2012 Minerals Yearbook

BORON

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

August 2016

Boron

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U.S. consumption of minerals and compounds reported in boron oxide content increased in 2012; quantities were withheld to avoid disclosing company proprietary data (table 1). Turkey and the United States were the world's leading producers of boron minerals (table 6). World production of boron minerals increased in 2012 to an estimated 4.42 million metric tons (Mt) compared with 4.33 Mt in 2011 (excluding U.S. production). The United States exported 190,000 metric tons (t) of boric acid in 2012, a decrease from 235,000 t in 2011. In 2012, 456,000 t of sodium borates were exported, a decrease from 492,000 t in 2011 (tables 1, 4). Boron imports consisted primarily of borax, boric acid, colemanite, and ulexite (tables 1, 5).

Elemental boron is a metalloid with limited commercial applications. The main applications were as a doping agent in the manufacture of semiconductors and as an ignition source in airbags. The global rate of consumption of elemental boron was estimated to be 15 metric tons per year (t/yr). Boron compounds, chiefly borates, are commercially important; therefore, boron products are priced and sold based on boric oxide content (B_2O_3), which varies by ore and compound, and on the absence or presence of sodium and calcium (table 2). Borax, one of the most important boron minerals for industrial use, is a white crystalline substance chemically known as sodium tetraborate decahydrate and is found in nature as the mineral tincal. Boric acid, also known as orthoboric acid or boracic acid, is a white, colorless crystalline solid sold in technical, national formulary, and special quality grades as granules or powder. Colemanite (hydrated calcium borate), kernite (hydrated sodium borate), tincal, and ulexite (hydrated sodium calcium borate) were the boron minerals of the most commercial importance in the United States (table 2).

Production

Four minerals make up 90% of the borates used by industry worldwide: the sodium borates tincal and kernite, the calcium borate colemanite, and the sodium-calcium borate ulexite. Borate deposits are associated with volcanic activity and arid climates, and the largest borate deposits are located in the Mojave Desert of the United States, the Alpide belt in southern Asia, and the Andean belt of South America. As a result, borates were extracted primarily in California and Turkey and to a lesser extent in Argentina, Bolivia, Chile, China, and Peru. Boron compounds and minerals were produced by surface and underground mining and from brine.

Domestic data for boron were derived by the U.S. Geological Survey from a voluntary survey of two U.S. producers—Rio Tinto Group's U.S. Borax Inc. (U.S. Borax) and Searles Valley Minerals, Inc. (SVM). Data from both companies were withheld to avoid disclosing company proprietary data (table 1).

SVM (a subsidiary of the Indian company Nirma Ltd.) produced borax and boric acid from brines containing potassium and sodium borates that were extracted from three salt layers, up to 100 meters (m) deep, in Searles Lake, located near Trona in San Bernardino County, CA. SVM's Trona and Westend plants refined the brines, producing anhydrous, decahydrate, and pentahydrous borax. These brines also supplied other commercial salts in addition to sodium borates and boric acid. The Trona plant has a reported capacity of 27,500 t/yr B_2O_3, and the Westend plant has a reported capacity of 82,300 t/yr B_2O_3.

U.S. Borax mined mainly tincal and kernite at Boron, CA, by open pit methods, and the ore was transported by truck to a storage area. The tincal had an average grade of 25.3% B_2O_3 and the kernite had an average grade of 31.9% B_2O_3. Boric acid and refined sodium borates were produced at an onsite processing plant. Refined borate products were shipped by railcar or truck to North American customers or to the company's Wilmington, CA, facility and exported from the Port of Los Angeles. Specialty borate products were made at the Wilmington plant. According to a Securities and Exchange Commission report filed by U.S. Borax, the company produced 463,000 t of borates in 2012, a decrease of 8% from the 504,000 t reported in 2011 (Rio Tinto plc, 2013, p. 26).

Consumption

The first reported use of borax was as a flux or bonding agent by Arabian gold and silversmiths in the eighth century, but current research suggests Babylonians may have used it 4,000 years ago. Today, borates are used in more than 300 end uses, but more than three-quarters of the world's non-agricultural supply is sold and distributed for five end uses: glass, ceramics, soaps, detergents, and bleaches (Garrett, 1998; Hamilton, 2006).

