

# 2006 Minerals Yearbook

**BORON** 

# BORON

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Data for boron production and consumption in 2006 in the United States were withheld because two of the four domestic producers were idle, resulting in not having the minimum number of respondents necessary to publish production statistics.

Elemental boron is a nonmetal that is marketed in grades from 90% to 99% purity. Borax is a white crystalline substance chemically known as sodium tetraborate decahydrate and found in nature as the mineral tincal. Boric acid, also known as orthoboric acid or boracic acid, is a white, colorless crystalline solid containing 56% boron oxide  $(B_2O_3)$  and sold in technical national formulary and special quality grades as granules or powder. Boron oxide is a colorless hard, brittle, solid resembling glass that is ground and marketed most often under the name anhydrous boric acid. The most common minerals of commercial importance in the United States were colemanite, kernite, tincal, and ulexite (table 2). Boron compounds and minerals were produced by surface and underground mining and from brine.

U.S. consumption of minerals and compounds reported in boron oxide content was significantly more than that reported for previous years and has been withheld pending verification of the reported data (table 1). Boron products are priced and sold based on the boric oxide content, which varies by ore and compound, and on the absence or presence of sodium and calcium (table 3). Boron compounds exported by producers were boric acid [221,000 metric tons (t)] and sodium borate (393,000 t) (tables 1, 4). Boron imports consisted primarily of borax, boric acid, colemanite, and ulexite (tables 1, 5). Turkey and the United States were the world's leading producers of boron minerals (table 6).

#### **Production**

More than 200 minerals contain boric oxide, but only a few were of commercial importance (table 2). Four minerals make up 90% of the borates used by industry worldwide; they are the sodium borates borax and kernite, the calcium borate colemanite, and the sodium-calcium borate ulexite. These minerals were extracted primarily in California and Turkey and to a lesser extent in Argentina, Bolivia, Chile, China, and Peru.

Domestic data for boron were derived by the U.S. Geological Survey from a voluntary survey of four U.S. operations. The majority of boron production continued to be from Kern County, CA, with the balance from San Bernardino and Inyo Counties, CA. All four operations to which a survey request was sent responded; however, because two of the four companies were idle in 2006, data were withheld to avoid disclosing company proprietary data (tables 1, 3).

The calcium borate mine in Newberry Springs, CA, that was owned and operated by Fort Cady Minerals Corp. has been

idle since February 1, 2003. In 2005, the Billie Mine at Death Valley, CA (owned by American Borate Co.), had sold product from inventory and imported borates from Turkey. The company relied exclusively on imported material in 2006, resulting in only two active borate producers operating four operations during the year. One of the active producers was Searles Valley Minerals, Inc., which produced borax and boric acid from brines pumped from Searles Lake in San Bernardino County.

The second active domestic producer was U.S. Borax, Inc. (a wholly owned subsidiary of London, United Kingdombased Rio Tinto Minerals) which mined borate ores at Boron, CA, by open pit methods and transported the ores to a storage area by trucks. The property is the world's leading producer of refined borate products. The ore was processed into sodium borate or boric acid products in the refinery complex adjacent to the mine. An onsite plant also produced anhydrous sodium borate and boric oxide. Refinery products were shipped by railcar or truck to North American customers or to the U.S. Borax Wilmington, CA, facility at the Port of Los Angeles for international distribution. In addition to its refinery and shipping terminal in Wilmington, U.S. Borax has its global headquarters in Valencia, CA, and the Owens Lake, CA, trona mine supplies raw material to the Boron refinery. U.S. Borax's Owens Lake operation allowed the company to ensure control of the trona supply used in the borate refining process. Trona provided a cost-effective source of carbonates, which helped reduce scaling in the processing equipment. Multiyear labor agreements that will provide additional operational flexibility and efficiency were negotiated at U.S. Borax's U.S. operations.

