CCE%20MDA%20Q1%20January%2031%202019%20FINAL.pdf.)

Cotting, Ashleigh, Woodall, Toby, and Javier, Jose, 2019, Russia struggling to capitalize on rare earth reserves: S&P Global Market Intelligence. (Accessed January 25, 2021, at https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/russia-struggling-to-capitalize-on-rare-earth-reserves-52525919.)

Defense Logistics Agency Strategic Materials, 2018, Annual Materials Plan for FY 2019: Fort Belvoir, VA, Defense National Stockpile Center news release DLA–SM–18–3152, October 3, 1 p. (Accessed January 11, 2021, at https://www.dla.mil/Portals/104/Documents/Strategic%20Materials/Announcements/3152%20FY19%20AMP_ACQ.pdf?ver=2018-10-03-091748-770.)

Greenland Minerals and Energy Ltd., 2016, Raw materials for a clean and energy efficient future—2015 annual report: Subiaco, Western Australia, Australia, Greenland Minerals and Energy Ltd., March 30, 77 p. (Accessed January 22, 2021, at https://www.ggg.gl/assets/Uploads/Annual-Reports/e3721988ca/2015-Annual-Report.pdf.)

Greenland Minerals and Energy Ltd., 2019, Materials for an energy efficient future—2018 annual report: Subiaco, Western Australia, Australia, Greenland Minerals and Energy Ltd., March 29, 70 p. (Accessed January 22, 2021, at https://wcsecure.weblink.com.au/pdf/GGG/02091508.pdf.)

Hastings Technology Metals Ltd., 2019, December 2018 quarterly report: Perth, Western Australia, Australia, Hastings Technology Metals Ltd., December 31, 11 p. (Accessed January 21, 2021, at https://www.investi.com.au/api/announcements/has/52a7044d-dfa.pdf.)

IHS Markit Ltd., 2021, Global trade atlas: London, United Kingdom, IHS Markit Ltd. (Accessed January 21, 2021, via https://connect.ihsmarkit.com/home.)

Indian Bureau of Mines, 2020, Rare earths, *in* Part III—Mineral reviews (58th ed.) (advance release): Nagpur, India, Indian Minerals Yearbook 2019, v. III, September, p. 24–1 to 24–10. (Accessed January 22, 2021, at https://ibm.gov.in/writereaddata/files/10012020172151RareEarth_2019_AR.pdf.)

Japan Society of Newer Metals, 2019, Demand for rare earths in 2018: Tokyo, Japan, Japan Society of Newer Metals, March 27. (Accessed January 22, 2021, via http://www.jsnm.or.jp/news/?p=1176.)

JSC Atomredmetzoloto, 2019, The power of generations—2018 annual report: Moscow, Russia, JSC Atomredmetzoloto, August 21, 117 p. (Accessed January 25, 2021, at https://report.rosatom.ru/go_eng/atomredmedzoloto/go_armz_2018/go_armz_2018.pdf.)

JSC Solikamsk Magnesium Works, 2020, Annual report 2019: Solikamsk, Russia, JSC Solikamsk Magnesium Works, June 18, 38 p. (Accessed January 21, 2021, at http://xn--g1ajo.xn--p1ai/raport/2020/2019_Solikamsk_Magnesium_Works_Annual_Report_ENG.pdf.)

Kingsnorth, Dudley, 2018, Rare earth supply today—Lacking diversity for long term sustainability: Mount Claremont, Western Australia, Australia, Industrial Minerals Co. of Australia Pty Ltd., October, 17 p.

Leading Edge Materials Corp., 2019, Management's discussion and analysis for the year ended October 31, 2018: Vancouver, British Columbia, Canada, Leading Edge Materials Corp., January 23, 14 p. (Accessed January 26, 2021, at https://leadingedgematerials.com/wp-content/uploads/2019/01/LEM-MDA-OCTOBER-31-2018.pdf.)

Lynas Corp. Ltd., 2018a, Lynas announces a 60% increase to Mt Weld ore reserves, one of the world's richest sources of rare earths: East Perth, Western Australia, Australia, Lynas Corp. Ltd., August 6, 29 p. (Accessed January 21, 2021, at https://www.lynascorp.com/wp-content/uploads/2019/05/180806-Resources-and-Reserves-Update-2018-1827684.pdf.)

Lynas Corp. Ltd., 2018b, Review committee report summary: East Perth, Western Australia, Australia, Lynas Corp. Ltd. news release, December 5. (Accessed January 25, 2021, at https://www.lynascorp.com/news/review-committee-report-summary/.)

Lynas Corp. Ltd., 2019, Quarterly report for the period ending 31 December 2018: East Perth, Western Australia, Australia, Lynas Corp. Ltd., January 22, 10 p. (Accessed January 25, 2021, at https://www.lynascorp.com/wp-content/uploads/2019/04/190122-Quarterly-Activities-Report-1.pdf.)

