# LITHIUM

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The United States has been the largest producer and consumer of lithium, and two U.S. companies have been the leading lithium carbonate producers in the world for many years. Chile has become an increasingly important player in the lithium industry, and with the completion of a second lithium operation in that country expected by early 1997, it may become the world lithium leader by the end of this century.

Because lithium is electrochemically reactive and has other unique properties, there are many commercial lithium products. Producers sold lithium as mineral concentrate, brine, compound, or metal depending on the end use. Most lithium compounds were consumed in the production of ceramics, glass, and primary aluminum.

## Legislation and Government Programs

During the 1950's and 1960's, the U.S. Government conducted nuclear weapons programs that required lithium hydroxide monohydrate for the recovery of the lithium 6 isotope that was used in the production of tritium, a compound necessary for nuclear fission reactions. When these weapons programs were discontinued, a stockpile of lithium hydroxide monohydrate remained, about 75% of which had been depleted of lithium 6 isotope. The processed material could contain 8 to 9 parts per million of mercury.

In 1993, the Department of Energy (DOE), now the administrator of the stockpile, completed an environmental assessment of the material to determine if sales of the mercury-contaminated material presented a risk to environmental quality. DOE issued a "Finding of No Significant Impact" and the material was offered for sale. After negligible sales in 1993 and 1994, the remaining stocks of about 41,000 metric tons of the lithium hydroxide were sold in 1995.

ToxCo, Inc., a lithium product recycler based in Anaheim, CA, bought approximately 31,000 tons of processed material, and Cyprus Foote Mineral Co., a major lithium producer based in Kings Mountain, NC, purchased 10,000 tons of virgin lithium hydroxide monohydrate.[1]

The sale is complicated by the condition that the successful bidders are only entitled to 70% of the material that they agreed to buy until DOE offers the additional 30% of the stockpile to the general public at the same prices paid by Cyprus Foote and ToxCo. The remaining 30% of the virgin material was expected to be offered to any qualified purchaser for 18.3¢ per pound, and the processed material for 13¢ per pound in early 1996. Successful purchasers must certify having sufficient knowledge of chemical and physical characteristics; of the regulations governing its use, discharges, or hazards; complete understanding of responsibilities and requirements to accept the material; and possess a suitable facility to process or possess the material at the time of purchase.[2]

## Production

The U.S. Geological Survey collects domestic production data for lithium from a voluntary survey of U.S. operations. Two U.S. companies responded to the survey, representing 100% of total production. Production and stock data were withheld from publication to avoid disclosing company proprietary data. *(See table 1.)*

FMC Corp., Lithium Div., mined spodumene, a lithium ore, from pegmatite dikes near Bessemer City, NC, and produced lithium carbonate and a full range of downstream compounds, including lithium metal and some organic lithium compounds, at a chemical plant near the mine. The company also operated a butyllithium plant in Bayport, TX. FMC was developing a large lithium brine operation in Argentina. At the completion of the project in Argentina, FMC intends to phase out mining in North Carolina but will maintain all the other facilities at its operations there.

Cyprus Foote Mineral Co. produced about 4,300 tons of lithium carbonate from its brine deposit in Silver Peak, NV.[3] In addition to its Nevada operation, Cyprus Foote, a subsidiary of Cyprus Amax Minerals Co. and the world's largest lithium producer, owned a spodumene mine in Kings Mountain, NC, that has been inactive since 1991. Cyprus Foote's lithium carbonate plant in Kings Mountain was dismantled in 1994. A new lithium hydroxide production facility was under construction at Silver Peak; upon completion of the new plant, Cyprus Foote's lithium hydroxide plant in Sunbright, VA, will be closed. The company operates a butyllithium plant in New Johnsonville, TN. Cyprus Foote also owned and operated a large lithium operation in Chile.

Spodumene is the most common lithium ore, but petalite and lepidolite are other types of lithium ores that are mined in different parts of the world. These three types of ore are beneficiated to produce lithium ore concentrates that can be consumed directly in certain applications. Spodumene concentrates and brines are converted to lithium carbonate and then other compounds for consumption in other end uses.