Agriculture.—Fertilizers represented the third-ranked application of borates. Boron was the most widely used micronutrient, applied primarily to promote fruit and seed production. Boron fertilizers were mostly sourced from borax, boric acid, and calcium borate owing to their high water solubility; thus, boron fertilizers can be delivered through sprays or irrigation water. Domestic consumption of boron fertilizers was estimated to be approximately 2% of total U.S. fertilizer consumption.

Boron is essential for plant uptake of primary and secondary nutrients, such as calcium, manganese, magnesium, phosphorus, and zinc. It influences the transport of nutrients through plant membranes, which directly correlates into improved fruit development, germination, plant reproduction, and pollen production. Normal plant leaves typically contain 25 to 100 parts per million of boron, with 1 kilogram per hectare of boron (1 pound per acre) in soil being adequate to maintain these levels. In the United States, crops with boron deficiencies are often found in the Atlantic coastal plains, Great Lakes region, and the coastal Pacific Northwest, where soils tend to be acidic, leached, coarse sandy, or organic in nature. Excessive boron fertilization, on the other hand, can cause crop toxicity, which studies suggested was more often caused by higher boron levels in irrigation water than those in soil (Troeh and Thompson, 2005, p. 489).

Ceramics.—Ceramics comprise the second-leading application for borates after glass, accounting for 10% of world consumption. Borates play an important role in ceramic glazes and enamels, increasing chemical, thermal, and wear resistance. Borax and colemanite are used in ceramics primarily as fluxing agents, with borax being used in higher temperature and colemanite in lower temperature firings. Borates also are used in technical ceramics, an industry with applications in aerospace, ballistics, electronics, and medicine, which experienced strong growth during the past decade. The amount of B_2O_3 used in glazes varies between 8% and 24% and the amount used in enamels varies between 17% and 32% by weight.

Boron carbide is a key ingredient in lightweight ceramic armor, the use of which increased United States and European consumption of boron carbide during the past few years. Small arms protective inserts, used by the U.S. military, are boron carbide ceramic plates inserted into Kevlar flak jackets to protect against high-velocity projectiles (Industrial Minerals, 2008b).

Detergents and Soaps.—The use of borates in detergents and soaps represented the fourth-ranked market, accounting for 4% of world consumption. Borates were incorporated into laundry detergents, soaps, and other cleaning products because they can be used as alkaline buffers, enzyme stabilizers, oxygen-based bleaching agents, and water softeners. Two borates, sodium perborate and perborate tetrahydrate, were used as oxidizing bleaching agents because they contain true peroxygen bonds. Hydrogen peroxide, a very effective bleaching agent, is produced when sodium perborate undergoes hydrolysis while in contact with water. Because hydrogen peroxide cannot be effectively incorporated into detergents, sodium perborate acts as its carrier (Rio Tinto Borax, 2005). Sodium perborate, however, requires hot water to undergo hydrolysis, and concerns have emerged over excessive boron levels in waterways owing to sodium perborate in detergents. Sodium percarbonate has been used as a substitute primarily in Europe because it produces hydrogen peroxide at lower temperatures. This substitution has affected boron consumption.

Ferroboron.—Ferroboron (FeB) is a binary alloy of iron with a boron content between 17.5% and 24% and is the lowest cost boron additive for steel and other ferrous metals. On average, the steel industry consumes more than 50% of the ferroboron produced annually (Eti Holding Inc., 2003, p. 8). Boron steel, a product manufactured through the addition of ferroboron, possesses a higher strength and lighter weight than average high-strength steel, which makes it useful in the manufacture of safe and fuel-efficient automobiles (Ray and others, 1966).

Fire Retardants.—Borates were incorporated into various materials, such as cellulosic insulation, textiles, and timber, to impart flame-retardant properties to the materials. Boric acid was incorporated into wood flame-retardants to inhibit the transfer of combustible vapors and to reduce the effective heat of combustion, resulting in reduced flame spread. Zinc borate was used in plastics as a multifunctional boron-based fire retardant, with applications in a variety of plastics and rubber compounds.

Glass.—The principal market for borates in 2012 was glass, representing approximately 60% of global borate consumption. Boron is used as an additive in glass to reduce thermal expansion; to improve strength, chemical resistance, and durability; and to provide resistance against vibration, high temperature, and thermal shock. Boron is also used as a fluxing agent, reducing the viscosity of glass during formation to improve manufacturing. Depending on the application and quality of the glass, borax, boric acid, colemanite, ulexite, and sodium borates can be used.