Mason, Brian, and Moore, Carleton, 1982, Principles of geochemistry (4th ed.): New York, NY, John Wiley & Sons, 344 p.

Matamec Explorations Inc., 2013, Matamec announces results of positive feasibility study for Kipawa JV heavy rare earth project: Montreal, Quebec, Canada, Matamec Explorations Inc., presentation, September 4, 17 p. (Accessed January 22, 2021, via https://www.sedar.com/.)

Medallion Resources Ltd., 2019, Medallion Resources Ltd. management discussion and analysis of financial results for the nine months ended December 31, 2018: Montreal, Quebec, Canada, Medallion Resources Ltd., February 21, 13 p. (Accessed January 22, 2021, via https://www.sedar.com/.)

MP Materials Corp., 2020, Prospectus: Las Vegas, NV, MP Materials Corp., December 28, 149 p. plus appendices. (Accessed March 9, 2022, at https://d18rn0p25nwr6d.cloudfront.net/CIK-0001801368/51640eb1-af07-4aa1-8d53-9760f2cfcce1.pdf.)

National Atomic Co. Kazatomprom JSC, 2019, 2018 integrated annual report: Astana, Kazakhstan, National Atomic Co. Kazatomprom JSC, 131 p. (Accessed January 25, 2021, at https://otp.tools.investis.com/clients/uk/kazatomprom/rns/regulatory-story.aspx?cid=2438&newsid=1257659.)

National Science Foundation, 2018, SBIR Phase II—Sustainable rare earth element recycling from neodymium magnets: National Science Foundation award abstract #1632711, June 25. (Accessed January 11, 2021, at https://www.nsf.gov/awardsearch/showAward?AWD_ID=1632711.)

NioCorp Developments Ltd., 2017, Revised NI 43–101 technical report feasibility study Elk Creek niobium project Nebraska: Centennial, CO, NioCorp Developments Ltd., December 15, 466 p. plus appendices. (Accessed February 14, 2019, via https://www.sedar.com/.)

NioCorp Developments Ltd., 2019, Form 10–Q: U.S. Securities and Exchange Commission, 25 p. (Accessed January 13, 2021, at http://www.niocorp.com/wp-content/uploads/NioCorp_10Q_Q2_2019_as_filed.pdf.)

Northern Minerals Ltd., 2015, Increased ore reserve for Browns Range project: West Perth, Western Australia, Australia, Northern Minerals Ltd., Australian Securities Exchange announcement, March 2, 18 p. (Accessed January 21, 2021, via https://northernminerals.com.au/asx-announcements/.)

Northern Minerals Ltd., 2019, Quarterly activities report—December 2018: West Perth, Western Australia, Australia, Northern Minerals Ltd., January 31, 13 p. (Accessed January 21, 2021, via https://northernminerals.com.au/news-reports-presentations/#halfyearlyreports.)

Peak Resources Ltd., 2018, Annual report 2018: West Perth, Western Australia, Australia, Peak Resources Ltd., October 10, 76 p. (Accessed January 26, 2021, at https://wcsecure.weblink.com.au/pdf/PEK/02033178.pdf.)

Peak Resources Ltd., 2019, Half year report 31 December 2018: West Perth, Western Australia, Australia, Peak Resources Ltd., March 8, 23 p. (Accessed January 26, 2021, at https://wcsecure.weblink.com.au/pdf/PEK/02085005.pdf.)

Platina Resources Ltd., 2018, Platina scandium project—Ore reserve increase: Mount Hawthorn, Western Australia, Australia, Platina Resources Ltd., December 13, 21 p. (Accessed January 21, 2021, via https://www2.asx.com.au/markets/trade-our-cash-market/announcements.pgm.)

Platina Resources Ltd., 2019, Interim financial report for the half-year ended 31 December 2018: Mount Hawthorn, Western Australia, Australia, Platina Resources Ltd., March 12, 19 p. (Accessed January 21, 2021, via https://www2.asx.com.au/markets/trade-our-cash-market/announcements.)

