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2011 Minerals Yearbook

RARE EARTHS [ADVANCE RELEASE]

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Rare Earths

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In 2011, world rare-earth production was primarily from the minerals bastnäsite and monazite. Rare-earth ores were primarily mined in China, with smaller amounts mined in India, Australia, Malaysia, and Brazil, listed in order of decreasing production (tables 6, 7). Processing of intermediate rare-earth concentrates took place at the Mountain Pass Mine in California. At yearend, plans were underway to resume mining at Mountain Pass for the first time since 2002.

Domestic use of scandium remained limited in 2011. Demand was primarily for aluminum alloys used in baseball and softball bats. Scandium alloys, compounds, and metals were also used in analytical standards, metallurgical research, and other sports equipment. Minor amounts of high-purity scandium were used in semiconductors and specialty lighting.

Based on import data from the Port Import Export Reporting Service (PIERS) database of Commonwealth Business Media, Inc. (undated), domestic yttrium imports for consumption decreased by 18% in 2011 compared with those of 2010. Yttrium was used primarily in linear fluorescent lamp and cathode-ray tube phosphors; lesser amounts were used in structural ceramics and oxygen sensors. Because yttrium stocks are replenished sporadically, year on year changes do not necessarily reflect trends in consumption.

The rare earths are a moderately abundant group of 17 elements comprising the 15 lanthanides, scandium, and yttrium. The lanthanides are the elements with atomic numbers 57 through 71 that include the following in order of atomic number: lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium. At an average concentration in the Earth's crust of 60 parts per million (ppm), cerium is more abundant than copper, followed in decreasing order, by yttrium at 33 ppm, lanthanum at 30 ppm, and neodymium at 28 ppm. Thulium and lutetium, the least abundant of the lanthanides at 0.5 ppm, occur in the Earth's crust in higher concentrations than antimony, bismuth, cadmium, and thallium. 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).

Rare earths can be classified as either light rare-earth elements (LREE) or heavy rare-earth elements (HREE). The LREE include the lanthanide elements from atomic number 57 (lanthanum) through atomic number 64 (gadolinium), and the HREE include the lanthanide elements from atomic number 65 (terbium) through atomic number 71 (lutetium). The division is based on the LREE having unpaired electrons in the 4f electron shell, and HREE having paired electrons in the 4f electron shell. Gadolinium has a very stable half-filled 4f electron shell with seven unpaired electrons. Proceeding with terbium and continuing along the series through lutetium, paired electrons are progressively added to the 4f electron shell for each respective element in the HREE lanthanide series until there is a full complement of 14 electrons in the 4f electron shell of lutetium. Yttrium is included as a HREE even though it is not part of the lanthanide contraction series.

Scandium (atomic number 21), a transition metal, is the lightest REE but it is not classified as one of the group of LREE nor one of the HREE. It is the 31st most abundant element in the Earth's crust, with an average crustal abundance of 22 ppm. Scandium is a soft, lightweight, silvery-white metal, 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 often occurs in the same minerals as a result of its similar ionic radius. Its atomic radius of 104 picometers in the trivalent state places it in relative size between the ionic radii of holmium and erbium (104.1 and 103 picometers, respectively) and it is included as one of the HREE. Yttrium is the second most abundant rare earth in the Earth's crust. Yttrium is a bright silvery metal that is soft and malleable, similar in density to titanium.

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° C for cerium to 1,663° C for lutetium. The unique properties of rare earths make them useful in a wide variety of applications such as batteries, catalysts, magnets, and phosphors. The principal economic ores of the rare earths are the minerals bastnäsite, loparite, and monazite and the lateritic ion-adsorption clays (table 2).

Production

In 2011, rare earths were not mined in the United States (table 1). Molycorp, Inc. resumed mining at its Mountain Pass operation at yearend, but production of rare-earth oxide (REO) products during the year was from stockpiled concentrates. In 2011, Molycorp sales from Mountain Pass increased to 3,050 metric tons (t) of REO equivalent, a 67% increase compared with sales in 2010. The first phase of the company's Project Phoenix was expected to add 19,100 t of annual REO capacity and was scheduled for completion by yearend 2012 (Molycorp, Inc., 2012b).

U.S. processors of rare-earth permanent magnets and permanent magnet materials included Arnold Magnetic Technologies Corp., Electron Energy Corp., Great Western Technologies, Inc., and Santoku America, Inc. Sigma-Aldrich

Co. LLC produced a variety of scandium compounds from imported materials. All domestic, commercially produced, purified yttrium products were derived from imported compounds. The principal source of these compounds was China.

