



2013 Minerals Yearbook

LITHIUM [ADVANCE RELEASE]

LITHIUM

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In the United States, one lithium brine operation with an associated lithium carbonate plant operated in Silver Peak, NV. Domestic and imported lithium carbonate, lithium chloride, and lithium hydroxide were consumed directly in industrial applications and used as raw materials for downstream lithium compounds. In 2013, lithium consumption in the United States was estimated to be 1,800 metric tons (t) of contained lithium, 10% lower than that in 2012 and 2011, but about 64% greater than that in 2010—the year the full impact of the worldwide economic downturn was felt by the U.S. lithium industry. Increased U.S. consumption since 2010 was primarily the result of increased demand for lithium-based air treatment, battery, ceramic and glass, grease, metallurgical, pharmaceutical, and polymer products in the United States. Net imports of lithium compounds into the United States in 2013 decreased by about 20% from those in 2012, but were about 13% higher than those in 2010. Argentina and Chile were the principal sources of imported lithium carbonate, lithium chloride, and lithium hydroxide.

World lithium production in 2013 (including U.S. production) was estimated to be 34,200 t of lithium contained in minerals and compounds, about the same as that of 2012. World lithium consumption was estimated to be 30,000 t of lithium contained in minerals and compounds, an increase of 6% from that of 2012, and China was reported to be the leading lithium consuming country. One major Chilean producer reduced lithium output owing to increased lithium production from other countries. Lithium prices, on average, remained unchanged owing to the balanced increases in worldwide lithium consumption and supply.

Lithium historically has been mined from two distinct sources—continental brines and hard rock minerals. In Chile, the world's leading producer of lithium carbonate, lithium was recovered from two brine operations on the Salar de Atacama in the Andes Mountains. Concentrated brines were transported to and processed at two lithium carbonate plants, one lithium chloride plant, and one lithium hydroxide plant in Antofagasta, on the Chilean coast. Lithium carbonate and lithium chloride also were produced from brines from the Salar del Hombre Muerto in the Andes Mountains in Argentina. A large percentage of the lithium carbonate produced in South America was exported to the United States. Australia was, by far, the leading producer of lithium mineral concentrates. Brazil, China, Portugal, and Zimbabwe also produced significant quantities, most of which were used directly in the production of ceramics and glass. In China, lithium carbonate was produced from brines from the Zabayu Salt Lake in western Tibet and from the Dongtai and Xitai Salt Lakes in Qinghai Province. China was the only country that produced large quantities of lithium

carbonate from mineral concentrates, mostly from imported Australian spodumene.

Worldwide lithium resource exploration (led predominantly by Australian and Canadian startup companies) has increased significantly in recent years. The continental brine and clay resources of Nevada and geothermal brines of California were a major focus of exploration in the United States, as were the brine resources of Argentina, the pegmatite and oil brine resources of Canada, and the pegmatite resources of Australia. Additionally, significant exploration was conducted in Bolivia and Chile for continental brines.

Lithium is sold as brines, compounds, metal, or mineral concentrates depending on the end use. Lithium's low atomic mass, low coefficient of thermal expansion, high electrochemical reactivity, and other unique properties resulted in many commercial lithium products. Lithium's properties make it one of the most attractive battery materials of all the elements. Worldwide, rechargeable lithium batteries powered most cellular telephones and laptop computers, as well as many heavy-duty power tools. Automakers were developing and improving lithium batteries for electric vehicles (EVs), hybrid-electric vehicles (HEVs), and plug-in hybrid electric vehicles (PHEVs).

Production

The U.S. Geological Survey (USGS) collects domestic production data for lithium from a voluntary canvass of the only U.S. lithium carbonate producer. Rockwood Lithium Inc. (a subsidiary of Rockwood Holdings, Inc., of Princeton, NJ) responded to the survey, representing 100% of total production. Production and stock data were withheld from publication in the past to avoid disclosing company proprietary data. In 2013, however, Rockwood publicly reported U.S. lithium carbonate production of 4,600 t from its Silver Peak, NV, operation. The company doubled lithium carbonate production capacity at Silver Peak to 6,000 metric tons per year (t/yr) in 2013 (Rockwood Holdings, Inc., 2014a, p. 16).

In 2012, Rockwood opened its new 5,000-t/yr battery-grade lithium hydroxide production facility in Kings Mountain, NC, displacing Silver Peak's operation as Rockwood's primary lithium hydroxide production facility. The Kings Mountain facility used the company's lithium carbonate as feedstock. Rockwood's Kings Mountain and Silver Peak plant expansions were funded in part by a \$28.4 million grant from the U.S. Department of Energy (DOE) as part of the American Recovery and Reinvestment Act of 2009 (ARRA, Public Law III-5). The company's other lithium operations included a butyllithium plant in New Johnsonville, TN, facilities for producing downstream lithium compounds in Kings Mountain, and

lithium carbonate and lithium chloride production from a brine operation in Chile (Rockwood Holdings, Inc., 2014a, p. 16, 44).