#### Consumption

The first reported use of borax was in the eighth century by Arabian gold and silversmiths. Today, there are more than 300 end uses for borates with nearly two-third of the world's supply sold into five end uses. New uses continue to be found each year (Hamilton, 2006). The distribution of borates by end use in 2006 was fiberglass insulation, 46%; textile fiberglass, 20%; nonfiberous borosilicate glass and ceramics, 6%; soaps, detergents, and bleaches, 4%; agriculture and enamels and glazes, 3% each; and other, 14% (Chemical Market Reporter, 2006).

Agriculture.—Boron is 1 of 16 nutrients essential to all plants. Boron is necessary in controlling flowering, fruit development, germination, plant reproduction, and pollen production. Domestic consumption in fertilizer was estimated to be 2%. Boron is essential to plant growth and can be applied as a spray and incorporated in fertilizer, herbicides, and irrigation water. Boron fertilizers can quadruple corn yields and increase cotton yields by more than 560 kilograms per hectares

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(500 pounds per acre). Boron deficiencies in crops are found primarily in soils low in organic matter and in acid, sandy soils in humid regions. Boron applied in May and June during early growth can be combined with calcium. For early season apples, boron can be applied postharvest to provide adequate nutrition when buds begin to develop for blooming the next growing season.

Fire Retardants.—Zinc borate was used in plastics as a multifunctional boron-base fire retardant with applications in a variety of plastics and rubber compounds. Depending on the polymer used and fire standards to be met, zinc bromate can replace other fire-retardant additives, such as antimony oxide. Zinc bromate was normally used in conjunction with aluminum trihydrate, magnesium hydroxide, or a silicon polymer. Boric acid is used in cellulose insulation, in cotton mattresses, and in wood as a fire retardant.

Glass.—Glass is a generic term for a fused-silica material with many different compositions. For most scientific glassware, low-expansion borosilicate glass is used because it is inert to most chemicals and can withstand changes in temperature. The major glass sectors are container, flat, fiber, and specialty. The glass industry remained the leading domestic market for boron production, as in previous years. Boron oxide generally reduces melting temperatures and helps with the fiberizing process by lowering viscosity, controlling thermal expansion, inhibiting devitrification, increasing durability and chemical resistance, and reducing susceptibility to mechanical and thermal shock. Various brands of borosilicate glass are Corning Inc.'s Pyrex®, Kimbel Glass Co.'s Kimax, and Schott North America Inc.'s Duran®.

Reinforcing fibers are produced by drawing fibers from orifices in a platinum bushing, spraying the fibers with a glaze, and winding onto a spool. Fiber glass for reinforced plastics accounted for most production. The fibers are mixed with thermosetting materials such as epoxy, polyester, and vinyl esters to form composites. In the United States, the following companies produce fiberglass: CertainTeed Corp., Owens-Corning Fibreglas Corp., PPG Industries, and Saint Gobain Owens.

Borosilicate glass, with a loading of high level nuclear waste of up to 30%, reduced the melting temperature without sacrifice in leach ability. Cleanup of defense sites, including those in France, Germany, Japan, the United Kingdom, and the United States, emphasizes use of glass technology to immobilize contaminated materials. The glass encased waste is encased in a nickel-base alloy that provides protective barriers against chemical and physical stresses during disposal, interim storage, and transportation.

High-boron frits mature rapidly, improve the speed at which smooth, even glaze surfaces develop, and provide good bases for coloring oxides. For the glass surfaces of ceramics and enamels, boric oxide acts as a network former and flux.

**Soaps and Detergents.**—Sodium percarbonate can substitute for sodium perborate in laundry products. Perborate is used in some detergent formulations as an oxygen carrier in high-temperature bleaching systems.

*Other.*—Boron oxide is incorporated into cellulose materials, as borates change the oxidation reactions and promote the

formation of "char," thereby inhibiting combustions. Boric acid is effective in reducing the flammability of cellulose insulation, cotton batting used in mattresses, and wood composites. Borates are a part of the starch adhesive formulation for corrugated paper and paperboard and peptizing agent in the manufacture of casein-base and dextrin-base adhesive.

