BORON—2006

By Dennis S. Kostick

Domestic survey data and tables were prepared by Cheryl J. Crawford, statistical assistant, and the world production table was prepared by Linder Roberts, international data coordinator.

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\(_2\)O\(_3\)) 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 Kingdom-based 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-thirds 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%; nonfibrous 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.
Various brands of borosilicate glass are Corning Inc.’s Pyrex®, devitrification, increasing durability and chemical resistance, lowering viscosity, controlling thermal expansion, inhibiting melting temperatures and helps with the fiberizing process by production, as in previous years. Boron oxide generally reduces glass industry remained the leading domestic market for boron with many different compositions. For most scientific glassware, Duran®. Kimbel Glass Co.’s Kimax, and Schott North America Inc.’s major glass sectors are container, flat, fiber, and specialty. The most chemicals and can withstand changes in temperature. The low-expansion borosilicate glass is used because it is inert to 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, sprawling 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 contamination 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 free-alongside 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 Borato 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, kermite, 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 P 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 Jujuy included Procesadora 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% $\text{B}_2\text{O}_3$; and Triboro S.A., which operated the Irene Mine where ulexite was mined that contained between 11% and 35% $\text{B}_2\text{O}_3$. 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 Uyuní. 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 cost-effective 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, 2006c).

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).

**References Cited**


Hamilton, S., 2006, Boron: Mining Engineering, v. 58, no. 6, June, p. 21-22.


Table 1
SALIENT STATISTICS OF BORON MINERALS AND COMPOUNDS

(Thousand metric tons and thousand dollars)

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>United States:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sold or used by producers:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Boric acid:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantity</td>
<td>84</td>
<td>70</td>
<td>61</td>
<td>183</td>
<td>221</td>
</tr>
<tr>
<td>Value</td>
<td>44,600</td>
<td>36,400</td>
<td>34,900</td>
<td>96,800</td>
<td>127,000</td>
</tr>
<tr>
<td>Sodium borates:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantity</td>
<td>150</td>
<td>131</td>
<td>135</td>
<td>308</td>
<td>393</td>
</tr>
<tr>
<td>Value</td>
<td>63,100</td>
<td>55,400</td>
<td>60,200</td>
<td>110,000</td>
<td>139,000</td>
</tr>
<tr>
<td><strong>Imports for consumption:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Borax</td>
<td>(5)</td>
<td>(5)</td>
<td>(5)</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Quantity</td>
<td>94</td>
<td>19</td>
<td>62</td>
<td>319</td>
<td>701</td>
</tr>
<tr>
<td>Value</td>
<td>18,500</td>
<td>19,000</td>
<td>20,300</td>
<td>22,500</td>
<td>34,900</td>
</tr>
<tr>
<td>Colemanite:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantity</td>
<td>32</td>
<td>24</td>
<td>21</td>
<td>31</td>
<td>25</td>
</tr>
<tr>
<td>Value</td>
<td>8,960</td>
<td>6,960</td>
<td>6,070</td>
<td>8,900</td>
<td>7,260</td>
</tr>
<tr>
<td>Ulexite:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantity</td>
<td>125</td>
<td>80</td>
<td>110</td>
<td>103</td>
<td>131</td>
</tr>
<tr>
<td>Value</td>
<td>25,000</td>
<td>16,000</td>
<td>21,900</td>
<td>31,000</td>
<td>39,200</td>
</tr>
<tr>
<td>Consumption, B₂O₃ content</td>
<td>359</td>
<td>366</td>
<td>385</td>
<td>W</td>
<td>W</td>
</tr>
<tr>
<td>World, production</td>
<td>4,580</td>
<td>4,720</td>
<td>5,070</td>
<td>5,090</td>
<td>4,260</td>
</tr>
</tbody>
</table>

1Estimated. 2Revised. W Withheld to avoid disclosing company proprietary data.
3Data are rounded to no more than three significant digits.
4Minerals and compounds sold or used by producers, including actual mine production, and marketable products.
5Source: U.S. Census Bureau.
6Includes orthoboric and anhydrous boric acid. Harmonized Tariff Schedule of the United States codes 2840.19.0000, 2840.20.0000, and 2840.30.0000.
7Less than ½ unit.
8Source: Journal of Commerce Port Import/Export Reporting Service.
### TABLE 2
BORON MINERALS OF COMMERCIAL IMPORTANCE