FMC Corp.'s Lithium Division produced a full range of downstream inorganic compounds, lithium metal, and organic lithium compounds at its facility in Bessemer City, NC. The company sourced its lithium carbonate and lithium chloride from its operation in Argentina. In 2013, FMC was considering lithium leases in Wyoming after researchers at the University of Wyoming's Carbon Management Institute discovered what appeared to be a large lithium brine resource near Rock Springs during a geologic carbon dioxide storage site characterization project. Preliminary analysis of fluid samples collected from a well drilled on the Rock Springs Uplift suggested that reservoir brines could contain 228,000 t of lithium (Lismore, 2013b).

Simbol Materials LLC began operating a pilot plant in California in 2011 using a reverse-osmosis process to produce high-purity lithium carbonate from geothermal brine. The company planned to begin construction of a commercial 15,000-t/yr lithium carbonate facility in California in mid-2014, and startup of the facility was expected by 2015. If successful, the reverse-osmosis process would eliminate the need for solar evaporation, a lengthy process used in traditional lithium brine operations (Syrett, 2013a).

Recycling

In 2013, lithium battery recycling projects were under development in Belgium, Germany, Japan, and the United States. As part of the ARRA, the DOE awarded \$9.5 million to California-based battery recycler Retrieval Technologies (previously Toxco, Inc.) to construct the first U.S. recycling facility for lithium-ion vehicle batteries. The company has been recycling lithium batteries at its facility in Trail, British Columbia, Canada, since about 1993, and recycled nickel-metal-hydride and lead-acid batteries from HEVs at its plant in Lancaster, OH. The new facility was designed to process up to 4,000 t/yr of lithium-ion battery packs (U.S. Department of Energy, 2013, p. 59–60).

Consumption

In 2013, the main global markets for lithium products were estimated to be ceramics and glass, 35%; rechargeable batteries, 29%; lubricating greases, 8%; continuous casting mold flux powders, 6%; air treatment, 5%; polymer production, 5%; primary batteries, 2%; primary aluminum production, 1%; and other uses, 9% (Merriman, 2014, p. 5). Other uses may have included agrochemicals, alloys, cement and concrete additives, dyes and pigments, industrial bleaching and sanitation products, organic synthesis, pharmaceuticals, pool chemicals, and welding (Rockwood Lithium GmbH, 2014). Data to make reliable estimates of U.S. consumption were not available.

In 2012, consumer applications including cameras, cellular telephones, computer tablets, and laptop computers accounted for 64% of global lithium-ion battery market revenues; industrial applications including aerospace and defense, energy storage, industrial tools, and medical devices accounted for 22%; and transportation applications such as EVs, HEVs, PHEVs, and electric bicycles accounted for 14%. Although the

consumer segment accounted for the highest revenues in 2012, the industrial and transportation segments increased at a faster pace. The greatest share of consumer and industrial revenues came from North America, and China led in transportation revenues (Tohani, 2013). China, Japan, and the Republic of Korea accounted for 85% to 90% of global lithium-ion battery production. Germany, Switzerland, and the United States were among other countries producing lithium-ion batteries (Tohani, 2013). According to a Japanese market research firm, the Republic of Korea overtook Japan (the leading lithium-ion battery producer since 1991) in 2011 to become the leading manufacturer of lithium-ion batteries (Kim, 2012).

Japan's Institute of Information Technology reported that global production of lithium-ion battery cells increased to approximately 34 gigawatt hours (GWh) in 2013, a 20% increase from 28 GWh in 2012. Annual growth of lithium-ion cells produced globally averaged 16% per year between 2010 and 2013 (Tesla Motors, Inc., 2014). In 2013, China's domestic lithium-ion battery revenues were reported to have increased by 84% from those of 2012, attributable primarily to increased sales of electric bicycle batteries (Antaike Minor Metal Monthly, 2014).

Increased use of lithium-ion batteries can be attributed in part to the rapid acceptance of lithium-ion batteries rather than nickel-cadmium batteries in heavy-duty power tools. According to Robert Bosch GmbH, a leading manufacturer of power tools, 83% of new cordless power tools produced for the European market in 2013 were powered by lithium-ion batteries, up from 52% in 2009 (von Boxberg, 2014). It was likely that the United States market experienced a similar trend.

Electric car manufacturer Tesla Motors, Inc. (Palo Alto, CA) announced plans to construct an immense lithium-ion battery plant in the United States capable of producing up to 500,000 lithium-ion vehicle batteries per year by 2020. The plant was expected to be vertically integrated, capable of producing finished battery packs directly from raw materials (Tesla Motors, Inc., 2013).

In 2011, Alcoa Inc. developed a third-generation aluminum-lithium alloy that could contribute to lighter, less costly, and more corrosion-resistant airplanes compared with those using composite alternatives. The alloy reduces density by up to 7% in critical structural components. During 2013, Alcoa continued to construct a \$90 million 20,000-t/yr aluminum-lithium facility adjacent to its Lafayette, IN, plant that was scheduled to begin production in late 2014. Alcoa completed the expansion of aluminum-lithium capacity at its Technical Center in Alcoa Center, PA, and its Kitts Green plant in the United Kingdom, creating additional aluminum-lithium casting capacity (Alcoa Inc., 2014, p. 15).