Boron fiber is a wire of tungsten with elemental boron deposited during a reaction of boron trichloride and hydrogen gas at 800° to 2,000° C. Boron fiber is so stiff and strong that it has been used to patch across the fuselage of jet fighter aircraft to hold the wings on. The primary structural member of the B-1 bomber is a single lengthwise beam constructed of boron fiber.

Borazine and polyborazylene can be used as precursor chemicals to boron nitride coatings and composites.

Boric acid has applications in cosmetics, pharmaceuticals, and toiletries. Borates are also added to lubricants, brake fluids, metalworking fluids, water treatment chemicals, and fuel additives. Boron oxide inhibits corrosion.

#### **Transportation**

The Trona Railway, connected to the Southern Pacific Railroad between Trona and Searles Stations in California, provided a dedicated line with access to the national rail systems for the borate and soda ash markets.

Almost all U.S. Borax bulk products were shipped in North America by rail. The Boron Mine at Boron is 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, which is served by the Union Pacific Railroad. Trucks of product from Boron are driven to Cantil, about 64 kilometers (km) (40 miles) northwest of Boron and loaded into dedicated railcars to be shipped to customers.

Prices for rail haulage depended on a number of factors, including the ability of customers to load and unload efficiently, the ability to use whole unit trains, and the ability to supply their own railcars. The recent increase in fuel prices is another factor affecting cost, with carriers passing on surcharges to customers.

Ocean transport of U.S. Borax products was from the Port of Wilmington where the company had a privately owned berth in the harbor. Products destined for Europe were shipped from the bulk terminal in Wilmington to a company-owned facility in the Port of Rotterdam, Netherlands, to company facilities in Spain and to contracted warehouses. Borax Group also maintains secondary stock points that include Austria, Germany, Norway, the Republic of Korea, Taiwan, and Ukraine. 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, such as Austria, the Czech Republic, and Slovenia. A decision to import borates was based on the geographic location, the range of service needed, and prices.

U.S. Borax used barges to ship borates from Rotterdam, Netherlands, to customers in Belgium, Eastern Europe, France, Germany, and countries even farther away. Barges were the most efficient and reliable method of transporting goods in Europe because most of the large industrial areas could be reached on waterways that link parts of the North, Baltic, Black, and Mediterranean Seas and the Atlantic Ocean.

#### **Prices**

Yearend prices of boron minerals and compounds produced in the United States are listed in table 3. Table 4 lists the freealongside ship values for exports of boric acid and refined sodium borate compounds to various countries.

Rio Tinto Minerals was the world's leading zinc borates producer. Because of rising energy, freight, and raw material costs, the company raised its zinc borate prices. The company also began increasing capacity because of growing global consumption in existing markets and optimistic developments in some new applications (Industrial Minerals, 2006d).

#### World Review

Argentina.—In 2006, Argentina was the leading producer of boron minerals in South America (tables 5, 6). Borax Argentina S.A. (a subsidiary of Rio Tinto Minerals) was the country's leading producer of borates and exported to the United States. Borax Argentina mined borates at four deposits—Tincalayu and Sijes in Salta Province, at more than 4,270 meters (m) (14,000 feet) above sea level, and two dry lake beds, Salars Cauchari and Diabillo in Jujuy Province at 3,370 m. Yacimiento de Boroato El Porvenir at the Salar Cauchari produces ulexite that grades 37% boron oxide. The Tincalayu Mine, originally developed in 1976, was Argentina's largest open pit operation and measured 1.5 km long, 500 m wide, and 100 m deep. Commercial borates mined were colemanite, hydroborocite, kernite, tincal, and ulexite. The clay overburden averages 50 m and typically overlies 30 to 40 m of ore. Tailings from the company's ulexite concentration operation were used as feedstock to supply 8,000 t of boric acid production.