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Chemical composition</th>
<th>B₂O₃ weight percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boracite (stassfurite)</td>
<td>Mg₃B₇O₁₃Cl</td>
<td>62.2</td>
</tr>
<tr>
<td>Colemanite</td>
<td>Ca₂B₆O₁₁·5H₂O</td>
<td>50.8</td>
</tr>
<tr>
<td>Datolite</td>
<td>CaBSiO₄OH</td>
<td>24.9</td>
</tr>
<tr>
<td>Hydroboracite</td>
<td>CaMgB₆O₁₁·6H₂O</td>
<td>50.5</td>
</tr>
<tr>
<td>Kernite (rasorite)</td>
<td>Na₂B₄O₇·4H₂O</td>
<td>51.0</td>
</tr>
<tr>
<td>Priceite (pandermite)</td>
<td>CaB₁₀O₁₉·7H₂O</td>
<td>49.8</td>
</tr>
<tr>
<td>Probertite (kramerite)</td>
<td>NaCaB₃O₉·5H₂O</td>
<td>49.6</td>
</tr>
<tr>
<td>Sassolite (natural boric acid)</td>
<td>H₃BO₃</td>
<td>56.3</td>
</tr>
<tr>
<td>Szaibelyite (ascharite)</td>
<td>MgBO₂OH</td>
<td>41.4</td>
</tr>
<tr>
<td>Tincal (natural borax)</td>
<td>Na₂B₄O₇·10H₂O</td>
<td>36.5</td>
</tr>
<tr>
<td>Tincalconite (mohavite)</td>
<td>Na₂B₄O₇·5H₂O</td>
<td>47.8</td>
</tr>
<tr>
<td>Ulexite (boronatrocalkite)</td>
<td>NaCaB₅O₉·8H₂O</td>
<td>43.0</td>
</tr>
</tbody>
</table>

1Parentheses include common names.

### TABLE 3
YEAREND PRICES FOR BORON MINERALS AND COMPOUNDS

(Dollars per metric ton)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Borax, technical, anhydrous, 99%, bulk, carload, works²</td>
<td>900-930</td>
<td>900-930</td>
</tr>
<tr>
<td>Borax, technical, anhydrous, 99%, bags, carload, works²</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Borax, technical, granular, decahydrate, 99%, bags, carload, works²</td>
<td>378</td>
<td>378</td>
</tr>
<tr>
<td>Borax, technical, granular, decahydrate, 99.5%, bulk, carload, works²</td>
<td>340-380</td>
<td>340-380</td>
</tr>
<tr>
<td>Borax, technical, granular, pentahydrate, 99.5%, bags, carload, works²</td>
<td>426</td>
<td>426</td>
</tr>
<tr>
<td>Borax, technical, granular, pentahydrate, 99.5%, bulk, carload, work²</td>
<td>400-425</td>
<td>400-425</td>
</tr>
<tr>
<td>Boric acid, technical, granular, 99.9%, bags, carload, works²</td>
<td>836</td>
<td>836</td>
</tr>
<tr>
<td>Boric acid, technical, granular, 99.9%, bulk, carload, works²</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Boric acid, U.S. Borax, Inc. &amp; Chemical Corp., high-purity anhydrous, 99% B₂O₃, 100-pound-bags, carlots²</td>
<td>900-935</td>
<td>900-935</td>
</tr>
<tr>
<td>Colemanite, Turkish, 42% B₂O₃, ground to a minus 70-mesh, free on board (f.o.b.) railcars, Kings Creek, SC²</td>
<td>270-290</td>
<td>270-290</td>
</tr>
<tr>
<td>Ulexite, Lima, 40% B₂O₃, ground to a minus 6-mesh, f.o.b railcars, Norfolk, VA</td>
<td>250-300</td>
<td>250-300</td>
</tr>
</tbody>
</table>

NA Not available.

¹U.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.