Prices

Customs values for U.S. imports of lithium carbonate and lithium hydroxide were used as an indication of the trends in lithium pricing; producer pricing was not available for lithium carbonate or lithium hydroxide. In 2013, the average customs unit value for imported lithium carbonate was \$4.39 per kilogram, 4% higher than that of 2012. The average customs unit value for imported lithium hydroxide

was \$5.81 per kilogram, 10% lower than that of 2012. The average unit value of exported lithium carbonate in 2013 was \$5.64 per kilogram, 10% lower than that of 2012. The average unit value of exported lithium hydroxide was \$7.43 per kilogram, 5% lower than that of 2012. The average unit values of exported lithium carbonate and of lithium hydroxide in 2013 were 28% higher than the average unit values of imported carbonate and hydroxide. This suggests that the materials exported from the United States were higher quality than those that were imported.

At yearend, the battery-grade lithium carbonate price in China was \$6,380 to \$6,810 per metric ton; technical-grade lithium carbonate was \$5,700 to \$6,100 per metric ton; and lithium hydroxide (56.5% to 57.5% lithium hydroxide) was \$6,550 to \$6,900 per metric ton (Syrett, 2014). The U.S. import price for glass-grade spodumene [(5% lithium oxide), cost, insurance, and freight] was \$417 to \$463 per metric ton. The U.S. import price for >7.5% lithium oxide spodumene (cost, insurance, and freight) was \$653 to \$699 per metric ton (Industrial Minerals, 2013).

In 2013, FMC and Rockwood Lithium each increased butyllithium prices by 4% (Rockwood Holdings, Inc., 2013; Syrett, 2013b). Sociedad Química y Minera de Chile S.A. (SQM) reported a 12% average price increase for its lithium products (Sociedad Química y Minera de Chile S.A., 2014, p. 64).

Foreign Trade

In 2013, total exports of lithium compounds from the United States decreased by 6% compared with those of 2012. About 30% of all U.S. exports of lithium compounds went to Japan, 22% went to Germany, and 9% went to Belgium (table 2).

Imports of lithium compounds into the United States decreased by 20% in 2013 compared with those of 2012. About 58% came from Chile and 39% from Argentina (table 3). Lithium concentrates from Australia and Zimbabwe may have entered the United States, but because these materials have no unique import code, no import data were available.

World Review

World lithium production in 2013 (including U.S. production) was estimated to be 34,200 t of lithium contained in minerals and compounds, about the same as that of 2012 (table 1). Two leading producing countries, Argentina and Chile, decreased lithium production by 3% and 15%, respectively, from that of 2012. Gross weight production figures for lithium carbonate, lithium chloride, lithium hydroxide, and lithium mineral concentrates are listed in table 4. Argentina, Chile, China, and the United States were the leading producers of brine-based lithium carbonate. Significant quantities of lithium compounds and concentrates also were produced in Australia, Brazil, China, Portugal, and Zimbabwe. Several brine operations were under development in Argentina, Bolivia, and Chile; spodumene mining operations were under development in Australia, Canada, China, and Finland; and a jadarite mining operation was under development in Serbia. Pegmatites containing lithium minerals also have been identified in Afghanistan, Austria,

France, India, Ireland, Mozambique, Spain, Sweden, and Congo (Kinshasa), but have not been developed. Lithium also has been identified in subsurface brines in Afghanistan and Israel. Companies in China, France, Germany, Japan, the Republic of Korea, Russia, Taiwan, the United Kingdom, and the United States produced downstream lithium compounds from imported lithium carbonate.

Lithium compounds accounted for an estimated 79% of global lithium consumption in 2012 (the latest year for which data were available), and lithium minerals accounted for the remaining 21%. Of the estimated 28,200 t of lithium consumed worldwide in 2012, lithium carbonate accounted for approximately 48%, essentially split evenly between technical-grade carbonate and battery-grade carbonate. Lithium hydroxide was the second most used lithium compound, accounting for approximately 15% of total consumption, with technical-grade hydroxide estimated at 12% of consumption and battery-grade hydroxide at 3% (Roskill Information Services Ltd., 2013, p. 245).

In 2013, lithium consumption for batteries, ceramics and glass, grease, and other industrial applications all increased; lithium consumption for primary aluminum production decreased. Major lithium producers and an industry analyst indicated that world lithium consumption increased between 4% and 6% from that of 2012. Assuming a 6% average rate of growth, the USGS estimates that about 30,000 t of lithium contained in minerals and compounds were consumed worldwide in 2013 (Merriman, 2014, p. 5; Sociedad Química y Minera de Chile S.A., 2014, p. 64; Rockwood Holdings, Inc., 2014b, p. 18). Total lithium consumption increased an average of approximately 7% per year from 2003 through 2013, and lithium consumption for rechargeable batteries increased at an average rate of 25% per year during the same period (Sociedad Química y Minera de Chile S.A., 2014, p. 52).