Lithium carbonate is the most important lithium compound produced from brine and ore deposits. Spodumene was a major raw material for the production of lithium carbonate in North Carolina, and small amounts of spodumene concentrate were produced for sale. Extracting lithium from spodumene entails an energy-intensive chemical recovery process.

After mining, spodumene is crushed and undergoes a flotation beneficiation process to produce concentrate. Concentrate is heated to 1,075° C to 1,100° C, changing the molecular structure of the mineral, making it more reactive to sulfuric acid. A mixture of finely ground converted spodumene and sulfuric acid is heated to 250° C, forming lithium sulfate. Water is added to the mixture to dissolve the lithium sulfate. Insoluble portions are then removed by filtration. The purified lithium sulfate solution is treated with soda ash, forming insoluble lithium carbonate that precipitates from solution. The carbonate is separated and dried for sale or use by the producer as feedstock in the production of other lithium compounds.

Production of lithium carbonate from brine in Nevada and Chile is much less energy intensive than production from the spodumene. Brines enriched in lithium chloride—averaging about 300 parts per million when operation began in 1966—are pumped from the ground and progress through a series of evaporation ponds. Over the course of 12 to 18 months, concentration of the brine increases to 6,000 parts per million lithium through solar evaporation. When the lithium chloride reaches optimum concentration, the liquid is pumped to a recovery plant and treated with soda ash, precipitating lithium carbonate. The carbonate is then removed through filtration, dried, and shipped.

## Consumption and Uses

The aluminum, ceramics and glass, lubricating grease, and synthetic rubber industries consumed most of the lithium minerals and chemicals. These markets primarily were related to transportation; i.e., the aircraft and automotive industries. Industrial and consumer applications also used ceramics and glass. Estimated domestic consumption increased slightly from 1994. Ceramics and glass production and aluminum smelters were the largest consumers of lithium carbonate and lithium concentrates in the United States, comprising an estimated 20% and 18% of the lithium market, respectively. Other consuming industries were synthetic rubber and pharmaceuticals, 13%; chemical manufacturing, 13%; miscellaneous chemicals, 12%; lubricants, 11%; batteries, 7%; and air treatment, 4%.[4]

Lithium carbonate and mineral concentrate additions in ceramics and glass manufacturing processes lower process melting points, reduce the coefficient of thermal expansion and the viscosity, and eliminate the use of more toxic chemicals. The manufacture of thermal-shock-resistant cookware (pyroceramics) consumes the majority of lithium used in the ceramics and glass industry domestically. The manufacture of black and white television picture tubes consume significant amounts of lithium concentrates overseas. Low-iron spodumene and petalite are a source of lithium used to improve the physical properties of container and bottle glass and as a source of alumina, another important component of the glass. Glass manufacturers use lithium in container and bottle glass, enabling them to produce lighter weight, thinner walled products.

Aluminum producers add lithium carbonate to aluminum potlines to lower the melting point of the bath, allowing a lower operating temperature for the potline and increasing the electrical conductivity of the bath. These factors contribute to increased production or reduced power consumption as well as the indirect benefit of lower fluoride emissions.

The third largest end use for lithium compounds is as catalysts in the production of synthetic rubbers and plastics and pharmaceuticals. N-butyllithium initiates the reactions between styrene and butadiene that form abrasion-resistant synthetic rubber and thermoplastic rubbers that require no vulcanization. Other organic lithium compounds are catalysts for the production of plastics like polyethylene. Lithium metal and compounds also are used by drug manufacturers in the production of a number of drugs including Vitamin A, some steroids, an anticholesterol agent, an analgesic, antihistamines, tranquilizers, sleep inducers, and contraceptives. Pharmaceutical-grade lithium carbonate is approved directly for the treatment for manic-depressive psychosis. This is the only treatment approved by the U.S. Food and Drug Administration in which lithium is consumed by the patient.

The multipurpose grease industry was another of the important end uses for lithium in 1995. Lithium hydroxide monohydrate was the compound used for the production of lithium lubricants. Lithium-base greases are favored for their retention of lubricating properties over a wide temperature range; good resistance to water, oxidation, and hardening; and formation of a stable grease on cooling after melting. These greases continued to be utilized in military, industrial, automotive, aircraft, and marine applications.