In April, Molycorp acquired Santoku America which produced rare-earth metals and magnet alloys at its operations in Tolleson, AZ. Santoku America produced both neodymium-iron-boron and samarium-cobalt permanent magnets (Molycorp, Inc., 2012a, p. 13).

Owing to market conditions, several mineral exploration and development projects were underway. Drilling and prefeasibility studies were underway in Alaska, Nebraska, and Wyoming.

At yearend, Rare Element Resources Ltd. neared completion of an updated National Instrument (NI) 43–101 compliant mineral resource estimate at its Bear Lodge project near Sundance, WY. The updated estimate of the Bull Hill deposit consisted of 6.8 million metric tons (Mt) averaging 3.75% REO in measured and indicated mineral resources, using a 1.5% REO cutoff grade. At yearend, a preliminary feasibility study was underway and was scheduled to be completed in 2012 (Rare Element Resources Ltd., 2012).

In 2011, Ucore Rare Metals Inc. announced the results of a NI 43–101 report for its Bokan Mountain project in Alaska. Using a 0.5% REO cutoff, inferred resources were estimated to be 27,400 t of REO with 45% reported to be heavy REO. The resource was classified as inferred owing to the limited sample data available within the deposit area. A preliminary economic assessment was expected to be completed in 2012 (Ucore Rare Metals Inc., 2011).

Consumption

Data on domestic rare-earth consumption were developed by surveying known processors and manufacturers and evaluating import and export data. Domestic apparent consumption of rare earths was not calculated in 2011 because data were withheld to avoid disclosing company proprietary data.

In 2011, yttrium consumption was estimated to have decreased to 550 t from 670 t in 2010. Yttrium information was based on data retrieved from the PIERS database. The leading source of yttrium compounds and metal in 2011 was China (94%). The estimated use of yttrium, based on imports, was primarily in phosphors, ceramics, metal casting, and specialty alloys.

Prices

There was much speculation concerning China's ability to restrict the supply of REO through quotas, licensing, and taxes; prices of rare-earth products fluctuated significantly in 2011. According to Metal-Pages, most rare-earth metal and oxide prices spiked in mid-2011, fell toward yearend, but finished the year significantly higher than yearend 2010. Prices for dysprosium, europium, and terbium metals and oxides were among the most volatile.

The yearend prices of most rare-earth materials, provided by Rhodia Inc., were higher in 2011 compared with those of 2010 (table 3). On average, REO yearend prices increased by 182% from those in 2010. Scandium oxide prices were moderately higher than those in 2010.

Foreign Trade

Data in this section are based on gross weight, although data in the tables are also converted to REO content. U.S. exports totaled 10,050 t valued at $249 million, a 24% increase in quantity and a 183% increase in value compared with those of 2010. On a gross-weight basis, rare-earth compounds (excluding cerium) was the largest export category, accounting for 36% of total exports (table 4).

U.S. rare-earth imports totaled 10,000 t valued at $802 million, approximately a 38% decrease in quantity and a 324% increase in value compared with those of 2010 (table 5). Elevated prices caused U.S. imports to fall to the lowest level since 1994. China continued to dominate most import markets, especially for mixed and individual rare-earth compounds. France was the leading source of ferrocerium and other pyrophoric alloys.

World Review

Australia.—In New South Wales, Alkane Resources Ltd. continued to develop its Dubbo Zirconia project with planned production of hafnium, niobium, rare earths, tantalum, and zirconium products. In September, a definitive feasibility study was completed based on a 20-year operation with a potential production of 4,170 metric tons per year (t/yr) of REOs. Proven and probable reserves of REO, including yttrium oxide, were estimated to contain 316,000 t of REO, based on a 1.5% cutoff grade (combined ZrO_2, Nb_2O_5, and REO). Alkane expected to begin mine production in 2014 (Alkane Resources Ltd., 2011).

Arafura Resources Ltd. continued to develop its Nolans Bore mining and beneficiation project in the Northern Territory and its Whayalla processing operation in South Australia. In 2011, Arafura continued a demonstration project that began in 2010. In the fourth quarter of 2011, a mineral concentrate was produced from 1,500 t of ore and further pilot-scale processing into REO was planned to be completed in 2012. A bankable feasibility study was scheduled to be completed in 2012 (Arafura Resources Ltd., 2011).