In 2012, China was estimated to be the leading consumer of lithium with 35% of total world consumption—its lithium consumption having grown at a rate of 11.4% per year since 2002. The countries of Europe, combined, accounted for 24% of total world lithium consumption. Japan, the Republic of Korea, and North America accounted for 12%, 10%, and 9% of world consumption, respectively (Roskill Information Services Ltd., 2013, p. 243–244).

Argentina.—Production of lithium carbonate in 2013 was estimated to be 9,500 t, and production of lithium chloride was estimated to be 4,200 t, each slightly lower than that of 2012. FMC has operated its facility at the Salar de Hombre Muerto since 1998. It was initially designed to produce about 12,000 t/yr of lithium carbonate and about 5,500 t/yr of lithium chloride. In 2012, FMC's lithium carbonate production capacity increased to 23,000 t/yr; however, operational issues associated with the expansion, as well as adverse weather conditions, reduced lithium production during the first three quarters of 2013 (FMC Corp., 2014, p. 20).

In 2013, ADY Resources Ltd. (a subsidiary of Enirgi Group Corp.) produced approximately 1,200 t of lithium carbonate from its pilot operation at the Salar del Rincón in Salta Province. The company planned to increase its production capacity to 30,000 t/yr over a 3-year period, with construction scheduled to begin in early 2014 (El Inversor Energetico y Minero, 2013).

The Australian exploration company Orocobre Ltd. completed construction of approximately 70% of its joint venture Olaroz Lithium Project [Orocobre (66.5%), Toyota Tsusho Corp. (25%), Government of Jujuy Province (8.5%)] at the Salar de Olaroz in northwestern Argentina. Production was scheduled to begin in mid-2014, and full production was expected to be 17,500 t/yr of battery-grade lithium carbonate. Owing to the low magnesium-to-lithium ratio in its brine, Orocobre reported that the length of its brine evaporation process could be approximately 7 months, as compared with 18 months for Chile's lithium operations. Production was intended to supply low-cost lithium to automotive and battery industry markets (Orocobre Ltd., 2013; Vaccaro, 2013).

In January 2014, the Canadian exploration company Lithium Americas Corp. announced an agreement with the Republic of Korea's POSCO to install POSCO's lithium extraction pilot plant at Lithium Americas' Cauchari-Olaroz Lithium Project on the Puna plateau in northwestern Argentina. POSCO's new lithium extraction technology was reported to be faster than traditional brine extraction technology, and was expected to minimize the environmental effects associated with large-scale evaporation ponds (Lithium Americas Corp., 2014). Lithium Americas completed a definitive feasibility study of the project in 2012, which indicated proven and probable reserves sufficient to operate at a production rate of up to 40,000 t/yr of lithium carbonate for 40 years, including an initial 5-year ramp-up period. The company planned to build the project in two stages with each stage consisting of a 20,000-t/yr lithium carbonate equivalent (LCE) facility. Construction of the second stage, which would require a second definitive feasibility study, was not expected to begin until 2018 (Lithium Americas Corp., 2012, p. 4).

Australia's Galaxy Resources Ltd. completed a definitive feasibility study of its Sal de Vida lithium brine project at the Salar del Hombre Muerto in 2013. The feasibility study indicated proven and probable reserves sufficient to operate at a production rate of up to 25,000 t/yr of lithium carbonate for 40 years (Galaxy Resources Ltd., 2013b). Although the feasibility study was partially funded by South Korean companies [LG International Corp. and GS Caltex Corp.] and the South Korean Government-owned mining company Korea Resources Corp. (KORES), these companies declined to exercise their earn-in option for 30% interest in the project, giving Galaxy 96% ownership (Patersons Securities Ltd., 2013, p. 5).

Canadian exploration company Rodinia Lithium Inc. produced a second pilot batch of lithium carbonate from its Salar de Diabillos lithium deposit in Salta in 2013. A feasibility study was expected in 2014. The company's initial mineral resource estimate for the lithium deposit indicated the potential to produce up to 25,000 t/yr of lithium carbonate (Rodinia Lithium Inc., 2013).

Australia.—Talisson Lithium Pty Ltd. produced about one-third of global lithium supply from its deposit in Western Australia, which reportedly is the largest spodumene deposit in the world. Talison produced two types of lithium concentrate—chemical-grade (6% lithium oxide content), which is primarily used for conversion into lithium chemicals for applications

including lithium batteries, and technical-grade (5% to 7.5% lithium oxide content), a low-iron concentrate that is used directly in the manufacture of ceramics, glass, and heat-proof cookware. Talison's lithium concentrate production capacity was 740,000 t/yr, equivalent to approximately 100,000 t/yr of lithium carbonate (Talisson Lithium Pty Ltd., 2012, p. 11–12, 29).