Almost all major battery manufacturers marketed some type of lithium batteries, and research and development continued for further substitution in applications that implement more conventional alkaline batteries. These batteries represent a growth area for lithium consumption, and new battery configurations continue to be developed. Continued interest in electrically powered vehicles spurred additional interest in battery research. New, more efficient types of rechargeable (secondary) lithium batteries have been developed and improved to meet the needs for this market and for electronic equipment such as portable telephones and video cameras. Work continued on lithium polymer and lithium ion batteries. These batteries are of particular interest because they take advantage of large power capacity available from lithium batteries with fewer safety problems than encountered when these batteries contain lithium metal, a very reactive and volatile material when exposed to air and moisture.

Nonrechargeable (primary) lithium batteries offer improved performance over alkaline batteries at a slightly higher cost and have been commercially available for over 10 years. They are used in watches, microcomputers, cameras, small appliances, electronic games, and toys. The military purchased large and small lithium batteries for a variety of military applications. The Galileo spacecraft, launched in October 1989 for its 6-year trip to explore the atmosphere of Jupiter, contained lithium sulfur dioxide batteries to power its scientific instruments when it reaches its destination. Recent modifications to the lithium sulfur dioxide battery have extended the life of the batteries to at least 10 years with little or no reduction of performance. The final disposition of lithium batteries is of concern; until recently, no technology had been developed for the safe and economic disposal of large lithium batteries, especially the military types. ToxCo operates a facility for neutralization, disposal, and recycling of lithium batteries in Trail, British Columbia.[5]

Aircraft manufacturers in several countries are using or are considering the use of aluminum-lithium alloys for wing and fuselage skin or structural members in different types of aircraft. Use of aluminum-lithium alloys can reduce the weight of the aircraft by more than 10%, allowing significant fuel savings during the life of the aircraft. The alloys, which are 2% to 3% lithium by weight, are attractive to the aircraft and aerospace industry because of their reduced density and superior corrosion resistance compared with those of conventional aluminum alloys. These alloys face direct competition, however, from composite materials consisting of boron, graphite, or aramid fibers imbedded in polymers.

Small quantities of other lithium compounds are important to many industries. Lithium chloride and lithium bromide are used in industrial air-conditioning systems, commercial dehumidification systems, and in the production of sophisticated textiles. Sanitizers for swimming pools, commercial glassware, and public restrooms contain lithium hypochlorite, as do dry bleach for commercial laundries. Lithium metal is used as a scavenger to remove impurities from copper and bronze, and anhydrous lithium chloride is used as a component in fluxes for hard-to-weld metals such as steel alloys and aluminum.

## Prices

The price for lithium carbonate, the largest volume lithium compound, decreased slightly in 1995. Lithium hydroxide monohydrate remained about the same, and technical-grade lithium metal increased more than 8%. Price changes varied by compound, but overall, prices changed little. *(See table 2.)*

## Foreign Trade

Total U.S. exports of lithium compounds were nearly 20% higher in 1995 than in 1994. Almost 60% of all U.S. exports of lithium compounds were to Germany, Japan, and the United Kingdom.

Imports of lithium compounds increased 34%. Of all lithium imports 96% were from Cyprus Foote's operation in Chile. Lithium ore concentrates from Australia, Canada, and Zimbabwe were believed to have been consumed in the United States, but no import statistics were available. *(See tables 3 and 4.)*

## World Review

A small number of countries throughout the world produced lithium ore and brine. Chile and the United States were the leading producers of lithium carbonate; significant quantities of lithium compounds and ore concentrates also were produced in Australia, Canada, Chile, China, Portugal, Russia, and Zimbabwe. Argentina, Brazil, and Namibia produced smaller quantities; production primarily consisted of concentrates. Rwanda, South Africa, and Zaire are past producers of concentrates. Pegmatites containing lithium minerals have been identified in Austria, France, India, Ireland, Mozambique, Spain, and Sweden, but economic conditions have not favored development of the deposits. Lithium has been identified in subsurface brines in Argentina, Bolivia, China, and Israel. Companies in France, Germany, Japan, and the United Kingdom produced downstream lithium compounds from imported lithium carbonate.