In 1998, Minera Santa Rita S.R.L. bought the boric acid manufacturing plant in Campo Quijano, and had doubled production in 1999. In 2005, boric acid sales were reported to be 27,657 kilograms (kg). The company produced derivatives products for specific applications such as granular deca- and penta-hydrate borax, technical-grade boric acid power, and various grades and sizes of the natural boron minerals. The products are sold in 25 kg and 1 t bags. The ore was mined from Salar de Pozuelos at Mina San Mateo, Salar de Pastos Grandes at Mina San Cayetona, and Salar de Ratones at Mina Isla. The company reported a reserve of more than 1 million metric tons (Mt) of boron minerals (Minera Santa Rita S.R.L., 2006).

Other borate producers in the Province of Juyuy included Processadora de Boratos Argentina S.A. (owned by Ferro Corp. and Canadian JEM Resources & Engineering, Inc.), which produced borates from 2-m thick layers of tincal and ulexite interbedded with clay and lenses of inyoite; Cia Minera Gavenda S.A., which produced borates at the La Inundada Mine at Salar Cauchari from layers of ulexite up to 1-m thick that grade between 11% and 35% B<sub>2</sub>O<sub>3</sub>; and Triboro S.A., which operated the Irene Mine where ulexite was mined that contained between 11% and 35% B<sub>2</sub>O<sub>3</sub>. Other producers in Argentina were

Coop. de Borateros, Moncholi y Guijarro, Ramiro Matinez, and Viento Blanco S.R.L.

Manufacturas Los Andes S.A., a newly formed company, produced boric acid at a plant located in the town of Olacapato. The mine and plant were located in the Andes Mountain Range at an elevation of 3,700 m, near the border with Chile. Ulexite from Salar de Diabillo is mined and produced into 99.5% pure boric acid (Gruposaenz, 2006).

*Bolivia.*—Chilean borates producer Quimica e Industrial del Borax Limitada (Quiborax), pursued compensation for damages of the ulexite mining concessions that were withdrawn by the Bolivian Government in Salar de Uyuni. Quiborax was seeking \$20 million in compensation (Industrial Minerals, 2006b).

China.—More than 100 borates deposits have been reported in 14 provinces in China. The northeastern province of Liaoning and the western province of Qinghai together account for more than 80% of the resources, mostly in the form of borax decahydrate and boric acid. Boron resources in Liaoning was estimated to be 330 Mt, representing 57% of China's total resources (Industrial Minerals, 2006a).

*India.*—A 10.75-crore enriched boric acid plant was expected to be built in Khamman district by 2009. The plant is being endorsed by India's Department of Atomic Energy (Business Standard, 2006).

*Kazakhstan.*—The Satimola borates deposit in western Kazakhstan is under development by Borates PLC of the United Kingdom. The deposit is about 220 km from the Caspian Sea port of Atyrau and 210 km from the mail railhead at Makat. Solution mining appears to be the most costeffective method of mining. The project was scheduled to produce 75,000 metric tons per year (t/yr) of boric acid, 50,000 t/yr of ulexite-hydroboracite concentrates, and 25,000 t/yr of anhydrous boric acid. Sodium borates also could be produced if a local source of trona could be found (Industrial Minerals, 2006e).

Serbia and Montenegro.—Rio Tinto Minerals was awarded a bid in December 2005 for the Piskanja borate deposit in southern Serbia. Erin Ventures Inc. also was pursuing development of the deposit but was unsuccessful in its bid attempt. The company was seeking monetary compensation against the government of Serbia (Industrial Minerals, 2006c).