In May, Lynas Corp. Ltd. began production of rare-earth concentrate from its Mount Weld mining and processing operations in Western Australia. At yearend, 6,060 t of concentrate containing 2,190 t of REO was bagged and ready for shipment pending the commissioning of processing operations in Malaysia (Lynas Corp. Ltd., 2011).

Canada.—In the Northwest Territories, Avalon Rare Metals Inc. completed an updated prefeasibility study on its Thor Lake (Nechalco) project. The study was based on an annual production output of 8,240 t/yr of REO and probable mineral reserves of 222,000 t REO. The updated study did not include a separation plant. Construction of a separation plant and refinery was to be included in a bankable feasibility study scheduled for 2012 (Avalon Rare Metals Inc., 2011).

In Quebec, Matamec Explorations Inc. contracted with SGS Geostat Inc. to complete a preliminary economic assessment on its Kipawa project. At yearend, the study neared completion

(Matamec Explorations Inc., 2011b). Matamec also signed a nonbinding memorandum of understanding (MOU) with Toyota Tsusho Corp. The MOU could facilitate Toyota support for feasibility study expenditures and set up offtake agreements for the Kipawa project (Matamec Explorations Inc., 2011c). In 2012, the company planned to proceed with processing and hydrometallurgical pilot-plant studies for the Kipawa project (Matamec Explorations Inc., 2011a).

In Quebec and Newfoundland and Labrador, Quest Rare Minerals Ltd. continued drilling and updated its resource estimate on its Strange Lake B-zone deposit. According to its NI 43–101 report, at a cutoff grade of 0.579% REO, the indicated resource estimate was 140.3 Mt grading 0.93% REO. In 2012, the company planned a parallel path for work required to complete prefeasibility and bankable feasibility studies (Quest Rare Minerals Ltd., 2012, p. 5–10).

China.—China continued to dominate the supply of REE, accounting for 95% of global mine production in 2011. Mine production was primarily from bastnäsite and other rare-earth minerals in Nei Mongol Autonomous Region and Sichuan Province and from ion adsorption ores in Fujian, Guangdong, and Jiangxi Provinces in southeastern China.

Citing domestic requirements and environmental concerns, China restricted supply of REE through quotas, licenses, and taxes. The Ministry of Land and Resources increased the quota for China's REO production in 2011 to 93,800 t compared with 89,200 t in 2010. The production quota included 80,400 t of light REOs and 13,400 t of heavy REOs. Ninety-three percent of the light REO quota was allocated to Nei Mongol Autonomous Region and Sichuan Province, and 99% of the heavy REO quota was allocated to the Fujian, Guangdong, and Jiangxi Provinces (Ministry of Land and Resources of the People's Republic of China, 2011). In December, China's Ministry of Commerce announced a first-batch rare-earth export quota of 24,900 t for 2012. Unlike prior years, the Government specified quantities for light or middle and heavy rare earths allocated to each company. The Government also withheld export quotas for companies that did not meet the environmental protection guidelines (Reuters, 2011).

Estonia.—Molycorp acquired AS Silmet. Silmet's operations in Sillamäe produced rare-earth compounds and metals from rare-earth concentrates. The acquisition was renamed Molycorp Sillamäe and increased Molycorp's REO separation capacity by 3,000 t/yr (Molycorp, Inc., 2012a, p. 4).

India.—In July, Toyota Tsusho Corp.'s Indian subsidiary, Toyotsu Rare Earths Orissa Pvt. Ltd., started construction of a REO processing plant in Orissa. The plant was scheduled to be completed in 2012 and was expected to produce as much as 2,500 t/yr of REO derived from monazite produced at Indian Rare Earth Ltd.'s heavy-mineral sands operation (Toyota Tsusho Corp., 2012, p. 23).

Japan.—Sojitz Corp. and Japan Oil, Gas and Metals National Corp. (JOGMEC) agreed to provide Lynas with $250 million in financial assistance through a loan and equity. The companies also agreed that Lynas would provide an 8,500-t allocation of rare-earth products for the Japanese market during a 10-year period. The assistance was expected to allow Lynas Corp. to expand its production capacity in Australia and Malaysia (Lynas Corp. Ltd., 2012, p 12).