In March, Talison Lithium was sold to Chengdu Tianqi (Group) Co., Ltd. (Chengdu, China), the world's leading producer of lithium compounds from concentrates, for approximately \$832 million. Chengdu sought to secure chemical-grade spodumene to produce lithium chemicals for its growing battery and electronics markets (Diniz, 2013). Subsequently, Rockwood entered into an agreement to acquire a 49% interest in Talison from Tianqi. The Talison acquisition, which was expected to close in mid-2014, was expected to provide Rockwood with access to another significant lithium reserve, raw material diversity, and the flexibility to quickly ramp up production if necessary (Rockwood Holdings, Inc., 2014a, p. 17). Talison previously reported that 100% of its chemical-grade lithium concentrate was sold to China, and its technical-grade lithium concentrate was distributed throughout the world with approximately 40% (by weight) going to China, 37% to Europe, 13% to North America, and 7% to Japan (Talisson Lithium Pty Ltd., 2012, p. 11–12). In 2012, Talison was the source of about 80% of the lithium consumed in China (Wheatley, 2012, p. 21).

Talisson planned to build a 20,000-t/yr lithium carbonate plant in Kwinana, Western Australia, with plant commissioning expected in 2017. At yearend 2013, an engineering study of the plant was being finalized (Talisson Lithium Pty Ltd., 2013, p. 9, 16).

Galaxy Resources announced that its Mount Cattlin spodumene operation, near Ravensthorpe, Western Australia, would remain suspended indefinitely owing to exchange rate deterioration and its impact on local operating costs. The Mount Cattlin operation was initially placed in temporary suspension in July 2012 due to high inventory levels of spodumene at Galaxy's Jiangsu lithium carbonate plant in China. In March 2013, Galaxy signed a 3-year contract with Talison to supply spodumene to the Jiangsu plant (Galaxy Resources Ltd., 2013a).

In 2013, Reed Resources Ltd. tested a process to produce battery-grade lithium hydroxide from spodumene sourced from its Mount Marion lithium project in Western Australia (jointly owned with Mineral Resources Ltd). At yearend, Reed was working to set up a continuous semi-pilot plant for its proprietary process. A 2012 prefeasibility study indicated that the Mount Marion lithium project could support a production capacity of 10,000 t/yr of lithium hydroxide and 8,800 t/yr of lithium carbonate (Reed Resources Ltd., 2013).

Bolivia.—Bolivia's undeveloped Salar de Uyuni is the largest salt flat in the world, with an area of about 11,000 square kilometers containing vast lithium resources. In January 2013, the state-owned mining company Corporacion Minera de Bolivia (COMIBOL) commenced operation of a 40-ton-per-month lithium carbonate pilot plant at the Salar de Uyuni (Lismore-Scott, 2013). Bolivia signed an agreement with China's LinYi Dake Trade Co. to build a lithium-ion battery pilot plant in La Palca in the Potosi region of Bolivia.

Construction of the facility began during the last quarter of 2013, and production capacity was expected to be 1,000 batteries per day (GlobalPost, 2014).

Canada.—At yearend, RB Energy Inc. (previously Canada Lithium Corp.) was in the process of commissioning its open pit and hydro-metallurgical processing plant at its Quebec Lithium Project near Val d'Or, Quebec. Production from the 20,000-t/yr lithium carbonate-processing plant was expected to be between 9,000 and 11,000 t in 2014. Earlier in 2013, RB Energy signed a 3-year lithium carbonate offtake agreement with Japan's Marubeni Corp. for a minimum commitment of 5,000 t/yr. In November, RB Energy successfully produced samples of battery-grade lithium carbonate (Lismore, 2013a; RB Energy Inc., 2014).

Nemaska Lithium Inc. completed an updated mineral resource estimate on its Whabouchi Mine and lithium hydroxide-lithium carbonate plant in Quebec. The estimate showed a measured resource of 13 million metric tons (Mt) of spodumene grading 1.60% lithium oxide, and an additional indicated resource of 15 Mt grading 1.54% lithium oxide. The company developed a proprietary membrane electrolysis process, which would produce lithium hydroxide directly from spodumene concentrate. The new technology was expected to reduce processing costs by using electricity to replace caustic soda, as well as eliminating the production, handling, and disposal of sodium sulfate. Nemaska expected to commission a 500-t/yr phase I lithium hydroxide demonstration plant in 2014 (Pistilli, 2013a; Nemaska Lithium Inc., 2014).

Chile.—With a reported 27% share of the world lithium chemicals market, SQM's sales of 36,100 t of LCE in 2013 were 21% less than those in 2012 principally owing to increased competition from China, and the value of sales decreased by 12% to \$197 million. The company's lithium products were distributed throughout the world, with 56% going to Asia and Oceania; 30% to Europe, the Middle East, and Africa; 13% to North America; and 1% to other regions in 2013. SQM's lithium carbonate production capacity was 48,000 t/yr in 2013, and its lithium hydroxide production capacity was 6,000 t/yr. The company was completing engineering work to increase lithium carbonate capacity to 60,000 t/yr (Harrison, 2013; Sociedad Química y Minera de Chile S.A., 2014, p. 64, 79).