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#### Other

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 ${\bf TABLE~1}$  SALIENT STATISTICS OF BORON MINERALS AND COMPOUNDS  $^1$ 

(Thousand metric tons and thousand dollars)

	2002	2003	2004	2005	2006
United States:					
Sold or used by producers:					
Quantity:					
Gross weight <sup>2</sup>	1,050	1,150	1,210	1,150	W
B <sub>2</sub> O <sub>3</sub> content	543	605	637	612	W
Value	513,000	591,000	626,000	713,000	W
Exports: <sup>3</sup>					
Boric acid: <sup>4</sup>					
Quantity	84	70	61	183	221
Value	44,600	36,400	34,900	96,800	127,000
Sodium borates:					
Quantity	150	131	135	308	393
Value	63,100	55,400	60,200	110,000	139,000
Imports for consumption:					
Borax: <sup>3</sup>					
Quantity	(5)	(5)	(5)	1	2
Value	94	19	62	319	701
Boric acid: <sup>3</sup>					
Quantity	49	47	49	52	85
Value	18,500	19,000	20,300	22,500	34,900
Colemanite:					
Quantity <sup>6</sup>	32	24	21	31	25
Value	8,960	6,960	6,070	8,900	7,260
Ulexite:					
Quantity <sup>6</sup>	125	80	110	103	131
Value	25,000	16,000	21,900	31,000	39,200
Consumption, B <sub>2</sub> O <sub>3</sub> content	359	366	385	W	W
World, production	4,580 <sup>r</sup>	4,720 <sup>r</sup>	5,070	5,090 <sup>r</sup>	4,260

<sup>&</sup>lt;sup>e</sup>Estimated. <sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data.

<sup>&</sup>lt;sup>1</sup>Data are rounded to no more than three significant digits.

<sup>&</sup>lt;sup>2</sup>Minerals and compounds sold or used by producers, including actual mine production, and marketable products.

<sup>&</sup>lt;sup>3</sup>Source: U.S. Census Bureau.

<sup>&</sup>lt;sup>4</sup>Includes orthoboric and anhydrous boric acid. Harmonized Tariff Schedule of the United States codes 2840.19.0000, 2840.20.0000, and 2840.30.0000.

<sup>&</sup>lt;sup>5</sup>Less than ½ unit.

<sup>&</sup>lt;sup>6</sup>Source: Journal of Commerce Port Import/Export Reporting Service.

 ${\it TABLE~2} \\ {\it BORON~MINERALS~OF~COMMERCIAL~IMPORTANCE} \\$ 

		B <sub>2</sub> O <sub>3</sub> ,
	Chemical	weight
Mineral <sup>1</sup>	composition	percentage
Boracite (stassfurite)	$Mg_3B_7O_{13}Cl$	62.2
Colemanite	$Ca_2B_6O_{11}\cdot 5H_2O$	50.8
Datolite	CaBSiO <sub>4</sub> OH	24.9
Hydroboracite	CaMgB <sub>6</sub> O <sub>11</sub> ·6H <sub>2</sub> O	50.5
Kernite (rasortie)	$Na_2B_4O_7 \cdot 4H_2O$	51.0
Priceite (pandermite)	CaB <sub>10</sub> O <sub>19</sub> ·7H <sub>2</sub> O	49.8
Probertite (kramerite)	NaCaB <sub>3</sub> O <sub>9</sub> ·5H <sub>2</sub> O	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 <sub>2</sub> B <sub>4</sub> O <sub>7</sub> ·5H <sub>2</sub> O	47.8
Ulexite (boronatrocalcite)	NaCaB <sub>5</sub> O <sub>9</sub> ·8H <sub>2</sub> O	43.0

<sup>&</sup>lt;sup>1</sup>Parentheses include common names.