Insulation and textile fiberglass represented the largest single use of borates worldwide, at 45% of world consumption. End uses for fiberglass are corrosion-resistant, heat-resistant, and high-strength fabrics; insulation; reinforcement; and sound absorption. The incorporation of borates into fiberglass greatly improves quality, establishing a product that is strong, lightweight, and thermal and chemical resistant (Garrett, 1998).

Borosilicate refers to glass with boric oxide content between 5% and 30%. The boron in borosilicate imparts many valuable properties to the glass, such as increased mechanical strength, low coefficient of thermal expansion, and resistance to chemical attack and thermal shock. Past application of borosilicate ranged from Pyrex® kitchenware to the thermal protection tiles on the National Aeronautics and Space Administration Space Shuttle Orbiters.

Other.—Various boron compounds are used in nuclear powerplants to control neutrons produced during nuclear fission. The isotope boron-10, in particular, possesses a high propensity for absorbing free neutrons, producing lithium and alpha particles after absorbing neutrons. Control rods composed of boron carbide are lowered into a nuclear reactor to control the fission reaction by capturing neutrons. Boric acid is used in the cooling water surrounding nuclear reactors to absorb escaping neutrons (Ceradyne Inc., 2011).

Boron nitride is used in many cosmetics owing to its low coefficient of friction and lack of toxicity. It has been shown to be a useful alternative in those applications (Emsley, 2004, p. 15–17). Boric acid has applications in cosmetics, pharmaceuticals, and toiletries. Borates are also added to brake fluids, fuel additives, lubricants, metalworking fluids, and water treatment chemicals. Boron oxide inhibits corrosion.

Transportation

Almost all U.S. borates were shipped in North America by rail. Both U.S. producers had rail fleets dedicated to the exclusive transportation of their products. Small quantities of borates were shipped by rail or truck in specialty bags, usually of 2,100-pound capacity. Prices for rail haulage depended on the ability of customers to load and unload efficiently, the ability to use unit trains and to supply one's own railcars, and fuel prices.

SVM owned the Trona Railway, a 50-kilometer (km) (31-mile) shortline railroad that connects to the Southern Pacific Railroad between Trona and Searles stations in California.

The Trona Railway provided a dedicated line with access to the national rail system for the borate, soda ash, and sodium sulfate markets. Nearly 80% of output was transported by rail to domestic consumers and to the ports of Long Beach, CA, and San Diego, CA, for export.

The Boron Mine was served solely by the Burlington Northern Santa Fe Railroad. In order to connect to another rail line, a transload or transfer point was set up in Cantil, CA, served by the Union Pacific Railroad. Trucks of product from Boron were driven to Cantil, about 64 km (40 miles) northwest of Boron and loaded onto dedicated railcars to be shipped to customers.

U.S. Borax used a privately owned berth located in the Port of Los Angeles, CA, for ocean transportation of borate products. Products destined for Europe were shipped from the bulk terminal in Wilmington, CA, to a company-owned facility in the Port of Rotterdam, Netherlands, company facilities in Spain, or contracted warehouses. The most centrally located U.S. Borax port location in Europe was Antwerp, Belgium. The industrial minerals market in Europe was characterized by high volumes of imported materials, mostly forwarded through the industrialized areas of Belgium, France, Germany, and the Netherlands for destinations in Central Europe, including Austria, the Czech Republic, and Slovenia. A decision to import borates was based on the geographic location, the range of borate products needed, and prices.

Prices

Prices for borates, based on publicly available information obtained through export data, decreased by 7% in 2012 compared with those reported for 2011.

Foreign Trade

Exports of boron compounds and minerals decreased by 11% in 2012 to 646,000 t from 727,000 t in 2011. In 2012, China received the largest combined amount of sodium borates and boric acid from the United States owing to increased consumption of borates used in China's glass and ceramic industries. Boron compound imports of 97,000 t in 2012 represented a 13% increase from the 84,000 t reported in 2011 (table 1). In 2012, U.S. imports for consumption of borax, boric acid, colemanite, and ulexite were 97,000 t, a 15% increase from 84,000 t imported in 2011.

