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2014 Minerals Yearbook

BORON [ADVANCE RELEASE]

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BORON

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In 2014, most of the boron products consumed in the United States were manufactured domestically. Two companies produced borates in the United States—U.S. Borax, Inc., in Boron, CA, and Searles Valley Minerals, Inc., in Trona, CA. U.S. consumption of minerals and compounds reported in boric oxide (B_2O_3) content increased in 2014; however, 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 slightly in 2014 to an estimated 5.86 million metric tons (Mt) compared with 5.83 Mt in 2013 (excluding U.S. production). The United States exported an estimated 225,000 metric tons (t) of boric acid in 2014, a decrease of 3% from 232,000 t in 2013.

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. Global consumption of elemental boron was estimated to be 15 metric tons per year (t/yr). Boron compounds, chiefly borates, are commercially important; boron products are priced and sold based on B_2O_3 content, 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.

Production

Although there are more than 200 naturally occurring boron minerals, only 4 account for 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, most 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 and from publicly available U.S. Securities and Exchange Commission (SEC) information for two U.S. producers—Searles Valley Minerals (SVM) and Rio Tinto Group's U.S. Borax. 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.

U.S. Borax (a wholly owned subsidiary of United Kingdom-based Rio Tinto plc) mined mainly tincal and kernite at Boron, CA, by open pit methods. 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. U.S. Borax supplied more than 30% of the world's refined borates (Rio Tinto plc, 2015, p. 32). According to an SEC report filed by Rio Tinto, the company produced 508,000 t of borates in 2014, an increase of 3% from the 495,000 t reported in 2013 (Rio Tinto plc, 2015, p. 196).

Consumption

The first reported use of borax was as a flux or bonding agent by Arabian goldsmiths and silversmiths in the eighth century, but current research suggests that the Babylonians may have used it 4,000 years ago. Today, borates are used in more than 300 end uses, but the 5 leading uses, in order of greatest consumption, are glass, ceramics, agriculture, detergents, and bleaches (Hamilton, 2006).

Agriculture.—Boron was the most widely used fertilizer 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 water for irrigation.

Boron is essential for plant uptake of primary and secondary nutrients, such as calcium, magnesium, manganese, phosphorus, and zinc. It improves 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 of boron per hectare (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 Plain, Great Lakes region, and the coastal Pacific Northwest, where soils tend to be acidic, leached, coarse sandy, or organic in nature (Albrecht, 1967; U.S. Department of Agriculture, 1998).

Ceramics.—Ceramics were 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, products with applications in aerospace, ballistics, electronics, and medicine, all of 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 consumption of boron carbide in the United States and Europe 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. 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 (U.S. Borax, Inc., undated). 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 reduced boron consumption for this application.

Glass.—The principal market for borates in 2014 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, sodium borates, and ulexite can be used.

Insulation and textile fiberglass represented the largest single use of borates worldwide, accounting for 45% of world borate 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 by increasing the absorbance of infrared radiation (U.S. Borax, Inc., 2015).

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, lower coefficient of thermal expansion, and greater resistance to chemical attack and thermal shock. Applications of borosilicate range from Pyrex® kitchenware to the thermal protection tiles for spacecraft.

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, resulting in the production of lithium and alpha particles. 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. 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. Boric oxide inhibits corrosion.

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, is stronger and lighter in weight than average high-strength steel, which makes it useful in the manufacture of safe and fuel-efficient automobiles (Ray and others, 1966). Ferroboron is also used in the manufacture of neodymium magnets, rare-earth permanent magnets frequently used in actuators, bearings and couplings, computer drives, and servomotors.

Borates were incorporated into various materials, such as cellulosic insulation, textiles, and timber, to impart flame-retardant properties. Boric acid was incorporated into wood flame-retardants to inhibit the transfer of combustible vapors and 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.

Transportation

Almost all U.S. borates were shipped by rail in North America. 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 950-kilogram 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) short-line 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 Rio Tinto 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 to other destinations in 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

Average unit values for borates, based on publicly available information obtained through SEC filing information, increased by 3% in 2014 compared with those reported for 2013 (Rio Tinto plc, 2015, p. 33). Other 2014 borate values, as published by Industrial Minerals, ranged in average unit price from $620 per metric ton (ulexite) to $975 per metric ton (borax) (table 3).