Malaysia.—Lynas neared completion of its processing plant near Kuantan with an initial capacity of 11,000 t/yr of REO. Mineral concentrate from Australia was expected to supply the cracking and separation operation. The company commenced work on expanding REO capacity at Kuantan to 22,000 t/yr (Lynas Corp. Ltd., 2012, p. 12).

South Africa.—Great Western Minerals Group Ltd. (GWMG) was moving ahead with a project to recommission the abandoned Steenkampskraal (SKK) Mine in the Western Cape owned by Steenkampskraal Monazite Mine Ltd. (SMM). In July, GWMG received approval for a work program from the South African National Nuclear Regulator. The approval was expected to enable SMM to begin refurbishing the mine site and conduct a drilling program to confirm and expand resources. GWMG and China's Ganzhou Qiandong Rare Earth Group Ltd. agreed to form a joint venture to build a rare-earth separation plant near the SKK Mine. A detailed design for a processing plant in which ore is converted into rare-earth chlorides was expected by yearend (Great Western Minerals Group Ltd., 2012, p. 5–6).

Outlook

Rare-earth use in catalysts, magnets, phosphors, and rechargeable batteries is expected to continue to increase to keep up with future global demand for automobiles, consumer electronics, energy efficient lighting, and alternative energy sources. Demand for cerium and lanthanum for use in automotive catalytic converters and catalysts for petroleum refining is expected to follow refinery and automotive production.

REE magnet production was projected to increase to 150,000 t by 2014 from 92,000 t in 2011. Future growth was expected for rare earths in rechargeable NiMH batteries, especially those used in hybrid vehicles, increasing to 62,000 t REO by 2014 (BCC Research, 2010). NiMH demand was expected to be moderated by increasing demand for lithium-ion batteries. Increased rare-earth use was expected in fiber optics, medical applications that include dental and surgical lasers, magnetic resonance imaging, medical contrast agents, medical isotopes, and positron emission tomography scintillation detectors.

Rare-earth content of world reserves is greater than cumulative world consumption expected into the 21st century; however, recent shortages of rare earths for alloys, magnets, and phosphors have compelled companies to explore and develop rare-earth deposits throughout the world. Although the industry had shifted away from using naturally occurring radioactive rare-earth ores, several new projects are based on monazite ores. Long-term demand for monazite is expected to increase because of the mineral's abundant supply and low-cost byproduct recovery. Thorium's use as a nuclear material is a possible substitute for uranium in the future. If consumption of thorium increases, monazite could resume its role as a major source of rare earths.

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TABLE 1

SALIENT U.S. RARE EARTH STATISTICS[1]

		2007	2008	2009	2010	2011
Production of rare-earth concentrates, rare-earth oxide (REO) basis[e, 2]	metric tons	--	--	--	--	--
Exports, REO basis:						
Cerium compounds	do.	1,470	1,380	840	1,350	1,640
Ferrocerium and pyrophoric alloys	do.	3,210	4,490	2,970	3,460	2,010
Rare-earth metals, scandium, yttrium	do.	1,470	1,390	4,930	1,380	3,030
Rare-earth compounds, organic or inorganic	do.	1,300	663	455	1,690	3,620
Imports for consumption, REO basis:[e]						
Cerium compounds	do.	2,680	2,080	1,500	1,770	1,120
Ferrocerium and pyrophoric alloys	do.	123	125	102	131	186
Mixtures of rare-earth chlorides except cerium chloride	do.	1,610	1,310	411	956	382
Mixtures of REOs except cerium oxide	do.	2,570	2,400	4,750	5,480	1,830
Rare-earth compounds, oxides, hydroxides, nitrates, other compounds except chlorides	do.	9,900	8,820	5,080	3,980	3,770
Rare-earth metals, whether intermixed or alloyed	do.	784	679	226	525	468
Yttrium compounds	do.	21	10	7	73	35
Prices, yearend:						
Bastnäsite concentrate, REO basis	dollars per kilogram	6.61	8.82	5.73	6.87	NA
Monazite concentrate, REO basis	do.	0.73	0.48	0.87	0.87	2.70
Mischmetal, metal basis[3]	do.	7.00–8.00	8.00–9.00	8.00–9.00	45.00–55.00	47.00–50.00

NA Not available. do. Ditto. -- Zero.

[1]Data are rounded to no more than three significant digits.

[2]Includes only the rare earths derived from bastnäsite as obtained from Molycorp, Inc.

[3]Source: Hefa Rare Earths Canada Co. Ltd., Vancouver, British Columbia, Canada.