Quebec Precious Metals Corp., 2018, Management discussion and analysis for the three and nine month periods ended October 31, 2018: Eeyou Istchee Baie-James, Quebec, Canada, Quebec Precious Metals Corp., December 20, 28 p. (Accessed March 18, 2021, via https://www.sedar.com/.)
Rainbow Rare Earths Ltd., 2019, Rainbow Rare Earths Ltd interim results for the six months ended 31 December 2018: St. Peter Port, Guernsey [United Kingdom], Rainbow Rare Earths Ltd., March 12, 22 p. (Accessed January 21, 2021, at https://rainbowrareearths.com/wp-content/uploads/2019/03/Rainbow-Group-Interims-31Dec18-FINAL.pdf.)
Rare Element Resources Ltd., 2018, Form 10–K—2017: U.S. Securities and Exchange Commission, March 26, 73 p. (Accessed January 21, 2021, at https://www.sec.gov/Archives/edgar/data/1419806/000105291818000086/rer10kmar26-18v2.htm.)
Rare Element Resources Ltd., 2019, Form 10–K—2018: U.S. Securities and Exchange Commission, March 29, 89 p. (Accessed January 26, 2021, at https://www.sec.gov/Archives/edgar/data/1419806/000105291819000058/rer10kmar29-19.htm.)
Rio Tinto plc, [undated], QIT Madagascar Minerals: London, United Kingdom, Rio Tinto plc (Accessed May 24, 2019, at https://www.riotinto.com/en/operations/madagascar/qit-madagascar-minerals.)
Roscoe Associates Inc., 2016, Search Minerals Inc.—Technical report on the Foxtrot project, Newfoundland & Labrador, Canada: North Vancouver, British Columbia, Canada, Search Minerals Inc., April 28, [variously paged]. (Accessed January 22, 2021, via https://www.sedar.com/.)
Roskill Information Services Ltd., 2019, Rare earths—Outlook to 2029 (19th ed.): London, United Kingdom, Roskill Information Services Ltd., 373 p.
Scandium International Mining Corp., 2019, Form 10–K—2018: U.S. Securities and Exchange Commission, February 27, 47 p. (Accessed January 21, 2021, at https://www.sec.gov/Archives/edgar/data/0001408146/000106299319001141/form10k.htm.)
Search Minerals Inc., 2019, Search Minerals Inc. management's discussion and analysis for the year ended November 30, 2018: North Vancouver, British Columbia, Canada, Search Minerals Inc., April 1, 20 p. (Accessed January 21, 2021, via https://www.sedar.com/.)
Steenkampskraal Holdings Ltd., 2018, Steenkampskraal rare earth and thorium project: Strand, South Africa, Steenkampskraal Holdings Ltd., January, 58 p. (Accessed January 26, 2021, at https://steenkampskraal.com/wp-content/uploads/STEENKAMPSKRAAL-INFORMATION-MEMORANDUM-JANUARY-2018.pdf.)
Sumitomo Metal Mining Co., Ltd., 2018, Integrated report 2018: Tokyo, Japan, Sumitomo Metal Mining Co., Ltd., November, 173 p. (Accessed January 25, 2021, at https://www.smm.co.jp/en/ir/library/integrated_report/.)
Sumitomo Metal Mining Co., Ltd., 2019, Integrated report 2019: Tokyo, Japan, Sumitomo Metal Mining Co., Ltd., October, 258 p. (Accessed January 25, 2021, via https://www.smm.co.jp/ir/library/integrated_report/.)
Tasman Metals Ltd., 2015, Form 20–F—For the fiscal year ended August 31, 2015: U.S. Securities and Exchange Commission, November 30, 116 p. (Accessed January 26, 2018, at http://www.sedar.com/GetFile.do?lang=EN&docClass=2&issuerNo=00029095&issuerType=03&projectNo=02424798&docId=3837116.)
Texas Mineral Resources Corp., 2014, Amended NI 43–101 preliminary economic assessment Round Top project: Sierra Blanca, TX, Texas Mineral Resources Corp., April 28, 197 p. (Accessed January 14, 2021, at http://tmrcorp.com/_resources/reports/Amended_TRER_NI43-101_PEA_FINAL_28April2014.pdf.)
Texas Mineral Resources Corp., 2018, TMRC secures development and funding partner for Round Top rare earth project: Sierra Blanca, TX, Texas Mineral Resources Corp. press release, November 20. (Accessed January 14, 2021, at http://tmrcorp.com/news/press_releases/index.php?content_id=189.)
Ucore Rare Metals Inc., 2019, Management's discussion and analysis for the year ended December 31, 2018: Bedford, Nova Scotia, Canada, Ucore Rare Metals Inc., April 30, 29 p. (Accessed January 14, 2021, via https://www.sedar.com/.)
United Company RUSAL Plc, 2018, RUSAL to complete a feasibility study for an industrial-scale scandium plant in 2018: Moscow, Russia, United Company RUSAL Plc press release, June 2. (Accessed January 26, 2021, at https://rusal.ru/en/press-center/press-releases/rusal_to_complete_a_feasibility_study_for_an_industrial_scale_scandium_plant_in_2018/?sphrase_id=19582.)
U.S. Department of Energy, 2019, The Critical Materials Institute—An energy innovation hub: U.S. DOE Advanced Manufacturing Office program review meeting, Washington, DC, June 11, 29 p. (Accessed January 11, 2021, at https://www.energy.gov/sites/prod/files/2019/07/f64/003-Consortia19%20-%20Critical%20Materials%20Institute.pdf.)
U.S. Small Business Administration, 2021, Award database: Washington, DC, U.S. Small Business Administration. (Accessed January 11, 2021, via https://www.sbir.gov/sbirsearch/award/all/rare%20earth?f%5B0%5D=itm_field_award_yr%3A2018&f%5B1%5D=im_field_agencies%3A105731.)