***Argentina***.—FMC had been developing a lithium brine deposit at the Salar de Hombre Muerto with the intention of spending $45 million and producing about 13,600 tons of lithium carbonate equivalent (LCE) annually. Based on a new technology for recovering lithium chloride from the deposit and a revised reserve estimate for the deposit, the company announced plans to increase its investment in the project by 50%, expand the operation to produce more than 20,000 tons of LCE, and speed up the project to begin commercial production late in 1996 or early 1997.

A proprietary selective purification process developed by FMC reduces the number of steps required to recover lithium chloride from the brine as one product from the operation and reduces the cost of production as compared to other lithium brine operations. A lithium carbonate plant also will operate at the site and both lithium chloride and lithium carbonate will be products from the operation. Reserves at the Salar should last at least 75 years at design capacity.[6]

***Australia***.—Gwalia Consolidated Ltd., the only lithium ore concentrate producer in Australia and the largest in the world, was building a lithium carbonate plant at its spodumene mine at Greenbushes, Western Australia. Completion of the plant, expected in 1995, was delayed; commissioning of the plant was expected to occur in early to mid-1996. The plant will have the capacity to produce 5,000 tons of lithium carbonate per year. Initial production is planned to be 1,000 tons.[7]

***Chile***.—Sociedad Quimica y Minera de Chile (SQM), a Chilean fertilizer producer, was developing a second project on the Salar de Atacama for the potash raw material to supply its potassium nitrate plant. Production of lithium carbonate is important to the economics of the project and the original plans called for the production of 9,000 tons per year of lithium carbonate. The second stage of the project was planned to begin by the end of the century.[8]

SQM announced plans to double the production of lithium carbonate to more than 18,000 tons from the Minsal Mine by early 1997. The company also reported its intention to undercut prices offered by other producers. SQM expects significantly lower prices to help the company establish its market and to increase the demand for lithium products in new uses for which the cost of lithium compounds has been a prohibiting factor.[9] Cyprus Foote has been recovering lithium carbonate from the same deposit since 1984.

***Zimbabwe***.—Bikita Minerals Ltd., one of the oldest lithium ore concentrate operations in the world, was considering the possiblity of expanding into lithium carbonate production. Primarily a petalite concentrate producer, Bikita produces about 35,000 tons of lithium minerals with a high lithium content.[10]

## Current Research and Technology

In addition to the extensive research that was ongoing for various lithium battery technologies, two new and related areas are being investigated for new applications of lithium materials. This was the first time in many years that research was being conducted that had the potential of creating a significant new demand for lithium for new applications in the foreseeable future.

Alkali silica reactivity (ASR) has been identified as one cause of the premature cracking of concrete that is a problem in many roads and buildings nationwide, but especially in California. The addition of lithium salts, primarily lithium hydroxide, to the concrete mix has been shown to prevent the abnormal expansion due to ASR that causes deterioration of some concrete.[11] Investigations are expected to continue and pilot tests to prove the effectiveness of lithium hydroxide additions to alleviate ASR on a larger scale than the bench-top tests completed thus far.

ToxCo, the company that bought the majority of the lithium hydroxide monohydrate from the DOE stocks, intends to target at least a portion of the DOE material to the concrete industry. Because the company purchased the lithium hydroxide monohydrate at a fraction of the normal selling price listed in table 2, the lithium hydroxide can be offered to concrete producers at reduced prices that may increase the willingness to test this new technology and perhaps cause an increased demand for lithium.[12]

In a related application, a lithium electrolyte is being tested in electrochemical chloride extraction (ECE), a process by which chloride ions are removed from concrete and reinforcing steel. The primary cause much concrete degradation is of the migration of chloride into concrete through the use of deicing chemicals. In colder regions of the United States, the use of deicing chemicals is believed to be the cause of much deterioration of concrete bridges and structures.