TABLE 2

RARE EARTH CONTENTS OF MAJOR AND POTENTIAL SOURCE MINERALS[1, 2]

(Percentage of total rare-earth oxide)

Rare earth	Bastnäsite: Mountain Pass, CA, United States[3]	Bastnäsite: Bayan Obo, Inner Mongolia, China[4]	Monazite: North Capel, Western Australia[5]	Monazite: North Stradbroke Island, Queensland, Australia[6]	Monazite: Green Cove Springs, FL, United States[7]	Monazite: Nangang, Guangdong, China[8]
Yttrium	0.10	trace	2.40	2.50	3.20	2.40
Lanthanum	33.20	23.00	23.90	21.50	17.50	23.00
Cerium	49.10	50.00	46.00	45.80	43.70	42.70
Praseodymium	4.34	6.20	5.00	5.30	5.00	4.10
Neodymium	12.00	18.50	17.40	18.60	17.50	17.00
Samarium	0.8	0.8	2.53	3.10	4.90	3.00
Europium	0.1	0.2	0.053	0.8	0.16	0.1
Gadolinium	0.2	0.7	1.49	1.80	6.60	2.00
Terbium	trace	0.1	0.035	0.3	0.26	0.7
Dysprosium	trace	0.1	0.7	0.60	0.9	0.8
Holmium	trace	trace	0.053	0.1	0.11	0.12
Erbium	trace	trace	0.2	0.2	trace	0.3
Thulium	trace	trace	trace	trace	trace	trace
Ytterbium	trace	trace	0.1	0.1	0.21	2.40
Lutetium	trace	trace	trace	0.01	trace	0.14
Total	100	100	100	100	100	100

Rare earth	Monazite—Continued: Eastern coast, Brazil[9]	Monazite—Continued: Mount Weld, Australia[10]	Xenotime: Lahat, Perak, Malaysia[3]	Xenotime: Southeast Guangdong, China[11]	Rare earth laterite: Xunwu, Jiangxi Province, China[12]	Rare earth laterite: Longnan, Jiangxi Province, China[12]
Yttrium	1.40	trace	61.00	59.30	8.00	65.00
Lanthanum	24.00	26.00	1.24	1.20	43.4	1.82
Cerium	47.00	51.00	3.13	3.00	2.40	0.4
Praseodymium	4.50	4.00	0.5	0.6	9.00	0.7
Neodymium	18.50	15.00	1.60	3.50	31.70	3.00
Samarium	3.00	1.80	1.10	2.20	3.90	2.80
Europium	0.1	0.4	trace	0.2	0.5	0.10
Gadolinium	1.00	1.00	3.50	5.00	3.00	6.90
Terbium	0.1	0.1	0.9	1.20	trace	1.30
Dysprosium	0.4	0.2	8.30	9.10	trace	6.70
Holmium	trace	0.1	2.00	2.60	trace	1.60
Erbium	0.1	0.2	6.40	5.60	trace	4.90
Thulium	trace	trace	1.10	1.30	trace	0.7
Ytterbium	0.02	0.1	6.80	6.00	0.3	2.50
Lutetium	not determined	trace	1.00	1.80	0.1	0.4
Total	100	100	100	100	100	100

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

[2]This table is in atomic numerical order.

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TABLE 3
RARE-EARTH OXIDE PRICES IN 2011[1]

Product (oxide)	Purity (percentage)	Standard package quantity (kilograms)	Price (dollars per kilogram)
Scandium[2]	99.99	NA	3,700
Yttrium[3]	99.99	20	165
Lanthanum[3]	99.99	20	100
Cerium[3]	99.50	20	100
Praseodymium[3]	96.00	20	225
Neodymium[3]	95.00	20	270
Samarium[3]	99.90	20	118
Europium[3]	99.99	20	3,300
Gadolinium[3]	99.99	20	239
Terbium[3]	99.99	20	2,750
Dysprosium[3]	99.00	20	1,600
Holmium[3]	99.90	10	NA
Erbium[3]	96.00	20	255
Thulium[3]	99.90	5	NA
Ytterbium[3]	99.00	10	450
Lutetium[3]	99.99	1 or 10	4,000

NA Not available.
[1]This table is in atomic numerical order.
[2]Source: Stanford Metals Corp.
[3]Source: Rhodia Electronics & Catalysis, Inc.