 ${\bf TABLE~3}$  YEAREND PRICES FOR BORON MINERALS AND COMPOUNDS  $^1$ 

### (Dollars per metric ton)

	Price,	Price,
	December 31,	December 31,
Product	2005	2006
Borax, technical, anhydrous, 99%, bulk, carload, works <sup>2</sup>	900-930	900-930
Borax, technical, anhydrous, 99%, bags, carload, works <sup>2</sup>	NA	NA
Borax, technical, granular, decahydrate, 99%, bags, carload, works <sup>2</sup>	378	378
Borax, technical, granular, decahydrate, 99.5%, bulk, carload, works <sup>3</sup>	340-380	340-380
Borax, technical, granular, pentahydrate, 99.5%, bags, carload, works <sup>2</sup>	426	426
Borax, technical, granular, pentahydrate, 99.5%, bulk, carload, works <sup>2</sup>	400-425	400-425
Boric acid, technical, granular, 99.9%, bags, carload, works <sup>2</sup>	836	836
Boric acid, technical, granular, 99.9%, bulk, carload, works <sup>2</sup>	NA	NA
Boric acid, U.S. Borax, Inc. & Chemical Corp., high-purity anhydrous, 99% B <sub>2</sub> O <sub>3</sub> , 100-pound-bags, carlots <sup>2</sup>	900-935	900-935
Colemanite, Turkish, 42% B <sub>2</sub> O <sub>3</sub> , ground to a minus 70-mesh, free on board (f.o.b.) railcars, Kings Creek, SC <sup>3</sup>	270-290	270-290
Ulexite, Lima, 40% B <sub>2</sub> O <sub>3</sub> , ground to a minus 6-mesh, f.o.b railcars, Norfolk, VA	250-300	250-300

NA Not available.

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<sup>&</sup>lt;sup>1</sup>U.S. f.o.b. plant or port prices per metric ton of product. Other conditions of final preparation, transportation, quantities, and qualities not stated are subject to negotiation and/or somewhat different price quotations. Values have been rounded to the nearest dollar.

<sup>&</sup>lt;sup>2</sup>Source: Chemical Market Reporter, pricelist April 17-23, 2006; pricelist June 18-24, 2007.

<sup>&</sup>lt;sup>3</sup>Source: Industrial Minerals, no. 459, December 2005, p. 70; no. 470, November 2006, p. 80.

 ${\it TABLE~4}\\ {\it U.S.~EXPORTS~OF~BORIC~ACID~AND~REFINED~SODIUM~BORATE~COMPOUNDS,~BY~COUNTRY}^{1}$ 

	2005			2006			
	Boric acid <sup>2</sup>		Sodium	Boric	Boric acid <sup>2</sup>		
	Quantity	Value <sup>3</sup>	borates <sup>4</sup>	Quantity	Value <sup>3</sup>	borates <sup>4</sup>	
Country	(metric tons)	(thousands)	(metric tons)	(metric tons)	(thousands)	(metric tons)	
Australia	1,900	\$931	6,680	1,990	\$1,130	7,620	
Belgium			102	23	29	44	
Brazil	2,640	1,420	875	1,650	978	1,570	
Canada	5,350	3,850	50,400	4,800	4,530	54,900	
China	20,600	9,700	62,100	22,400	11,100	69,900	
Colombia	54	53	4,430	192	157	4,770	
France	125	111	117	1,460	987	548	
Germany	432	1,070	11	701	1,380	20	
Hong Kong	4,350	2,080	317	1,460	748		
India	701	254	9,010	1,160	447	16,500	
Indonesia	586	341	310	1,040	608	531	
Italy	40	53	3,440			1,820	
Japan	22,500	21,300	24,300	34,900	36,500	26,100	
Korea, Republic of	19,000 <sup>r</sup>	9,820	14,900	22,400	11,900	13,400	
Malaysia	1,370	1,080	20,000	869	722	30,400	
Mexico	2,870	1,680	11,100	2,310	1,580	8,390	
Netherlands	53,500	20,800	57,900	64,600	25,900	91,200	
New Zealand	817	414	2,880	992	606	1,420	
Philippines	111	68	1,130	190	125	1,050	
Singapore	950	541	753	1,290	791	799	
Spain	13,700	5,090	17,700	24,200	8,880	42,500	
Taiwan	23,000	11,900	4,100	25,100	13,800	3,140	
Thailand	3,520	1,940	7,240	4,140	2,380	6,670	
United Kingdom	1,600	646	1,500	46	57	37	
Venezuela	72	80	400	74	91	449	
Vietnam	1,170	615	1,440	429	247	1,720	
Other	1,980 <sup>r</sup>	948 <sup>r</sup>	4,560 <sup>r</sup>	2,210	1,020	7,510	
Total	183,000	96,800	308,000	221,000	127,000	393,000	

<sup>&</sup>lt;sup>r</sup>Revised. -- Zero.