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

Historical Statistics for Mineral and Material Commodities in the United States. Data Series 140.
Rare-Earth Elements. Ch. in Critical Mineral Resources of the United States—Economic and Environmental Geology and Prospects for Future Supply, Professional Paper 1802, 2017.
Rare-Earth Metals (Ce, Dy, Eu, Gd, La, Nd, Pr, Sm, Sc, Tb, Y). Ch. in Metal Prices in the United States Through 2010, Scientific Investigations Report 2012–5188, 2013.
Rare-Earth Oxides. International Strategic Minerals Inventory Summary Report, Circular 930–N, 1993.
Rare Earths. Ch. in Mineral Commodity Summaries, annual.
Scandium. Ch. in Mineral Commodity Summaries, annual.
Thorium. Ch. in Mineral Commodity Summaries, annual.
Thorium. Ch. in Minerals Yearbook, annual.
Yttrium. Ch. in Mineral Commodity Summaries, annual.

Other

China Rare Earth Information (newsletter), monthly.
Industrial Minerals, monthly.
Metal Bulletin, weekly.
Rare Earth Elements and Yttrium. Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.
Rare Earth Market Outlook to 2030. Adamas Intelligence, 2020.
Rare Earths. Ch. in Industrial Minerals and Rocks—Commodities, Markets, and Uses, Society for Mining, Metallurgy, and Exploration Inc., 7th ed., 2006.
Rare Earths—Outlook to 2029. Roskill Information Services Ltd., 2019.

TABLE 1
SALIENT RARE EARTH STATISTICS[1]

		2014	2015	2016	2017	2018
United States:						
Production of rare-earth concentrates, rare-earth-oxide (REO) equivalent[e]	metric tons	5,400 [2]	5,900 [2]	--	--	14,000 [3]
Exports, REO equivalent:[e]						
Rare-earth concentrates, monazite	do.	--	--	--	--	261 [e]
Compounds:						
Cerium compounds	do.	406 [r]	440	309	1,140	304
Other rare-earth compounds	do.	3,800 [r]	4,540	281	595 [r]	17,300 [4]
Metals:						
Ferrocerium and pyrophoric alloys	do.	1,640	1,220	943	982	1,250
Rare-earth metals, scandium, yttrium	do.	149 [r]	60	103	55	28
Imports for consumption, REO equivalent:[e]						
Compounds:						
Cerium compounds	do.	1,440 [r]	1,440	1,830	2,430 [r]	2,940
Other rare-earth compounds	do.	9,150 [r]	7,720	9,650	8,570 [r]	7,890
Metals:						
Ferrocerium and pyrophoric alloys	do.	371	356	268	309	298
Rare-earth metals, scandium, yttrium	do.	428 [r]	385	404	524	526
Price, annual average:						
Monazite concentrate, gross basis[e]	dollars per kilogram	3.50	2.56	2.57	2.70	2.36
Mischmetal, 65% cerium, 35% lanthanum, metal basis[5]	do.	9.56	6.93	5.17	5.51	6.16
World production, REO equivalent	metric tons	125,000 [r]	129,000	133,000 [r]	147,000 [r]	190,000

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

[1]Table includes data available through January 26, 2021. Data are rounded to no more than three significant digits, except U.S. production, which is rounded to two significant digits.

[2]Sources: Molycorp, Inc., 2015a, Form 10–K—2014: Greenwood Village, CO, Molycorp, Inc., 148 p.; Molycorp, Inc., 2015b, Form 10–Q—For the quarterly period ending June 30, 2015: U.S. Securities and Exchange Commission, 71 p.

[3]Sources: MP Materials Corp., 2020, Prospectus: Las Vegas, NV, MP Materials Corp., December 28, 149 p.; U.S. Census Bureau.

[4]Includes bastnaesite mineral concentrates.

[5]Source: Argus Media group – Argus Metals International.

TABLE 2
RARE EARTH CONTENTS OF SELECTED SOURCE MINERALS[1, 2]

(Percentage of total rare-earth oxide)