Foreign Trade

Boric acid exports for 2014 were 225,000 t, a 3% decrease from the 232,000 t reported in 2013. Boron imports consisted primarily of borax, boric acid, colemanite, and ulexite (tables 1, 5).

Exports of sodium borates increased by 19% in 2014 to 584,000 t from 489,000 t in 2013 (table 4). In 2014, China received the largest amount of sodium borates from the United States, totaling 41% of all exports, and increased by 36% from those in 2013. China, India, Japan, Malaysia, and Netherlands received the largest quantities of mined borates from the United States in 2014 (table 4). U.S. imports for consumption of boric acid were 56,600 t in 2014 and represented a 7% increase from the 52,800 t reported in 2013 (table 5).

World Review

Argentina.—Argentina was the second-leading producer of boron minerals in South America in 2014 (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. The principal markets for borates produced in Argentina were Brazil and, to a lesser degree, domestic consumers (Orocobre Ltd., 2015).

Borax Argentina S.A. (a subsidiary of Orocobre Ltd.), the country's leading producer of borates, operated the Tincalayu Mine, the largest open pit operation in the country, which is 4,100 m (13,500 feet) above sea level. The deposit consisted primarily of borax, with rare occurrences of ulexite and 15 other borates (Orocobre Ltd., 2015).

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 various grades and sizes of natural boron minerals. MSR exported 97% of its mined borates to 30 countries through the Port of Buenos Aires and by land to Brazil (Minera Santa Rita S.R.L., undated).

Chile.—Chile was the leading borate producer in South America with 580,000 t of borates, primarily ulexite, in 2014. The largest ulexite deposit in the world, Salar de Suirire, was operated by Quimica e Industrial del Borax Ltda., a Government entity with reserves estimated at 1.5 Mt. Almost all the material mined at this location was exported in 2014 (Quiborax SA, 2015).

China.—Because China has low-grade boron resources and demand for boron is expected to increase, imports from Chile, Russia, Turkey, and the United States also were expected to increase during the next several years. 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% B_2O_3, in comparison with reserves from Turkey and the United States, which average about 26% to 31% and 25% to 32% B_2O_3, respectively (Industrial Minerals, 2008a; Baylis, 2010, p. 5; National Boron Research Institute, 2012).

Serbia.—A Canadian mining and exploration company, Erin Ventures Inc., initiated proceedings to begin borate mining in Piskanja, a mining region in Serbia approximately 250 km (155 miles) south of Belgrade. The deposit is primarily composed of colemanite and ulexite with estimated reserves of 11.8 Mt at an average B_2O_3 content between 29% and 31%. Mining did not commence in 2014 but was expected to begin in the near future (Erin Ventures Inc., 2015).

Turkey.—Approximately 61% of the world's boron reserves are in Turkey, with the Kirka deposit at Eskisehir reported to be the largest boron deposit in the world (Engineering and Mining Journal, 2012; National Boron Research Institute, 2012; Özdemir and others, 2013). 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. A recent examination of plant species in boron-rich areas of Turkey revealed a number of indicator plants, which may be used for boron prospecting in Turkey or in similar biome areas elsewhere in the world (Özdemir and others, 2013).

Outlook

Consumption of borates is expected to increase, spurred by strong demand in agriculture, ceramic, and glass markets in Asia and South America. Continued investment in new refineries and technologies and the continued increase in demand were expected to fuel growth in world production during the next several years. In 2013, the European Union (EU) added borates to the Registration, Evaluation, Authorization, and Restrictions of Chemicals (REACH) Restricted Substances List (RSL), following an EU study that determined continuous exposure may be harmful. The ruling required detergent makers to decrease their use of boron (Lismore, 2012). Consumption of boron-based fertilizers is expected to increase as the demand for food and biofuel crops also increases. 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 is expected to shift away from Europe to Asia, which accounted for the majority of world demand for ceramics in 2014.