Lithium carbonate production capacity for Rockwood Lithium's operation in Chile was 27,000 t/yr, and lithium chloride capacity was 4,500 t/yr. Rockwood reported lithium carbonate production of 23,800 t in Chile during 2013. Sales of lithium products increased slightly from those of 2012 owing to increased production of lithium carbonate, lithium chloride, and lithium hydroxide, as well as higher selling prices. The company began construction of a 20,000-t/yr lithium carbonate plant in La Negra in 2012, which was expected to be completed in 2014. The company used lithium carbonate and lithium chloride from its operations in Chile as feedstock for some of its downstream chemical production in Germany, India, Taiwan, and the United States. Rockwood's lithium compounds and value added lithium specialty products were distributed throughout the world, with 43% going to Europe, the Middle East, and Africa; 27% to Asia; 19% to North America; and 11% to Latin America in 2012

(Haber, 2013, p. 3, 27; Roskill Information Services, Ltd., 2013, p. 136; Rockwood Holdings, Inc., 2014a, p. 14, 16, 44, 52).

In 2013, Li3 Energy, Inc. (Santiago, Chile) acquired 100% ownership of the SLM Cocina mining concession within the Maricunga lithium project at the Salar de Maricunga in northern Chile. The property adjoins the Litio 1–6 mining concessions previously acquired by Li3 (60% ownership). The company formed a joint venture with POSCO Canada Ltd. to build a pilot plant to recover lithium and other elements including boron, calcium, magnesium, and potassium using a proprietary direct extraction technology developed by POSCO (Li3 Energy, Inc., 2014, p. 3–6).

China.—China was the only country that continued to produce large quantities of lithium carbonate and lithium hydroxide from domestic and imported mineral concentrates. Lithium mineral concentrates were estimated to contain 22% of China's lithium reserves, and lithium brines were estimated to contain the remaining 78%. Roskill Information Services reported the country's total lithium production (measured as LCE) increased at an average rate of 16% per year from 2003 to 2012 (Roskill Information Services Ltd., 2013, p. 147, 149).

In 2012, China produced an estimated 16,400 t of LCE (4,000 t from brines and 12,350 t from domestic spodumene). Brine-based production capacity was 34,000 t/yr of LCE and its spodumene-based capacity was 49,000 t/yr of LCE. China's spodumene production was mostly within Sichuan Province, but also took place in Hunan, Jiangxi, and Xinjiang Provinces. By yearend 2012, the country's capacity to produce lithium compounds from spodumene was estimated to be 83,500 t/yr of LCE, increasing from 7,800 t in 2005. China produced 42,450 t of LCE from domestic and imported spodumene feedstock in 2012, 71% of which was from Australia. The rapid expansion of China's spodumene-based lithium carbonate facilities in recent years has significantly affected the global lithium supply chain and has enabled spodumene-sourced lithium to account for one-half of the world's lithium supply in 2012 and 2013 (Roskill Information Services Ltd., 2013, p. 43, 146, 149, 151, 154).

Qinghai Lanke Lithium Industry Co., Ltd. operated a 10,000-t/yr lithium carbonate-lithium chloride project in the Chaerhan Salt Lake Zone in Qinghai Province and a 200-t/yr lithium carbonate pilot project (with Qinghai Salt Lake Industry Group Co., Ltd.) in the East Taijiner Salt Lake Zone. Qinghai Lanke planned to expand production capacity of both operations to a total of 16,500 t/yr of LCE. CITIC Guoan Lithium Science & Technology Co., Ltd. operated a 20,000-t/yr lithium carbonate plant at West Taijiner Salt Lake in Qinghai Province with plans to expand capacity to 30,000 t/yr. Tibet Mineral Development Co., Ltd. operated a 3,750-t/yr lithium carbonate-lithium hydroxide project at the Zabayu Salt Lake in western Tibet with plans to expand to 18,000 t/yr (Merriman, 2012, p. 16–17).

In 2013, Galaxy Resources produced 5,844 t of lithium carbonate from its plant in Jiangsu Province. The plant depleted its stockpiles of spodumene from Mount Cattlin in November and received its first shipment of Talison feedstock in December. The Jiangsu plant was designed to produce 17,000 t/yr of lithium carbonate and supply users across the Asia-Pacific region (Galaxy Resources, Ltd., 2014).

Japan.—Consumption of lithium in Japan in 2013 was estimated to be 14,600 t of LCE, slightly higher than that of 2012, but 16% lower than that of 2011. Lithium carbonate consumption decreased owing to slower than anticipated growth of lithium-ion batteries in electric vehicles and the continued transfer of lithium-ion battery manufacturing plants from Japan to China. Japan's lithium metal consumption decreased owing to primary battery manufacturing plants relocating from Japan to Indonesia (Roskill's Letters from Japan, 2013).