			Rare earth element														
Primary source	Country	Location	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Y
Bastnaesite	China	Bayan Obo, Nei Mongol Autonomous Region[3]	23.00	50.00	6.20	18.50	0.80	0.20	0.70	0.10	0.10	NA	NA	NA	NA	NA	NA
Do.	do.	Dechang, Sichuan Province[4]	35.63	43.81	4.73	13.06	1.22	0.23	0.52	0.06	0.09	0.05	0.04	0.01	0.06	NA	0.40
Do.	do.	Maoniuping, Sichuan Province[4]	29.49	47.56	4.42	15.18	1.24	0.23	0.65	0.12	0.21	0.05	0.06	0.04	0.05	0.01	0.70
Do.	do.	Weishan, Shandong Province[4]	35.46	47.76	3.95	10.90	0.79	0.13	0.53	0.14	NA	NA	NA	NA	0.03	NA	0.76
Do.	United States	Mountain Pass, CA[5]	34.00	48.80	4.20	11.70	0.79	0.13	0.21	NA	NA	NA	NA	NA	NA	NA	0.12
Loparite	Russia	Revda, Murmansk Oblast[6]	25.00	50.50	5.00	15.00	0.70	0.09	0.60	NA	0.60	0.70	0.80	0.10	0.20	0.15	1.30
Monazite	Australia	Mount Weld Central Lanthanide, Western Australia[7]	23.88	47.55	5.16	18.13	2.44	0.53	1.09	0.09	0.25	0.03	0.06	0.01	0.03	NA	0.76
Do.	China	Nangang, Guangdong Province[4]	23.00	42.70	4.10	17.00	3.00	0.10	2.00	0.70	0.80	0.12	0.30	NA	2.40	0.14	2.40
Do.	India	Manavalakurichi, Tamil Nadu[8]	22.00	46.00	5.50	20.00	2.50	0.02	1.20	0.06	0.18	0.02	0.01	0.00	0.00	0.00	0.45
Rare-earth laterite	China	Xunwu, Jiangxi Province[4]	38.00	3.50	7.41	30.18	5.32	0.51	4.21	0.46	1.77	0.27	0.88	0.13	0.62	0.13	10.07
Do.	do.	Xinfeng, Jiangxi Province[4]	27.26	3.23	5.62	17.55	4.54	0.93	5.96	0.68	3.71	0.74	2.48	0.27	1.13	0.21	24.26
Do.	do.	Longnan, Jiangxi Province[4]	2.18	<1.09	1.08	3.47	2.34	<0.37	5.69	1.13	7.48	1.60	4.26	0.60	3.34	0.47	64.90
Xenotime	do.	Southeast Guangdong Province[9]	1.20	3.00	0.60	3.50	2.20	0.20	5.00	1.20	9.10	2.60	5.60	1.30	6.00	1.80	59.30

Do., do. Ditto. NA Not available.

[1]Table includes data available through December 20, 2019. Data are rounded to no more than three significant digits; rows may not add to 100 percent.

[2]Rare earths are listed in order of atomic number except yttrium, which is listed after the lanthanide elements.

[3]Zang, Zhang Bao, Lu, Ke Yi, King, Kue Chu, Wei, Wei Cheng, and Wang, Wen Cheng, 1982, Rare-earth industry in China: Hydrometallurgy, v. 9, no. 2, p. 205–210.

[4]Zhi Li, Ling, and Yang, Xiaosheng, 2014, China's rare earth ore deposits and beneficiation techniques: ERES 2014—1st European Rare Earth Resources Conference, Milos, Greece, April 4–7, 11 p.

[5]Molycorp, Inc., 2015, Form 10–K—2014: Greenwood Village, CO, Molycorp, Inc., 145 p. (Accessed June 30, 2016, at http://www.molycorp.com/investors.)

[6]Hedrick, J.B., Sinha, S.P., and Kosynkin, V.D., 1997, Loparite, a rare-earth ore: Journal of Alloys and Compounds, v. 250, p. 467–470.

[7]Lynas Corp. Ltd., 2012, Increase in Mt Weld resource estimate for the Central Lanthanide deposit and Duncan deposit: Sydney, New South Wales, Australia, Lynas Corp. Ltd. news release, January 18, 5 p.

[8]Patra, R.N., 2014, Latest scenario in rare earth and atomic minerals in India: PDAC Convention 2014, Toronto, Ontario, Canada, March 2–4, 42 p.

[9]Nakamura, Shigeo, 1988, China and rare metals—Rare earth: Industrial Rare Metals, no. 94, May, p. 23–28.

TABLE 3
RARE-EARTH-OXIDE PRICES[1]

Product (oxide)	Purity (percent)	Price (dollars per kilogram) 2017	2018
Scandium[2]	99.990	4,600	4,600
Yttrium[3]	99.999	3	3
Lanthanum[3]	99.500	2	2
Cerium[3]	99.500	2	2
Praseodymium[3]	99.500	65	63
Neodymium[3]	99.500	50	50
Samarium[3]	99.500	2	2
Europium[3]	99.990	77	53
Gadolinium[3]	99.999	37	44
Terbium[3]	99.990	501	455
Dysprosium[3]	99.500	187 r	179

rRevised.
[1]Products are listed in order of atomic number.
[2]Source: Stanford Metals Corp.
[3]Source: Argus Media group – Argus Metals International.