### TABLE 4
**U.S. EXPORTS OF BORIC ACID AND REFINED SODIUM BORATE COMPOUNDS, BY COUNTRY**

<table>
<thead>
<tr>
<th>Country</th>
<th>2005 Quantity Boric acid (metric tons)</th>
<th>2005 Value Boric acid (thousands)</th>
<th>2006 Quantity Sodium borates (metric tons)</th>
<th>2006 Value Sodium borates (thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Australia</strong></td>
<td>1,900</td>
<td>$931</td>
<td>6,680</td>
<td>1,990</td>
</tr>
<tr>
<td><strong>Belgium</strong></td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>23</td>
</tr>
<tr>
<td><strong>Brazil</strong></td>
<td>2,640</td>
<td>1,420</td>
<td>875</td>
<td>1,650</td>
</tr>
<tr>
<td><strong>Canada</strong></td>
<td>5,350</td>
<td>3,850</td>
<td>50,400</td>
<td>4,800</td>
</tr>
<tr>
<td><strong>China</strong></td>
<td>20,600</td>
<td>9,700</td>
<td>62,100</td>
<td>22,400</td>
</tr>
<tr>
<td><strong>Colombia</strong></td>
<td>54</td>
<td>53</td>
<td>4,430</td>
<td>192</td>
</tr>
<tr>
<td><strong>France</strong></td>
<td>125</td>
<td>111</td>
<td>117</td>
<td>1,460</td>
</tr>
<tr>
<td><strong>Germany</strong></td>
<td>432</td>
<td>1,070</td>
<td>11</td>
<td>701</td>
</tr>
<tr>
<td><strong>Hong Kong</strong></td>
<td>4,350</td>
<td>2,080</td>
<td>317</td>
<td>1,460</td>
</tr>
<tr>
<td><strong>Indonesia</strong></td>
<td>701</td>
<td>254</td>
<td>9,010</td>
<td>1,160</td>
</tr>
<tr>
<td><strong>Italy</strong></td>
<td>586</td>
<td>341</td>
<td>310</td>
<td>1,040</td>
</tr>
<tr>
<td><strong>Japan</strong></td>
<td>22,500</td>
<td>21,300</td>
<td>24,300</td>
<td>34,900</td>
</tr>
<tr>
<td><strong>Korea, Republic of</strong></td>
<td>19,000</td>
<td>9,820</td>
<td>14,900</td>
<td>22,400</td>
</tr>
<tr>
<td><strong>Malaysia</strong></td>
<td>1,370</td>
<td>1,080</td>
<td>20,000</td>
<td>869</td>
</tr>
<tr>
<td><strong>Mexico</strong></td>
<td>2,870</td>
<td>1,680</td>
<td>11,100</td>
<td>2,310</td>
</tr>
<tr>
<td><strong>Netherlands</strong></td>
<td>53,500</td>
<td>20,800</td>
<td>57,900</td>
<td>64,600</td>
</tr>
<tr>
<td><strong>New Zealand</strong></td>
<td>817</td>
<td>414</td>
<td>2,880</td>
<td>992</td>
</tr>
<tr>
<td><strong>Philippines</strong></td>
<td>111</td>
<td>68</td>
<td>1,130</td>
<td>190</td>
</tr>
<tr>
<td><strong>Singapore</strong></td>
<td>950</td>
<td>541</td>
<td>753</td>
<td>1,290</td>
</tr>
<tr>
<td><strong>Spain</strong></td>
<td>13,700</td>
<td>5,090</td>
<td>17,700</td>
<td>24,200</td>
</tr>
<tr>
<td><strong>Taiwan</strong></td>
<td>23,000</td>
<td>11,900</td>
<td>4,100</td>
<td>25,100</td>
</tr>
<tr>
<td><strong>Thailand</strong></td>
<td>3,520</td>
<td>1,940</td>
<td>7,240</td>
<td>4,140</td>
</tr>
<tr>
<td><strong>United Kingdom</strong></td>
<td>1,600</td>
<td>646</td>
<td>1,500</td>
<td>46</td>
</tr>
<tr>
<td><strong>Venezuela</strong></td>
<td>72</td>
<td>80</td>
<td>400</td>
<td>74</td>
</tr>
<tr>
<td><strong>Vietnam</strong></td>
<td>1,170</td>
<td>615</td>
<td>1,440</td>
<td>429</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>1,980</td>
<td>948</td>
<td>4,560</td>
<td>2,210</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>183,000</td>
<td>96,800</td>
<td>308,000</td>
<td>221,000</td>
</tr>
</tbody>
</table>

---

1Revised. -- Zero.
2Data are rounded to no more than three significant digits; may not add to totals shown.
3Harmonized Tariff Schedule of the United States (HTS) code 2810.00.0000.
4Free alongside ship valuation.
5HTS 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

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

-- Zero.

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

2U.S. customs declared values.

Source: U.S. Census Bureau.

### TABLE 6
BORON MINERALS: WORLD PRODUCTION, BY COUNTRY

<table>
<thead>
<tr>
<th>Country</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>516</td>
<td>512</td>
<td>821</td>
<td>633</td>
<td>650</td>
<td></td>
</tr>
<tr>
<td>Bolivia, ulexite</td>
<td>40</td>
<td>110</td>
<td>68</td>
<td>63</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Chile, ulexite</td>
<td>431</td>
<td>461</td>
<td>594</td>
<td>461</td>
<td>460</td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>145</td>
<td>135</td>
<td>140</td>
<td>145</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany, borax</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iran, borax</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peru</td>
<td>7</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td>1,000</td>
<td>500</td>
<td>440</td>
<td>400</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turkey</td>
<td>1,368</td>
<td>1,697</td>
<td>2,200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td>1,050</td>
<td>1,150</td>
<td>1,150</td>
<td>W</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>4,580</td>
<td>4,720</td>
<td>5,070</td>
<td>5,090</td>
<td>4,260</td>
<td></td>
</tr>
</tbody>
</table>

1Estimated. 2Preliminary. 3Revised. W Withheld to avoid disclosing company proprietary data, not included in total.

World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

Table includes data available through May 20, 2007.

Boron oxide (B₂O₃) equivalent.

Data are for years beginning March 21 of that stated.

Reported figure.

Blended Russian datolite ore that reportedly grades 8.6% B₂O₃.

Concentrates from ore.

Minerals and compounds sold or used by producers, including both actual mine production and marketable products.