In ECE, concrete surfaces are kept wet with an electrolytic solution (possibly a lithium electrolyte) and an electrical charge is applied to the surface for a period of 6 to 10 weeks. During that time, the chloride ions are drawn away from the steel and out of the concrete. The concrete is then sealed to prevent further permeation of chloride ions. Tests have shown the process to be especially effective in removing chloride ions from bridge surfaces, and research is expected to continue.[13]

## Outlook

The health of the lithium industry continues to be closely tied to the performance of the primary aluminum industry and the economy in general. Improved consumption of lithium in the aluminum industry has had a positive effect on lithium consumption. Demand for lithium compounds and minerals in the ceramics and glass industry continues to grow modestly. Similar increases are expected for the near future.

Demand for butyllithium is expected to continue to increase, and domestic producers have increased production capacity to meet that demand. Demand for lithium metal for batteries and to some extent for alloys should increase, but total consumption of metal will remain small in comparison to the demand for lithium compounds for the short term. The fate of the lithium battery market will be largely dependant on the success of electric vehicles and whether the best type of battery for powering them finally is determined to be some form of lithium battery.

Other markets should remain relatively stable with slight growth. Lithium demand could increase dramatically if any of the new technology areas such as nuclear fusion were perfected. This is not expected to occur within the remainder of this century and probably not within the next 25 years.

New uses of lithium in the remediation of premature deterioration of concrete could present a tremendous new market for lithium compounds; however, it will take a few years to determine if the use of lithium hydroxide monohydrate to combat ASR will become the norm. Use of lithium in ECE is still in its infancy and it is too early to predict if this will ever become a significant market.

The United States should remain the largest producer of lithium carbonate until either new South American project reaches full production. Regardless of which project is completed first, Chile is expected to become the leading producer of lithium compounds in the world.

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[1]Department of Energy News. DOE Sells Major Portion of Lithium Stockpile (news release). Aug. 24, 1995, DOE.

[2]Lockhead Martin. Lithium for Sale (news release). Apr. 26, 1996.

[3]Cyprus Amax Minerals Co. 1995 10-K Report. 1996, p. 13.

[4]Cyprus Minerals Co. 1992 Annual Report. 1993, p. 14.

[5]McLaughlin, W. J. Lithium Recycling and Disposal Techniques. Presented at the EV Battery Readiness Working Group, Aug. 1994, Washington, DC, 9 pp.

[6]FMC Corp. FMC Raises Argentine Lithium Outlays 50 Percent; New Technology Speeds Development, Cuts Costs (news release). Oct. 24, 1995, FMC Corp.

[7]Platt's Metals Week. Gwalia Lithium Carbonate Start-Up Delayed. V. 67, No. 11, 1996, p. 9.

[8]———. FMC Testing, Weighing Options in South America. V. 64, No. 11, 1993, pp. 9-10.

[9]Orgill, M. Chilean Fertilizer-Maker Will Sell Lithium. Reuters Online News Service. Feb. 2, 1996, 1 p.

[10]Platt's Metals Week. Zimbabwe Firm Mulls Lithium Expansion. V. 66, No. 33, 1995, p. 7.

[11]Stark, D., B. Morgan, and P. Okamoto. Eliminating or Minimizing Alkali-Silica Reactivity. National Research Council, Strategic Highway Research Program. SHRP-C-343, 1993, 104 pp.

[12]Chapman, P. Lithium Market Is Reshaping. Chem. Mark. Rep. V. 248, No. 19, 1995, p. 31.

[13]Jackson, D. Electrochemical Chloride Extraction: A Promising Technique for Extending the Life of Concrete Structures. Focus. U.S.

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## OTHER SOURCES OF INFORMATION

**U.S. Geological Survey/U.S. Bureau of Mines Publications**

Lithium. Ch. in Mineral Commodity Summaries, annual.
Lithium Availability—Market Economy Countries.

**Other Sources**

Canadian Minerals Yearbook, annual.
Chemical Marketing Reporter, weekly.
Chemical Week, weekly.
Engineering and Mining Journal, monthly.
European Chemical News (London), monthly.
Industrial Minerals (London), monthly.