TABLE 4

U.S. EXPORTS OF RARE-EARTH COMPOUNDS, BY COUNTRY OR LOCALITY[1]

Category and country or locality	HTS[2] code	2017 Gross weight (kilograms)	2017 Value	2018 Gross weight (kilograms)	2018 Value
Cerium compounds:	2846.10.0000				
Austria		25,900	$355,000	32,300	$433,000
China		1,410,000	2,950,000	26,500	1,120,000
Germany		16,500	644,000	37,300	1,050,000
Japan		48,600	361,000	35,600	431,000
Korea, Republic of		21,600	1,270,000	136,000	1,650,000
Taiwan		83,100	429,000	96,000	666,000
Other		97,200 r	2,010,000 r	90,700	11,100,000
Total		1,710,000	8,010,000	455,000	16,400,000
Total rare-earth-oxide (REO) equivalent		1,140,000 e	XX	304,000 e	XX
Other rare-earth compounds:					
Oxides:					
Lanthanum oxides:	2846.90.2005				
Colombia		--	--	1,780	17,600
India		--	--	4,550	16,700
Korea, Republic of		--	--	978	38,600
Thailand		--	--	7,120	39,300
Other		--	--	1,550	2,190,000
Total		--	--	16,000	2,300,000
Total REO equivalent		--	XX	16,000 e	XX
Scandium or yttrium oxides:	2846.90.2015				
Finland		--	--	4,090	19,500
Germany		1,150	371,000	7,480	315,000
Mexico		--	--	2,000	6,670
Other		675 r	36,100 r	503	142,000
Total		1,820	407,000	14,100	484,000
Total REO equivalent		1,820 e	XX	14,100 e	XX
Other oxides:	2846.90.2040				
Argentina		8,780	54,000	--	--
Finland		3,780	20,600	6,190	29,500
France		1,150	150,000	1,000	279,000
India		13,800	50,100	--	--
Singapore		2,250	14,200	3	16,700
Switzerland		2,740	1,710,000	3,650	2,490,000
Other		552 r	584,000 r	1,900	598,000
Total		33,100	2,580,000	12,700	3,410,000
Total REO equivalent		33,100 e	XX	12,700 e	XX
Chlorides:	2846.90.2060				
Australia		9,740	47,500	--	--
Colombia		13,500	28,600	15,300	18,900
Jordan		--	--	40,100	53,200
Kuwait		--	--	14,600	19,500
Mexico		90,300	177,000	10	4,370
Other		7,020 r	804,000 r	4,010	53,500
Total		121,000	1,060,000	74,000	149,000
Total REO equivalent		55,500 e	XX	34,000 e	XX
Unspecified rare-earth compounds:	2846.90.9000				
China		541,000	1,640,000	32,600,000	71,600,000
Other		376,000 r	6,870,000 r	411,000	8,270,000
Total		917,000	8,510,000	33,000,000	79,900,000
Total REO equivalent		504,000 r, e	XX	17,200,000 e	XX
Grand total		2,780,000	20,600,000	33,600,000	103,000,000
Grand total REO equivalent		1,740,000 e	XX	17,600,000 e	XX

eEstimated. rRevised. XX Not applicable. -- Zero.

[1]Table includes data available through December 20, 2019. Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Harmonized Tariff Schedule of the United States.

Source: U.S. Census Bureau.

TABLE 5
U.S. EXPORTS OF RARE-EARTH METALS AND ALLOYS, BY COUNTRY OR LOCALITY[1]

Category and country or locality	HTS[2] code	2017 Gross weight (kilograms)	2017 Value	2018 Gross weight (kilograms)	2018 Value
Ferrocerium and other pyrophoric alloys:	3606.90.0000				
Aruba		18,100	$51,700	18,900	$31,200
Barbados		41,700	92,000	48,200	112,000
Canada		382,000	1,170,000	394,000	1,260,000
China		98,300	2,970,000	12,700	529,000
Colombia		66	20,100	18,000	97,400
Costa Rica		109,000	240,000	40,900	121,000
Dominican Republic		47,800	96,400	27,700	51,200
Haiti		17,100	25,500	31,600	40,400
Honduras		44,000	47,500	208,000	230,000
Hong Kong		476	16,600	19,800	21,700
Jamaica		13,400	34,100	9,500	36,500
Japan		8,600	308,000	15,000	981,000
Mexico		50,900	205,000	159,000	602,000
Panama		5,520	71,100	75,600	126,000
Trinidad and Tobago		40,500	78,300	35,300	54,500
Turkey		16,600	49,100	--	--
United Kingdom		111,000	528,000	167,000	962,000
Other		101,000 r	2,420,000 r	131,000	4,450,000
Total		1,110,000	8,430,000	1,410,000	9,710,000
Total rare-earth-oxide (REO) equivalent		982,000 e	XX	1,250,000 e	XX
Rare-earth metals and alloys:	2805.30.0000				
Australia		6,340	56,000	2	3,000
Brazil		4,540	49,100	386	21,300
China		7,930	323,000	2,210	208,000
Hungary		1,390	89,900	1,140	86,000
India		2,940	119,000	816	52,900
Ireland		1,120	16,000	713	21,100
Japan		1,310	81,200	3,100	188,000
Mexico		3,880	234,000	644	193,000
Saudi Arabia		4,060	85,700	--	--
United Kingdom		6,620	333,000	10,700	2,010,000
Other		3,480	616,000 r	2,120	327,000
Total		43,600	2,000,000	21,800	3,110,000
Total REO equivalent		55,400 e	XX	27,700 e	XX

eEstimated. rRevised. XX Not applicable. -- Zero.