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 is 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)

	2010	2011	2012	2013	2014
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:					
Boric acid:[2]					
Quantity	264	235	190	232	225
Value	170,000	166,000	155,000	211,000	178,000
Sodium borates:					
Quantity	423	492	457	489 r	584
Value	218,000	244,000	260,000	287,000	304,000
Imports for consumption:					
Refined borax:[3]					
Quantity	42	69	86	127	152
Value	16,100	28,400	33,300	45,300	52,400
Boric acid:[2]					
Quantity	50	56 r	55	53	57
Value	30,300 r	40,800	42,800	36,700	37,400
Colemanite:[4]					
Quantity	-- r	-- r	24 r	38 r	45
Value[e]	-- r	-- r	8,410 r	12,400 r	14,500
Ulexite:[4]					
Quantity	-- r	-- r	1 r	-- r	34
Value[e]	-- r	-- r	77 r	-- r	2,840
Consumption, B_2O_3 content	W	W	W	W	W
World, production[5]	7,640 r	7,880 r	5,700 r, e	5,830 r, e	5,860 e

[e]Estimated. [r]Revised. W Withheld to avoid disclosing company proprietary data. -- Zero.
[1]Data are rounded to no more than three significant digits.
[2]Source: U.S. Census Bureau, Harmonized Tariff Schedule of the United States for boric acid, 2810.00.0000.
[3]Source: U.S. Census Bureau, Harmonized Tariff Schedule of the United States for refined borax, 2840.11.0000 and 2840.19.0000.
[4]Source: U.S. Census Bureau, Harmonized Tariff Schedule of the United States for calcium borates, 2528.00.0010.
[5]U.S. production withheld from world production to avoid disclosing company proprietary data.

TABLE 2
BORON MINERALS OF COMMERCIAL IMPORTANCE

Mineral[1]	Chemical composition	B_2O_3,[2] weight percent
Boracite (stassfurtite)	$Mg_3B_7O_{13}Cl$	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]Parentheses indicate common names.
[2]Boric oxide.

TABLE 3
YEAREND PRICES FOR BORON MINERALS AND COMPOUNDS

(Dollars per metric ton)

Product	Price, December 31, 2012	Price, December 31, 2013	Price, December 31, 2014
Borax, decahydrate, Buenos Aires	910–940	947–979	940–975
Boric acid, Chile	1,250–1,309	600–900	620–900
Colemanite, Buenos Aires, 40% boric oxide (B_2O_3)	690–730	690–730	690–730
Ulexite, Buenos Aires, 40% B_2O_3	666–697	666–697	690–750
Ulexite, granular, Chile, 40% B_2O_3	692–734	692–734	720–820
Ulexite, Lima, 40% B_2O_3	630–652	620–652	620–650

Source: Industrial Minerals, no. 543, December 2012, p. 76; no. 555, December 2013, p. 52–53; no. 567, December 2014, p. 52–53.