TABLE 4

U.S. EXPORTS OF RARE EARTHS, BY COUNTRY[1]

Category[2] and country	2010 Gross weight (kilograms)	2010 Value	2011 Gross weight (kilograms)	2011 Value
Cerium compounds (2846.10.0000):				
Australia	9	$8,060	2,040	$154,000
Austria	122,000	1,530,000	64,900	3,780,000
Belgium	5,000	5,000	9,060	378,000
Brazil	7,900	133,000	12,400	144,000
Canada	25,300	284,000	39,600	513,000
China	255,000	2,110,000	139,000	1,780,000
Estonia	--	--	378,000	6,380,000
France	95,300	412,000	69,700	3,490,000
Germany	124,000	1,110,000	141,000	1,800,000
Hong Kong	18,100	446,000	26,900	1,330,000
India	15,700	159,000	27,200	416,000
Japan	180,000	3,170,000	122,000	4,140,000
Korea, Republic of	25,900	214,000	7,590	82,000
Mexico	241,000	1,420,000	80,000	2,130,000
Netherlands	64,500	364,000	102,000	637,000
Russia	11,400	399,000	22,800	3,200,000
Singapore	181	9,500	4,850	121,000
Taiwan	8,490	156,000	4,740	158,000
United Kingdom	14,400	737,000	20,100	592,000
Vietnam	--	--	161,000	14,500,000
Other	139,000 [r]	1,680,000 [r]	202,000	5,210,000
Total	1,350,000	14,300,000	1,640,000	50,900,000
Total estimated equivalent rare-earth oxide (REO) content	1,350,000	XX	1,640,000	XX
Ferrocerium and other pyrophoric alloys (3606.90.0000):				
Argentina	143	4,920	142	5,160
Australia	12,700	2,750,000	15,300	3,660,000
Canada	513,000	2,040,000	462,000	2,040,000
China	100,000	789,000	1,610	18,900
Egypt	1,260	102,000	39	18,500
France	35,400	183,000	13,400	165,000
Germany	7,760	176,000	6,790	250,000
Greece	639	42,200	369	39,600
Hong Kong	9,450	305,000	16,300	567,000
India	315,000	182,000	14,300	378,000
Israel	1,210	10,700	77	3,230
Japan	17,100	504,000	31,300	559,000
Korea, Republic of	1,380	73,100	2,580	86,600
Mexico	2,300,000	4,840,000	1,120,000	2,590,000
Netherlands	229,000	1,180,000	33,700	114,000
New Zealand	16,700	55,600	--	--
Saudi Arabia	268	5,400	1,650	87,200
Singapore	1,280	40,300	1,250	41,800
Sweden	--	--	12,400	911,000
Taiwan	408	13,200	380	13,500
United Arab Emirates	--	--	52,400	111,000
United Kingdom	168,000	4,790,000	153,000	5,540,000
Other	163,000 [r]	941,000 [r]	333,000	1,150,000
Total	3,900,000	19,000,000	2,270,000	18,300,000
Total estimated equivalent REO content	3,460,000	XX	2,010,000	XX
Rare-earth compounds[3] (2846.90.0000):				
Austria	279,000	616,000	134,000	4,150,000
Brazil	9,450	248,000	1,530	223,000
Canada	49,600	588,000	88,900	1,360,000
China	47,000	906,000	61,900	3,150,000
Colombia	9,010	25,500	14,300	25,300
Czech Republic	--	--	136,000	2,300,000
Estonia	77,700	220,000	1,010,000	19,100,000
France	23,000	442,000	123,000	2,470,000
Germany	38,200	1,420,000	50,600	2,510,000

See footnotes at end of table.

TABLE 4—Continued

U.S. EXPORTS OF RARE EARTHS, BY COUNTRY[1]