[1]Table includes data available through December 20, 2019. Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Harmonized Tariff Schedule of the United States.

Source: U.S. Census Bureau.

TABLE 6

U.S. IMPORTS FOR CONSUMPTION OF RARE-EARTH COMPOUNDS, BY COUNTRY OR LOCALITY[1]

Category and country or locality	HTS[2] code	2017 Gross weight (kilograms)	2017 Value	2018 Gross weight (kilograms)	2018 Value
Cerium oxides:	2846.10.0010				
China		324,000	$1,690,000	275,000	$2,420,000
Japan		313,000	13,900,000	389,000	17,900,000
Other		41,900	975,000	22,600	690,000
Total		679,000	16,600,000	687,000	21,000,000
Total rare-earth-oxide (REO) equivalent		679,000 e	XX	687,000 e	XX
Cerium compounds, other than cerium oxide:	2846.10.0050				
China		1,930,000 r	7,320,000 r	2,400,000	9,530,000
Estonia		467,000	696,000	676,000	1,860,000
Other		227,000	1,460,000	295,000	1,410,000
Total		2,620,000 r	9,470,000 r	3,370,000	12,800,000
Total REO equivalent		1,750,000 r, e	XX	2,260,000 e	XX
Other rare-earth compounds:					
Carbonates:					
Lanthanum carbonates mixtures:	2846.90.8070				
China		657,000	2,270,000	219,000	989,000
Other		--	--	30	22,500
Total		657,000	2,270,000	219,000	1,010,000
Total REO equivalent		450,000 e	XX	150,000 e	XX
Other rare-earth carbonates mixtures:	2846.90.8075				
China		5,830	309,000	5,690	464,000
Germany		39	7,500	--	--
Total		5,870	316,000	5,690	464,000
Total REO equivalent		3,230 e	XX	3,130 e	XX
Chlorides:					
Scandium or yttrium chloride mixtures:	2846.90.2082				
Canada		--	--	4,000	15,600
China		--	--	4,030	24,400
Other		50	21,800	31	12,000
Total		50	21,800	8,060	52,000
Total REO equivalent		19 e	XX	2,980 e	XX
Unspecified mixtures of oxides or chlorides:	2846.90.2084				
China		402,000	1,350,000	832,000	2,270,000
Other		87,200 r	1,290,000 r	44,900	1,690,000
Total		489,000	2,640,000	877,000	3,960,000
Total REO equivalent		269,000 e	XX	483,000 e	XX
Oxides:					
Lanthanum oxides:	2846.90.2005				
China		2,160,000	5,400,000	1,400,000	3,560,000
Other		53,000	277,000	11,700	75,800
Total		2,220,000	5,680,000	1,410,000	3,640,000
Total REO equivalent		2,220,000 e	XX	1,410,000 e	XX
Scandium or yttrium oxides:	2846.90.2015				
China		39,000	719,000	10,100	265,000
Korea, Republic of		2,310	467,000	3,520	659,000
Other		2,590	558,000	3,140	922,000
Total		43,900	1,740,000	16,800	1,850,000
Total REO equivalent		43,900 e	XX	16,800 e	XX
Other oxides:	2846.90.2040				
China		33,000	1,550,000	118,000	4,420,000
Estonia		--	--	12,000	710,000
Other		6,970 r	194,000 r	10,700	366,000
Total		39,900	1,740,000	140,000	5,490,000
Total REO equivalent		39,900 e	XX	140,000 e	XX

See footnotes at end of table.

TABLE 6—Continued

U.S. IMPORTS FOR CONSUMPTION OF RARE-EARTH COMPOUNDS, BY COUNTRY OR LOCALITY[1]

Category and country or locality	HTS[2] code	2017		2018	
		Gross weight (kilograms)	Value	Gross weight (kilograms)	Value
Other rare-earth compounds or mixtures:					
Unspecified compounds or mixtures:	2846.90.8090				
China		8,590,000 r	50,300,000 r	8,140,000	60,600,000
Estonia		560,000	2,120,000	384,000	3,790,000
Malaysia		54,000	419,000	857,000	3,390,000
Other		807,000 r	31,800,000 r	672,000	26,000,000
Total		10,000,000 r	84,600,000 r	10,100,000	93,800,000
Total REO equivalent		5,510,000 r, e	XX	5,530,000 e	XX
Yttrium materials and compounds content by weight greater than 19% but less than 85% oxide equivalent:	2846.90.3999				
China		68,100	1,080,000	252,000	1,240,000
Other		791	1,340,000	914	1,580,000
Total		68,900	2,420,000	253,000	2,820,000
Total REO equivalent		41,300 e	XX	152,000 e	XX

eEstimated. rRevised. XX Not applicable. -- Zero.