TABLE 1
SALIENT LITHIUM STATISTICS 1/

(Metric tons of contained lithium)

| | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|
| United States: | | | | | |
| Production 2/ | W | W | W | W | W |
| Producers' stock changes 2/ | W | W | W | W | W |
| Imports 3/ | 590 | 770 | 810 | 851 | 1,140 |
| Exports 4/ | 2,400 | 2,100 | 1,700 | 1,700 | 1,900 |
| Consumption: | | | | | |
| Apparent | W | W | W | W | W |
| Estimated | 2,600 | 2,300 | 2,300 | 2,500 | 2,600 |
| Rest of world: Production 2/ | 5,000 | 5,700 | 5,900 | 6,100 r/ | 6,300 e/ |

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data.
1/ Data are rounded to three significant digits.
2/ Mineral concentrate and carbonate.
3/ Compounds, concentrate, ores, and metal.
4/ Compounds.

TABLE 2
DOMESTIC YEAREND PRODUCERS' AVERAGE PRICES OF LITHIUM AND LITHIUM COMPOUNDS

| | 1994 | | 1995 | |
|---|---|---|---|---|
| | Dollars per pound | Dollars per kilogram | Dollars per pound | Dollars per kilogram |
| Lithium bromide, 54% brine: Truckload lots, delivered in drums | 5.67 | 12.50 | 5.79 | 12.75 |
| Lithium carbonate, technical: Truckload lots, delivered | 2.00 | 4.41 | 1.97 | 4.34 |
| Lithium chloride, anhydrous, purfied: Truckload lots, delivered | 4.84 | 10.67 | 3.93 | 8.66 |
| Lithium fluoride | 7.14 | 15.74 | 7.70 | 16.96 |
| Lithium hydroxide monohydrate: Truckload lots, delivered | 2.55 | 5.62 | 2.55 | 5.62 |
| Lithium metal ingot, battery grade: 1,000-pound lots, delivered | NA | NA | 45.95 | 101.21 |
| Lithium metal ingot, technical grade: 1,000-pound lots, delivered | 35.98 | 79.32 | 39.05 | 86.01 |
| N-butylithium in n-hexane (15%): Truckload lots, delivered | 20.20 | 44.49 r/ | 20.20 | 44.49 |

r/ Revised. NA Not available.

Source: U.S. lithium producers.

TABLE 3
U. S. EXPORTS OF LITHIUM CHEMICALS, BY COMPOUND AND COUNTRY 1/

| Compound and country | 1994 Gross weight (metric tons) | 1994 Value (thousands) | 1995 Gross weight (metric tons) | 1995 Value (thousands) |
|---|---|---|---|---|
| Lithium carbonate: | | | | |
| Australia | 119 | $454 | 69 | $314 |
| Canada | 875 | 3,230 | 783 | 2,850 |
| Germany | 906 | 3,010 | 928 | 2,970 |
| India | 77 | 264 | 114 | 450 |
| Japan | 1,020 | 3,610 | 2,190 | 7,690 |
| Korea, Republic of | 97 | 319 | 138 | 468 |
| Mexico | 121 | 470 | 89 | 348 |
| Netherlands | 300 | 1,010 | 341 | 1,240 |
| United Kingdom | 933 | 2,880 | 963 | 2,860 |
| Venezuela | 613 | 1,890 | 196 | 385 |
| Other | 90 | 563 | 230 | 1,090 |
| Total | 5,150 | 17,700 | 6,040 | 20,700 |
| Lithium carbonate U.S.P.: 3/ | | | | |
| Colombia | -- | -- | 24 | 28 |
| Dominican Republic | -- | -- | 5 | 6 |
| Hong Kong | -- | -- | 10 | 20 |
| Japan | -- | -- | 22 | 141 |
| Mexico | 19 | 75 | 11 | 22 |
| United Kingdom | 7 | 62 | 25 | 365 |
| Venezuela | 28 | 190 | 409 | 1,000 |
| Other | 4 | 67 | 6 | 208 |
| Total | 58 | 394 | 512 | 1,790 |
| Lithium hydroxide: | | | | |
| Argentina | 110 | 471 | 100 | 427 |
| Australia | 149 | 584 | 92 | 390 |
| Canada | 88 | 394 | 114 | 537 |
| Germany | 711 | 3,210 | 682 | 2,770 |
| India | 221 | 852 | 573 | 2,180 |
| Japan | 693 | 3,360 | 933 | 4,270 |
| Korea, Republic of | 308 | 1,280 | 266 | 1,240 |
| Mexico | 143 | 608 | 176 | 685 |
| Singapore | 204 | 992 | 149 | 667 |
| Thailand | 83 | 373 | 135 | 618 |
| United Kingdom | 441 | 1,850 | 373 | 1,200 |
| Other | 283 | 1,520 | 461 | 2,440 |
| Total | 3,430 | 15,500 | 4,060 | 17,400 |