World Review

Argentina.—Argentina remained the leading producer of boron minerals in South America in 2012 (table 6). Borate deposits are located primarily in the Puna region, which includes the northwestern tip of Argentina, the southeastern corner of Peru, the southwestern corner of Bolivia, and the northeastern border of Chile. Recent increased consumption of borates in the ceramics and glass industries in Asia and North America led to increased production of Argentine borates, boric acid in particular.

Borax Argentina S.A. (a subsidiary of Rio Tinto Minerals), the country's leading producer of borates, operated the Tincalayu Mine, the largest open pit operation in the country, which is 4,100 m (13,400 feet) above sea level. The deposit consisted primarily of borax, with rare occurrences of ulexite and 15 other borates. Rio Tinto completed the sale of Borax Argentina in August 2012 to Orocobre Ltd., an Australian company with an Argentine subsidiary, for $8.1 million. (Orocobre Ltd., 2013, p. 35).

Minera Santa Rita S.R.L. (MSR) operated mines in Catamarca, Jujuy, and Salta Provinces and operated a processing plant in Campo Quijano, which produced granular deca- and pentahydrate borax, technical-grade boric acid powder, and various grades and sizes of natural boron minerals. MSR exports 97% of its products to 28 countries through the port of Buenos Aires and by land to Brazil (Minera Santa Rita S.R.L., undated).

China.—More than 100 borate deposits occur in 14 Provinces in China. The northeastern Province of Liaoning and the western Province of Qinghai accounted for more than 80% of the resources, mostly in the form of sassolite and tincal. China's boron resources are of low quality, averaging about 8.4% B_2O_3, when compared to reserves in Turkey and the United States, which average about 26% to 31% and 25.3% to 31.9% B_2O_3, respectively (Industrial Minerals, 2008a; Baylis, 2010, p. 5).

Turkey.—Approximately 73% of the world's boron reserves are in Turkey (Engineering and Mining Journal, 2012). The main borate producing areas of Turkey, all controlled by the state-owned mining company Eti Maden AS, are Bigadic (colemanite and ulexite), Emet (colemanite), Kestelek (colemanite, probertite, and ulexite), and Kirka (tincal). Production of refined borates increased during the past few years owing to continued investment in new refineries and technologies. Eti Maden planned to expand its share in the world boron market from 36% to 39% by 2013, increasing sales to $1 billion by expanding its production facilities and product range (Today's Zaman, 2009).

Outlook

Consumption of borates is expected to increase, spurred by strong demand in the Asian and South American agriculture, ceramic, and glass markets. World consumption of borates was projected to reach 2.0 Mt B_2O_3 by 2014, compared with 1.5 Mt B_2O_3 in 2010 (O'Driscoll, 2011; Roskill Information Services Ltd., 2010, p. 167).

The European Union (EU) added borates to a list of banned materials. Following an EU study that determined continuous exposure may be harmful, the ruling will require detergent makers to decrease their use of boron (Lismore, 2012). Demand for boron-based fertilizers was expected to rise as a result of an increase in demand for food and biofuel crops. Higher crop prices have enabled farmers to invest more capital in advanced farming techniques and higher grade fertilizers. Consumption of borates by the ceramics industry was expected to shift away from Europe to Asia, which accounted for 60% of world demand in 2012.

For more than a year following the devastating earthquake and tsunami that hit Japan in 2011, boric acid supplies remained limited in that country. Used extensively to cool the damaged Fukushima reactor cores following the destruction by the tsunami of the powerplant's cooling system, the demand for boric acid supplies remained high (Ollett, 2012). The demand for boric acid is likely to remain high because its use as a coolant in nuclear powerplants may expand.

Consumption of boron nitride is expected to increase owing to the development of high-volume production techniques coupled with the creation of new technologies requiring boron nitride. The properties intrinsic to cubic boron nitride, such as hardness (second only to diamond), high thermal conductivity, and oxidation resistance make it an ideal material in a variety of emerging applications. Hexagonal boron nitride was used in additives, ceramics, and intermetallic composites, imparting thermal shock resistance, improved machinability, and reduction of friction.