TABLE 4

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

	2013			2014		
	Boric acid[2]		Sodium	Boric acid[2]		Sodium
Country	Quantity (metric tons)	Value[3] (thousands)	borates[4] (metric tons)	Quantity (metric tons)	Value[3] (thousands)	borates[4] (metric tons)
Algeria	--	--	--	--	--	26
Argentina	1	$3	71	30	$43	10
Australia	1,700	1,630	6,740	1,210	1,070	6,100
Bangladesh	886	817	1,370	444	417	745
Brazil	4,250	3,630	749	4,630	3,420	1,110
Burma	5	4	292	30	26	207
Canada	2,880	2,980	18,600	2,850	2,930	22,700
Chile	--	--	1,300	--	--	1,800
China	30,900 r	25,600 r	175,000 r	37,300	27,100	238,000
Colombia	671	646	6,460	401	414	6,280
Costa Rica	1	6	503	--	--	1,470
Dominican Republic	1	4	30	--	--	18
Ecuador	198	203	1,470	60	61	1,160
Egypt	--	--	41	--	--	40
El Salvador	7	10	104	--	--	--
France	111	186	93	55	84	308
Germany	589	697	16	588	378	115
Ghana	12	15	--	19	23	--
Guatemala	--	--	4,520	--	--	5,630
Honduras	39	48	6 r	--	--	84
India	4,750	4,290	32,800	5,880	5,020	27,500
Indonesia	2,140	1,860	481	2,130	1,710	2,640
Italy	320	205	1,400	--	--	--
Jamaica	105	77	6	--	--	--
Japan	38,300	37,300	28,900 r	33,600	28,500	26,400
Korea, Republic of	46,700	43,300	13,700	38,900	30,800	12,200
Kuwait	58	65	2,390	--	--	2,100
Malaysia	3,530	2,830	47,700 r	6,150	4,330	92,500
Mexico	7,520 r	7,650 r	14,900	7,660	8,140	15,400
Netherlands	34,700	31,600	93,200	33,600	25,800	82,400
New Zealand	497	594	1,170	552	542	1,530
Nicaragua	--	--	61	--	--	509
Nigeria	38	48	40	60	74	20
Oman	--	--	97	--	--	49
Pakistan	897	809	1,010	1,610	772	931
Panama	2	3	36	5	5	35
Peru	256	292	995	379	350	1,080
Philippines	72	69	2,230	40	40	2,410
Russia	516	467	2,020	158	120	1,170
Saudi Arabia	1,930	1,660	836	2,530	2,070	901
Singapore	437	525	650	798	419	1,010
South Africa	178	213	2,580	219	208	2,150
Spain	--	--	851	--	--	2,630
Taiwan	39,700 r	33,400 r	4,360	37,200	28,000	2,440
Thailand	2,840	2,500	7,990	2,880	2,390	9,290
Tunisia	--	--	17	1	4	98
United Arab Emirates	138	123	--	161	130	4
United Kingdom	32	65	154	5	38	678
Venezuela	1,710 r	2,290 r	314	148	448	118
Vietnam	2,600	2,260	10,600	2,900	2,260	9,470
Other	21 r	86 r	174 r	77	69	148
Total	232,000	211,000	489,000 r	225,000	178,000	584,000

See footnotes at end of table.

TABLE 4—Continued

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

[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; data adjusted by the U.S. Geological Survey

TABLE 5

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

	2013		2014	
Country	Quantity (metric tons)	Value[2] (thousands)	Quantity (metric tons)	Value[2] (thousands)
Argentina	2,240	$1,900	1,840	$1,380
Australia	2	24	1	4
Bolivia	3,620	2,340	3,530	2,090
Canada	19	19	20	3
Chile	7,020	4,920	8,980	5,780
China	326 r	557 r	362	910
France	1080	917	48	64
Germany	53	98	45	56
Hong Kong	126	210	137	222
India	30	48	12	28
Ireland	1	9	--	--
Italy	2,840	2,140	3,090	2,310
Japan	80	92	55	72
Korea	--	--	44	33
Mexico	6	5	1	9
Netherlands	31	17	38	70
Peru	1,090	910	728	578
Russia	622	540	703	481
Turkey	33,500	21,700	37,000	23,500
United Kingdom	16	16	1	4
Total	52,700 r	36,400 r	56,600	37,600

[r]Revised. -- 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	2010	2011	2012	2013	2014[e]
Argentina	623	649	479	500 [e]	500
Bolivia, borax	(3)	(3)	(3)	(3)	(3)
Bolivia, boric acid	13	14	15	15	15 [4]
Chile, ulexite	504	489	444	581	580
China[e, 5]	150	150	160	160	160
Iran, borax[e, 6]	(3) [r]	1 [4]	1	1	1
Kazakhstan[e]	30	30	30	30	30
Peru	293	--	104	220 [e]	230
Russia[e, 7]	200	200	250	250	250
Turkey, run of mine[e, 8]	5,800 [r]	6,400 [r, 4]	4,200 [r]	4,100 [r]	4,100
United States[9]	W	W	W	W	W
Total	7,640 [r]	7,880 [r]	5,700 [r]	5,830 [r]	5,860

[e]Estimated. [r]Revised. W Withheld to avoid disclosing company proprietary data; not included in "Total." -- Zero.
[1]Totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.
[2]Includes data available through July 7, 2015.
[3]Less than ½ unit.
[4]Reported figure.
[5]Boric oxide (B_2O_3) equivalent.
[6]Data are for years beginning March 21 of that stated.
[7]Blended Russian datolite ore that reportedly grades 8.6% B_2O_3.
[8]Concentrates from ore, rounded to no more than two significant figures.
[9]Minerals and compounds sold or used by producers, including both actual mine production and marketable products.