Korea, Republic of.—As part of the effort to secure stable long-term supplies of lithium for its expanding automobile, battery, and electronics industries, the Government partnered with several companies, including POSCO and SK Energy Co., Ltd., to acquire lithium from a broad range of sources and countries. In 2013, POSCO announced that its Research Institute of Industrial Science and Technology had developed a chemical technology to directly extract lithium from brines, eliminating the need for natural evaporation and reducing the processing time from 12 months to less than 8 hours. The lithium recovery rate also rose from approximately 50% to more than 80% and produced lithium carbonate of up to 99.99% purity. POSCO planned to use its new technology to build direct extraction plants worldwide in association with lithium brine producers, with agreements with Lithium Americas and Li3 Energy previously announced (Pistilli, 2013b).

Outlook

Numerous lithium producers and lithium market analysts projected world lithium consumption levels through 2015 and 2020. On average, their conclusions indicate that world lithium consumption is likely to increase to approximately 190,000 t/yr of LCE by 2015 and to 280,000 t/yr of LCE by 2020 (Clarke, 2012). From 2013 to 2020, average annual growth in world lithium consumption is expected to be 9.5%. New lithium producers are expected to supply approximately 25% of the lithium required by 2020 (Merchant Research & Consulting Ltd., 2014).

For lithium consumed in batteries, rechargeable lithium-ion batteries continue to have the greatest potential for growth. The global lithium-ion battery market is expected to double by 2017, requiring an additional 90,000 t of LCE (Baylis, 2013, p. 26). Other lithium end uses also are projected to increase, but at lower rates than batteries.

Lithium supply security has become a top priority for Asian technology companies. Strategic alliances and joint ventures have been, and continue to be, established with lithium exploration companies worldwide to ensure a reliable, diversified supply of lithium for Asia's battery and vehicle manufacturers. With lithium carbonate being one of the lowest cost components of a lithium-ion battery, the issue to be addressed is not cost difference or production efficiency, but supply security.

A new technology, the lithium-air battery, may be capable of substantially increasing the energy density of lithium batteries, effectively rivaling the energy density of petroleum. Although development of lithium-air battery technology is still in its infancy, a coalition of U.S. national laboratories and

commercial partners led by International Business Machines Corp. anticipated having a laboratory prototype battery ready by yearend 2014 and commercial batteries in production within a decade (Licata, 2013).

Most global automobile manufacturers have announced plans to use lithium-ion batteries in current or future generations of EVs, HEVs, and PHEVs. Vehicles with lithium-ion batteries were introduced in 2013 by companies such as Bavarian Motor Works AG (BMW); Daimler AG (Mercedes-Benz); and Ford Motor Co. Major automobile manufacturers formed partnerships with established battery manufacturers to build battery plants for hybrid and electric-drive vehicles and to begin mass production of automotive lithium-ion batteries.

The worldwide market for lithium-ion batteries used in light duty vehicles is projected to increase to approximately \$22 billion by 2020 from \$1.6 billion in 2012. As manufacturing efficiencies improve, the cost of lithium-ion batteries is expected to decrease by more than one-third by 2017 (Pike Research, 2012; Navigant Research, 2013).

The successful use of lithium-ion batteries in EVs, HEVs, and PHEVs could greatly increase consumption of lithium. If the rate of consumption increases faster than supply, prices could increase, and other lithium resources that had been considered uneconomic might become economic for producing lithium carbonate. New lithium mineral operations under development throughout the world, which were specifically designed to produce battery-grade lithium carbonate and lithium hydroxide, demonstrate the potential economic viability of these operations.

Various countries worldwide are establishing national alternative energy policies that have the potential to substantially increase lithium demand. It is anticipated that Asia, North America, and Western Europe would be at the forefront of adopting utility-scale energy storage systems that would become integral components of electricity grids, for long-duration storage as well as short-duration ancillary services. China, in particular, is expected to become the largest utility-scale energy storage market in the world, with \$586 billion in Government funds to be invested by 2020. These energy storage systems could be the beneficiaries of the widespread research and development of lithium-ion batteries for the transportation sector. Of several energy storage technologies competing within the short-duration ancillary services market, advanced lithium-ion batteries are expected to hold the greatest potential, capturing approximately 70% of the ancillary services market worldwide by 2019. Worldwide revenue from sales of lithium-ion batteries for use in utility-scale energy storage systems is expected to increase to nearly \$6 billion in 2020, from \$72 million in 2012 (Pike Research, 2010; Oyama, 2011).

In addition to energy storage systems, several other potential growth areas could significantly increase demand for lithium by 2020. Solar power applications and nuclear reactor applications offer substantial opportunities for future growth in demand for lithium (Lee and Hykawy, 2011).

References Cited

Alcoa Inc., 2014, 2013 annual report: Pittsburgh, PA, Alcoa Inc., April, 208 p. (Accessed April 13, 2014, at http://www.alcoa.com/global/en/investment/pdfs/2013_Annual_Report.pdf.)