[1]Table includes data available through December 20, 2019. Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Harmonized Tariff Schedule of the United States.

Source: U.S. Census Bureau.

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF RARE-EARTH METALS AND ALLOYS, BY COUNTRY OR LOCALITY[1]

Category and country or locality	HTS[2] code	2017 Gross weight (kilograms)	2017 Value	2018 Gross weight (kilograms)	2018 Value
Ferrocerium and other pyrophoric alloys:	3606.90.3010, 3606.90.3090				
Austria		41,400	$427,000	54,300	$552,000
China		122,000	1,520,000	99,500	1,300,000
Spain		118,000	2,010,000	136,000	2,440,000
United Kingdom		52,400	271,000	30,900	170,000
Other		14,200	109,000	15,500	179,000
Total		348,000	4,340,000	336,000	4,640,000
Total rare-earth-oxide (REO) equivalent		309,000 e	XX	298,000 e	XX
Rare-earth metals and alloys:					
Cerium, unalloyed:	2805.30.0010				
China		65,900	482,000	71,000	617,000
United Kingdom		2,810	99,900	515	27,500
Total		68,700	581,000	71,500	645,000
Total REO equivalent		84,400 e	XX	87,900 e	XX
Lanthanum, unalloyed:	2805.30.0005				
China		97,800	887,000	70,700	1,310,000
Other		1	3,860	2,480	204,000
Total		97,800	891,000	73,100	1,520,000
Total REO equivalent		115,000 e	XX	85,800 e	XX
Neodymium, unalloyed:	2805.30.0020				
China		1,820	61,600	7,260	338,000
Japan		81	13,000	--	--
United Kingdom		1,480	71,200	350	51,200
Total		3,380	146,000	7,610	390,000
Total REO equivalent		3,940 e	XX	8,870 e	XX
Other rare-earth metals, unalloyed:	2805.30.0050				
China		36,300	1,430,000	46,800	1,570,000
Russia		3,500	280,000	9,310	743,000
Other		86	18,100	668	91,200
Total		39,900	1,720,000	56,800	2,400,000
Total REO equivalent		47,900 e	XX	68,200 e	XX
Other rare-earth metals, alloys:	2805.30.0090				
China		220,000	1,310,000	222,000	2,120,000
Other		7,350	679,000	7,670	684,000
Total		228,000	1,980,000	230,000	2,810,000
Total REO equivalent		273,000 e	XX	275,000 e	XX
Grand total		786,000	9,660,000	775,000	12,400,000
Grand total REO equivalent		833,000 e	XX	824,000 e	XX

eEstimated. XX Not applicable. -- Zero.

[1]Table includes data available through December 20, 2019. Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Harmonized Tariff Schedule of the United States.

Source: U.S. Census Bureau.

TABLE 8
RARE EARTHS: WORLD MINE PRODUCTION, BY COUNTRY OR LOCALITY[1]

(Metric tons, rare-earth-oxide equivalent)

Country or locality	2014	2015	2016	2017	2018
Australia[e]	8,000	12,000	15,000	19,000	21,000
Brazil	--	-- [r, e]	2,700 [r, e]	1,700 [e]	1,200 [e]
Burma[e]	200	370	3,500	15,000	23,000
Burundi[e]	--	--	--	40	620
China[2]	105,000	105,000	105,000	105,000	120,000
India[e, 3]	1,700	1,700	1,500	1,800	2,900
Madagascar[e]	--	--	--	--	2,000
Malaysia[e]	240	310	1,100	180	990
Russia	2,200 [e]	2,500 [e]	2,700 [r]	2,700 [r]	2,700
Thailand[e, 4]	1,900	760	1,600	1,300	1,000
United States[e]	5,400	5,900	--	--	14,000
Vietnam[e, 4]	--	270 [r]	240 [r]	220 [r]	920
Total	125,000 [r]	129,000	133,000 [r]	147,000 [r]	190,000

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

[1]Table includes data available through January 26, 2021. All data are reported unless otherwise noted. Totals and estimated data are rounded to no more than three significant digits, except U.S. data, which are rounded to two significant digits; may not add to totals shown.

[2]Official production quota. Illegal production could not be quantified.

[3]India's Department of Atomic Energy did not disclose monazite production data.

[4]Rare-earth-oxide equivalent of exports.