Category[2] and country	2010 Gross weight (kilograms)	2010 Value	2011 Gross weight (kilograms)	2011 Value
Rare-earth compounds[3] (2846.90.0000)—Continued:				
Hong Kong	1,090	$69,500	68,200	$2,380,000
India	18,500	127,000	96,900	2,510,000
Italy	16,300	108,000	2,050	140,000
Japan	379,000	13,900,000	115,000	11,700,000
Korea, Republic of	90,100	940,000	29,700	593,000
Mexico	79,800	1,160,000	351,000	4,570,000
Netherlands	107,000	1,560,000	569,000	9,040,000
Singapore	12,000	204,000	17,900	221,000
Taiwan	1,670	407,000	1,750	242,000
Thailand	1,140	385,000	334,000	36,700,000
United Kingdom	77,400	1,930,000	11,000	626,000
Vietnam	62,500	682,000	304,000	9,060,000
Other	313,000 r	1,300,000 r	100,000	2,700,000
Total	1,690,000	27,200,000	3,620,000	116,000,000
Total estimated equivalent REO content	1,690,000	XX	3,620,000	XX
Rare-earth metals, including scandium and yttrium (2805.30.0000):				
Brazil	84,200	1,290,000	56,100	1,330,000
China	316,000	1,230,000	951,000	2,750,000
Estonia	1,030 r	40,000 r	77,700	352,000
Germany	7,220	317,000	10,400	412,000
Hong Kong	990	190,000	56,600	274,000
India	6,780	380,000	10,600	840,000
Japan	639,000	19,800,000	839,000	48,000,000
Mexico	675	83,700	1,230	160,000
Philippines	--	--	394,000	3,400,000
Taiwan	801	64,700	--	--
Vietnam	49,000	3,310,000	76,700	1,620,000
Other	43,300 r	797,000 r	50,600	4,780,000
Total	1,150,000	27,500,000	2,520,000	63,900,000
Total estimated equivalent REO content	1,380,000	XX	3,030,000	XX

[r]Revised. XX Not applicable. -- Zero.

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

[2]Harmonized Tariff Schedule of the United States category numbers.

[3]Inorganic and organic.

TABLE 5

U.S. IMPORTS FOR CONSUMPTION OF RARE EARTHS, BY COUNTRY[1]

Category[2] and country	2010 Gross weight (kilograms)	2010 Value	2011 Gross weight (kilograms)	2011 Value
Cerium compounds, including oxides, hydroxides, nitrates, sulfate, chlorides, oxalates (2846.10.0000):				
Austria	131,000	$1,400,000	302,000	$10,400,000
China	2,010,000	13,500,000	640,000	38,500,000
Estonia	200,000	1,040,000	182,000	10,600,000
France	11,800	685,000	48,000	2,370,000
Japan	139,000	4,700,000	168,000	8,710,000
Korea, Republic of	32,400	275,000	7,360	298,000
United Kingdom	60,100	155,000	203	19,400
Other	61,500 r	939,000 r	327,000	16,200,000
Total	2,640,000	22,600,000	1,670,000	87,100,000
Total estimated equivalent rare-earth oxide (REO) content	1,770,000	XX	1,120,000	XX
Ferrocerium and other pyrophoric alloys (3606.90.3000):				
Austria	25,400	626,000	28,200	646,000
China	11,900	184,000	44,100	801,000
France	110,000	2,290,000	133,000	2,440,000
Germany	--	--	706	29,500
Netherlands	--	--	2,070	8,500
Taiwan	700	9,530	550	8,500
Total	148,000	3,110,000	209,000	3,930,000
Total estimated equivalent REO content	131,000	XX	186,000	XX
Mixtures of rare-earth chlorides, except cerium chloride (2846.90.2050):				
Australia	1,930	3,190	--	--
China	2,030,000	11,100,000	636,000	40,600,000
Estonia	4,000	126,000	12,000	1,610,000
France	10,300	243,000	120,000	2,010,000
Germany	336	87,000	10,400	2,980,000
Japan	19,500	206,000	21,200	2,360,000
Korea, Republic of	--	--	29,300	1,820,000
Russia	138	76,400	248	186,000
United Kingdom	15,000	121,000	--	--
Other	--	--	2,120	141,000
Total	2,080,000	12,000,000	831,000	51,700,000
Total estimated equivalent REO content	956,000	XX	382,000	XX
Mixtures of REOs except cerium oxide (2846.90.2010):				
Canada	--	--	11,000	1,080,000
China	5,410,000	33,400,000	1,740,000	92,600,000
Estonia	--	--	17,000	2,370,000
Germany	1,270	65,400	615	39,200
Ireland	34,600	2,830,000	43,600	4,240,000
Italy	18,400	1,790,000	6,760	656,000
Japan	9,310	148,000	12,200	797,000
Russia	63	35,100	1,870	230,000
Other	56 r	22,900 r	2,020	200,000
Total	5,480,000	38,300,000	1,830,000	102,000,000
Total estimated equivalent REO content	5,480,000	XX	1,830,000	XX
Rare-earth compounds, including oxides, hydroxides, nitrates, other compounds except chlorides (2846.90.8000):				
Austria	108,000	4,390,000	171,000	15,900,000
Canada	--	--	6,090	26,800,000
China	4,080,000	55,400,000	3,340,000	279,000,000
France	542,000	16,600,000	425,000	52,500,000
Germany	700	208,000	8,800	1,500,000
Hong Kong	100	6,800	1,240	127,000
Japan	417,000	17,300,000	701,000	74,200,000
Russia	13,200	339,000	360	208,000
South Africa	64,100	781,000	159,000	5,940,000
United Kingdom	43,800	211,000	27,300	465,000