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TABLE 1

SALIENT STATISTICS OF BORON MINERALS AND COMPOUNDS[1]

(Thousand metric tons and thousand dollars)

	2008	2009	2010	2011	2012
United States:					
Sold or used by producers:					
Quantity:					
Gross weight	W	W	W	W	W
B_2O_3 content	W	W	W	W	W
Value	W	W	W	W	W
Exports:[2]					
Boric acid:[3]					
Quantity	303	171	264	235	190
Value	165,000	109,000	170,000	166,000	155,000
Sodium borates:					
Quantity	519	417	423	492	456
Value	192,000	176,000	218,000	244,000	259,000
Imports for consumption:					
Borax:[2]					
Quantity	1	(4)	(4)	2 r	2
Value	750 r	376	183	959 r	844
Boric acid:[2]					
Quantity	50	36	50	57	55
Value	26,200	26,100	30,100	40,800	43,000
Colemanite:					
Quantity[5]	30	31	50	20	28
Value	8,880	8,630	18,400	19,000	23,200
Ulexite:					
Quantity[5]	75	28	1	5	12
Value	22,600	11,300	238	858	2,940
Consumption, B_2O_3 content	W	W	W	W	W
World, production[6]	4,480	3,760 r	4,300 r	4,330 r	4,420 e

[e]Estimated. [r]Revised. W Withheld to avoid disclosing company proprietary data.

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

[2]Source: U.S. Census Bureau.

[3]Includes orthoboric and anhydrous boric acid. Harmonized Tariff Schedule of the United States codes 2840.19.0000, 2840.20.0000, and 2840.30.0000.

[4]Less than ½ unit.

[5]Source: PIERS.

[6]U.S. production withheld to avoid disclosing company proprietary data.

TABLE 2
BORON MINERALS OF COMMERCIAL IMPORTANCE

Mineral[1]	Chemical composition	B_2O_3, weight percentage
Boracite (stassfurite)	$Mg_3B_7O_{13}Cl$	62.2
Colemanite	$Ca_2B_6O_{11}\cdot 5H_2O$	50.8
Datolite	$CaBSiO_4OH$	24.9
Hydroboracite	$CaMgB_6O_{11}\cdot 6H_2O$	50.5
Kernite (rasorite)	$Na_2B_4O_7\cdot 4H_2O$	51.0
Priceite (pandermite)	$CaB_{10}O_{19}\cdot 7H_2O$	49.8
Probertite (kramerite)	$NaCaB_3O_9\cdot 5H_2O$	49.6
Sassolite (natural boric acid)	H_3BO_3	56.3
Szaibelyite (ascharite)	$MgBO_2OH$	41.4
Tincal (natural borax)	$Na_2B_4O_7\cdot 10H_2O$	36.5
Tincalconite (mohavite)	$Na_2B_4O_7\cdot 5H_2O$	47.8
Ulexite (boronatrocalcite)	$NaCaB_5O_9\cdot 8H_2O$	43.0

[1]Common name in parentheses.

TABLE 3
YEAREND PRICES FOR BORON MINERALS AND COMPOUNDS

(Dollars per metric ton)

Product	Price, December 31, 2010	Price, December 31, 2011	Price, December 31, 2012
Borax, decahydrate, Buenos Aires	520	947–979	910–940
Boric acid, Chile	735	1,390–1,460	1,250–1,309
Colemanite, Buenos Aires, 40% boron oxide (B_2O_3)	370–420	690–730	690–730
Ulexite, Buenos Aires, 40% B_2O_3	350–380	666–697	666–697
Ulexite, granular, Chile, 40% B_2O_3	400	692–734	692–734
Ulexite, Lima, 40% B_2O_3	350–370	687–723	630–652

Source: Industrial Minerals, no. 519, December 2010, p. 69; no. 531, December 2011, p. 61; no. 543, December 2012, p. 76.

TABLE 4
U.S. EXPORTS OF BORIC ACID AND REFINED SODIUM BORATE COMPOUNDS, BY COUNTRY[1]