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Less than 1/2 unit.
3/ Pharmaceutical-grade lithium carbonate.

Source: Bureau of the Census.

TABLE 4
U. S. IMPORTS FOR CONSUMPTION OF LITHIUM CHEMICALS 1/

| Compounds | 1994 Quantity (metric tons) | 1994 Value 2/ (thousands) | 1995 Quantity (metric tons) | 1995 Value 2/ (thousands) |
|---|---|---|---|---|
| Lithium carbonate: | | | | |
| Chile | 4,450 | $12,500 | 5,860 | $16,500 |
| China | 50 | 177 | 71 | 251 |
| Hong Kong | (3/) | (3/) | 34 | 126 |
| Other | (3/) | 14 | 2 | 25 |
| Total | 4,500 | 12,700 | 5,970 | 16,900 |
| Lithium hydroxide: | | | | |
| China | (3/) | (3/) | 83 | 328 |
| Japan | 25 | 253 | 17 | 216 |
| Russia | (3/) | 21 | -- | -- |
| Switzerland | 3 | 19 | -- | -- |
| Other | 4 | 77 | 4 | 49 |
| Total | 32 | 370 | 104 | 593 |

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Customs value.
3/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 5
LITHIUM MINERALS AND BRINE: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

| Country 3/ | 1991 | 1992 | 1993 | 1994 | 1995 e/ |
|---|---|---|---|---|---|
| Argentina, spodumene and amblygonite | 287 | 620 | 300 e/ | 400 e/ | 400 |
| Australia, spodumene | 40,400 4/ | 42,500 4/ | 52,900 e/ | 53,000 e/ | 55,000 |
| Brazil, concentrates e/ | 1,560 5/ | 1,600 | 1,600 | 1,600 | 1,600 |
| Canada, spodumene e/ 6/ | 12,000 | 18,500 | 18,900 | 20,000 | 21,000 |
| Chile, carbonate from subsurface brine | 8,580 | 10,800 | 10,400 | 10,400 r/ | 10,600 |
| China (minerals not specified) e/ 7/ | 15,500 | 15,500 | 15,500 | 16,000 | 16,000 |
| Namibia, concentrates, chiefly petalite | 1,190 | 1,160 | 742 | 1,860 r/ | 2,610 |
| Portugal, lepidolite e/ | 10,000 | 9,000 | 9,000 | 9,000 | 8,000 |
| Russia (minerals not specified) e/ 7/ 8/ | XX | 45,000 | 40,000 | 40,000 | 40,000 |
| U.S.S.R. e/ 9/ | 50,000 | XX | XX | XX | XX |
| United States, spodumene and subsurface brine | W | W | W | W | W |
| Zimbabwe (minerals not specified) | 9,190 | 12,800 | 18,100 | 25,300 r/ | 26,000 |

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data. XX Not applicable.
1/ Data are rounded to three significant digits.
2/ Table includes data available through May 3, 1996.
3/ In addition to the countries listed, other nations may produce small quantities of lithium minerals, but output is not reported and no valid basis is available for estimating production levels.
4/ Data are for year ending June 30 of that stated.
5/ Reported figure.
6/ Based on all of Canada's spodumene concentrates (Tantalum Mining Corp. of Canada Ltd.'s Tanco property).
7/ These estimates denote only an approximate order of magnitude; no basis for more exact estimates is available.
8/ All production in the U.S.S.R. for 1991 came from Russia.
9/ Dissolved in Dec. 1991.