See footnotes at end of table.

TABLE 5—Continued
U.S. IMPORTS FOR CONSUMPTION OF RARE EARTHS, BY COUNTRY[1]

	2010		2011	
Category[2] and country	Gross weight (kilograms)	Value	Gross weight (kilograms)	Value
Rare-earth compounds, including oxides, hydroxides, nitrates, other compounds except chlorides (2846.90.8000)—Continued:				
Other	45,800	$1,080,000	191,000	$18,000,000
Total	5,310,000	96,300,000	5,030,000	475,000,000
Total estimated equivalent REO content	3,980,000	XX	3,770,000	XX
Rare-earth metals, whether intermixed or alloyed (2805.30.0000):				
Austria	3,610	223,000	13,400	870,000
Canada	224	19,700	70	5,240
China	361,000	12,300,000	282,000	54,600,000
Germany	70	17,600	6,800	620,000
Hong Kong	46,400	409,000	17,200	1,220,000
Japan	13,600	954,000	31,400	6,060,000
Korea, Republic of	53	51,600	--	--
Laos	--	--	16,100	4,290,000
Russia	3,620	328,000	5,510	463,000
Thailand	--	--	14,900	2,260,000
United Kingdom	8,480	413,000	3,070	510,000
Vietnam	219	4,150	--	--
Total	437,000	14,700,000	390,000	70,800,000
Total estimated equivalent REO content	525,000	XX	468,000	XX
Yttrium compounds content by weight greater than 19% but less than 85% oxide equivalent (2846.90.4000):				
Austria	--	--	12,100	169,000
China	98,000	586,000	37,000	9,140,000
France	9,100	589,000	828	14,800
Germany	17	9,610	4,720	1,430,000
Japan	5,100	641,000	3,060	739,000
Other	10,200 r	234,000 r	187	289,000
Total	122,000	2,060,000	57,900	11,800,000
Total estimated equivalent REO content	73,500	XX	34,700	XX

[r]Revised. XX Not applicable. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Harmonized Tariff Schedule of the United States category numbers.

Source: U.S. Census Bureau.

TABLE 6
RARE EARTHS: ESTIMATED WORLD MINE PRODUCTION, BY COUNTRY[1, 2, 3]

(Metric tons of rare earth oxide equivalent)

Country	2007	2008	2009	2010	2011
Australia	--	--	--	--	2,188 [4]
Brazil	645 [4]	460 [4]	170 [4]	140 [r, 4]	140 [p]
China	120,000	125,000	129,000	120,000	105,000
India	2,700	2,700	2,700	2,800	2,800
Malaysia	380	120	13	310 [r]	280
Total	124,000	128,000	132,000	123,000	110,000

[p]Preliminary. [r]Revised. -- Zero.
[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.
[2]Table includes data available through July 26, 2012.
[3]In addition to the countries listed, rare-earth minerals may be produced in other countries, but information is inadequate for the formulation of reliable estimates of output levels.
[4]Reported figure.

TABLE 7
MONAZITE CONCENTRATE: ESTIMATED WORLD PRODUCTION, BY COUNTRY[1, 2]

(Metric tons, gross weight)

Country[3]	2007	2008	2009	2010	2011
Brazil	1,173 r, 4	834 r, 4	303 r, 4	249 4	250
India	5,000	5,000	5,000	5,200	5,200
Malaysia[4]	682	233	25	732 r	779
Vietnam	1,400	1,400	1,200	310	360
Total	8,260 r	7,470 r	6,530 r	6,490 r	6,590

rRevised.
1World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.
2Table includes data available through May 9, 2012.
3In addition to the countries listed, other countries may produce monazite, but available information is inadequate for the formulation of reliable estimates of ouput levels.
4Reported figure.