Source: U.S. Census Bureau.

<sup>&</sup>lt;sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

 $<sup>^2\</sup>mbox{Harmonized Tariff Schedule}$  of the United States (HTS) code 2810.00.0000.

<sup>&</sup>lt;sup>3</sup>Free alongside ship valuation.

<sup>&</sup>lt;sup>3</sup>HTS codes 2840.19.0000, 2840.20.0000, and 2840.30.0000.

 ${\bf TABLE~5}$  U.S. IMPORTS FOR CONSUMPTION OF BORIC ACID, BY COUNTRY  $^1$ 

	200	)5	2006		
	Quantity	Value <sup>2</sup>	Quantity	Value <sup>2</sup>	
Country	(metric tons)	(thousands)	(metric tons)	(thousands)	
Argentina	1,630	\$694	849	\$360	
Australia	1	2	19	29	
Bolivia	3,840	1,360	7,600	2,770	
Chile	15,100	6,130	20,600	7,790	
China	32	83	134	204	
France	1,270	1,720	527	811	
Germany	22	31	42	67	
India	13	28	180	198	
Italy	1,290	1,500	962	1,370	
Japan	109	160	22	57	
Korea, Republic of			21	12	
Peru	4,610	1,700	3,740	1,470	
Russia	67	40	3,420	1,520	
Turkey	23,900	8,970	47,000	18,100	
United Kingdom	57	107	95	133	
Other	21	23	27	40	
Total	51,900	22,500	85,300	34,900	

<sup>--</sup> Zero.

Source: U.S. Census Bureau.

 ${\it TABLE~6} \\ {\it BORON~MINERALS:~WORLD~PRODUCTION,~BY~COUNTRY}^{1,\,2}$ 

#### (Thousand metric tons)

Country	2002	2003	2004	2005	2006 <sup>e</sup>
Argentina	516	512	821	633 <sup>r</sup>	650
Bolivia, ulexite	40	110	68	63 <sup>r</sup>	60
Chile, ulexite	431	401	594	461 <sup>r</sup>	460
China <sup>e, 3</sup>	145	130	135	140	145
Germany, borax <sup>e</sup>	r	r		r	
Iran, borax <sup>4</sup>	2	3	2	3 r, e	3
Kazakhstan <sup>e</sup>	30	30	30	30	30
Peru	7	9	10 <sup>r</sup>	10 <sup>r</sup>	10 <sup>p, 5</sup>
Russia <sup>e, 6</sup>	1,000	1,000	500	400	400
Turkey <sup>7</sup>	1,368	1,377	1,697	2,200 r, e	2,500
United States <sup>8</sup>	1,050	1,150	1,210	1,150	W
Total	4,580 <sup>r</sup>	4,720 <sup>r</sup>	5,070	5,090 <sup>r</sup>	4,260

<sup>&</sup>lt;sup>e</sup>Estimated. <sup>p</sup>Preliminary. <sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data, not included in total.

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<sup>&</sup>lt;sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>&</sup>lt;sup>2</sup>U.S. customs declared values.

<sup>&</sup>lt;sup>1</sup>World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

<sup>&</sup>lt;sup>2</sup>Table includes data available through May 20, 2007.

<sup>&</sup>lt;sup>3</sup>Boron oxide (B<sub>2</sub>O<sub>3</sub>) equivalent.

<sup>&</sup>lt;sup>4</sup>Data are for years beginning March 21 of that stated.

<sup>&</sup>lt;sup>5</sup>Reported figure.

<sup>&</sup>lt;sup>6</sup>Blended Russian datolite ore that reportedly grades 8.6% B<sub>2</sub>O<sub>3</sub>.

<sup>&</sup>lt;sup>7</sup>Concentrates from ore.

<sup>&</sup>lt;sup>8</sup>Minerals and compounds sold or used by producers, including both actual mine production and marketable products.