	2011			2012		
	Boric acid[2]		Sodium	Boric acid[2]		Sodium
	Quantity	Value[3]	borates[4]	Quantity	Value[3]	borates[4]
Country	(metric tons)	(thousands)	(metric tons)	(metric tons)	(thousands)	(metric tons)
Argentina	253	$260	30	1	$4	112
Australia	1,880	1,150	5,120	1,490	1,180	6,400
Belgium	31	62	12	--	--	24
Brazil	923	1,360	80	1,340	1,680	324
Canada	2,240	2,550	23,400	2,920	3,670	18,600
Chili	--	--	1,550	--	--	1,920
China	39,800	25,400	134,000	19,300	14,100	152,000
Colombia	219	298	7,270	693	716	7,760
Costa Rica	40	46	1,630	10	13	1,000
Ecuador	14	15	1,130	158	189	1,600
France	407	207	278	216	370	401
Germany	706	1,910	1	1,750	1,250	5
Guatemala	20	22	2,450	20	23	2,910
Honduras	--	--	216	20	24	1,710
Hong Kong	400	206	20	--	--	78
India	4,010	2,860	21,400	4,660	3,360	26,000
Indonesia	904	717	11,000	890	679	7,810
Italy	1	4	604	230	225	2,190
Japan	35,700	27,900	25,800	27,200	22,500	25,100
Korea, Republic of	50,200	33,300	13,500	40,700	34,300	14,300
Kuwait	20	14	2,200	20	14	1,900
Malaysia	6,510	3,870	54,000	3,490	2,710	62,800
Mexico	7,600	6,400	36,300	9,020	8,450	26,000
Netherlands	26,400	16,900	74,700	31,300	23,900	62,200
New Zealand	277	195	1,470	475	323	1,380
Pakistan	579	424	1,460	669	470	1,250
Peru	20	25	656	353	349	1,130
Philippines	87	92	2,200	77	62	2,300
Russia	298	216	128	--	--	958
Saudi Arabia	4,280	2,950	673	823	580	372
Singapore	1,160	2,230	913	1,790	2,880	708
South Africa	511	392	1,830	357	249	2,040
Spain	--	--	700	--	--	1,000
Taiwan	43,400	29,100	4,240	33,600	25,600	4,070
Thailand	2,790	1,940	8,740	2,510	1,950	8,590
United Kingdom	5	24	9	32	16	26
Venezuela	135	320	46	380	783	257
Vietnam	2,430	1,820	51,100	2,100	1,500	7,410
Other	995 r	843 r	1,590 r	1,080	811	1,390
Total	235,000	166,000	492,000	190,000	155,000	456,000

[r]Revised. -- 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 (HTS) code 2810.00.0000.
[3]Free alongside ship valuation.
[4]HTS codes 2840.19.0000, 2840.20.0000, and 2840.30.0000.

Source: U.S. Census Bureau.

TABLE 5
U.S. IMPORTS FOR CONSUMPTION OF BORIC ACID, BY COUNTRY[1]

	2011		2012	
Country	Quantity (metric tons)	Value[2] (thousands)	Quantity (metric tons)	Value[2] (thousands)
Argentina	506	$514	2,320	$2,330
Bolivia	4,180	2,840	4,470	3,180
Brazil	154	100	--	--
Chile	8,750	7,180	7,200	5,660
China	758	1,030	1,310	1,580
France	270	277	378	386
Germany	350	210	114	102
India	175	265	77	90
Italy	1,490	1,880	2,540	2,240
Japan	58	38	98	90
Peru	3,190	2,360	891	938
Russia	1,180	785	480	399
Turkey	35,500	23,300	34,900	25,900
United Kingdom	18	23	--	--
Other	37	69	44	89
Total	56,600	40,800	54,800	43,000

-- Zero.

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

[2]U.S. customs declared values.

Source: U.S. Census Bureau.

TABLE 6
BORON MINERALS: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Thousand metric tons)

Country	2008	2009	2010	2011	2012[e]
Argentina	786	500	623	649 [r]	650
Bolivia, ulexite	56	86	97	135	130
Chile, ulexite	583	608	504	489	444 [3]
China[e, 4]	140	145 [r]	150 [r]	150 [r]	160
Iran, borax[5]	1	(6) [r]	1 [r, e]	1 [r]	1
Kazakhstan[e]	30	30	30	30	30
Peru	350	187	293	199 [r]	104 [3]
Russia[e, 7]	400	400	400	400	400
Turkey[8]	2,139	1,800 [e]	2,200 [r, e]	2,273 [r]	2,500
United States	W	W	W	W	W

[e]Estimated. [r]Revised. W Withheld to avoid disclosing company proprietary data; not included in total.

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

[2]Includes data available through July 16, 2014.

[3]Reported figure.

[4]Boron oxide (B_2O_3) equivalent.

[5]Data are for years beginning March 21 of that stated.

[6]Less than ½ unit.

[7]Blended Russian datolite ore that reportedly grades 8.6% B_2O_3.

[8]Concentrates from ore.