- Antaika Minor Metal Monthly, 2014, Lithium power battery industry creates 5.86 billion value in 2013: Antaika Minor Metal Monthly, no. 170, June, p. 17.
- Baylis, Robert, 2013, Evaluating and forecasting the lithium market from a value perspective: Lithium Supply & Markets 2012, 5th, Las Vegas, NV, January 29–30, presentation, 29 p.
- Clarke, Gerry, 2012, Lithium supply—How much can the market digest?: Objective Capital's Rare Earths, Speciality & Strategic Metals Investment Summit 2012, London, United Kingdom, March 13–14, presentation, 14 p.
- Diniz, Vivien, 2013, China to secure one-third of global lithium supply—Talisson buyout finalized: Vancouver, British Columbia, Canada, Lithium Investing News, April 8. (Accessed July 3, 2013, at <http://lithiuminvestingnews.com/7162/china-global-lithium-supply-talisson-buyout-finalized-rockwood-tianqi-australia/>.)
- El Inversor Energetico y Minero, 2013, Comenzara en 2014 la construccion de una mina de litio en salta: Buenos Aires, Argentina, El Inversor Energetico y Minero, September 17. (Accessed February 19, 2014, at <http://www.inversorenergetico.com.ar/comenzara-en-2014-la-construccion-de-una-mina-de-litio-en-salta/>.)
- FMC Corp., 2014, Aligning for success—2013 annual report: Philadelphia, PA, FMC Corp., April, 90 p. (Accessed May 5, 2014, at https://materials.proxyvote.com/Approved/302491/20140304/AR_197157.PDF.)
- Galaxy Resources Ltd., 2013a, Galaxy secures spodumene supply agreement: West Perth, Western Australia, Australia, Galaxy Resources Ltd. press release, March 19. (Accessed April 9, 2013, at http://www.galaxyresources.com.au/documents/DocGXY275GalaxySecuresSpodumeneSupplyAgreement_000.pdf.)
- Galaxy Resources Ltd., 2013b, Sal de Vida definitive feasibility study supports low cost, long life lithium and potash operation: West Perth, Western Australia, Australia, Galaxy Resources Ltd. press release, April 12. (Accessed April 20, 2013, at http://www.galaxyresources.com.au/documents/DocGXY278GalaxyCompletesSDVFeasibilityStudy_000.pdf.)
- Galaxy Resources Ltd., 2014, December 2013—Quarterly report: West Perth, Western Australia, Australia, Galaxy Resources Ltd., 12 p. (Accessed February 8, 2014, at http://www.galaxyresources.com.au/documents/GXYDecember2013QuarterlyReport-FinalLodged_001.pdf.)
- GlobalPost, 2014, Bolivia inaugurates pilot plant for making lithium batteries: Boston, MA, GlobalPost, February 17. (Accessed February 18, 2014, at <http://www.globalpost.com/dispatch/news/agencia-efe/140217/bolivia-inaugurates-pilot-plant-making-lithium-batteries>.)
- Haber, Steffen, 2013, Rockwood Lithium—Our path to 1 billion euros: Princeton, NJ, Rockwood Holdings, Inc., presentation, January 17, 40 p. (Accessed February 12, 2013, at http://www.sec.gov/Archives/edgar/data/1315695/000110465913003108/a13-2919_1ex99d1.htm.)
- Harrison, Michael, 2013, Lithium—SQM comments positive on pricing, but new supply impacting volume: First Analysis Securities Corp., August 30. (Accessed August 31, 2013, via <http://www.firstanalysis.com/>.)
- Industrial Minerals, 2013, IM prices: Industrial Minerals, no. 555, December, p. 54.
- Kim, Sung-Mi, 2012, Korean secondary battery leaping 10 years, overtaking Japan: Korea IT Times, April 27. (Accessed May 14, 2012, at <http://www.koreaitimes.com/story/21199/korean-secondary-battery-leaping-10-years-overtaking-japan>.)
- Lee, Jonathan, and Hykawy, Jon, 2011, Lithium growth—More than just batteries: Lithium Supply & Markets 2011, 3d, Toronto, Ontario, Canada, January 19–21, presentation, 5 p.
- Li3 Energy, Inc., 2014, Corporate presentation—April 2014: Santiago, Chile, Li3 Energy, Inc. presentation, April, 25 p. (Accessed May 8, 2014, at http://www.li3energy.com/about/company-profile/corporate_presentation.htm.)
- Licata, John, 2013, IBM is prepared to turn the automotive world on its head: The Motley Fool, December 22. (Accessed January 17, 2013, at <http://www.fool.com/investing/general/2013/12/22/big-blues-big-hidden-potential.aspx?source=isesitlnk0000001&mrr=1.00>.)
- Lismore, Siobhan, 2013a, Canada Lithium signs 5,000 tpa offtake with Japan's Marubeni: Industrial Minerals, January 10. (Accessed January 17, 2013, via <http://www.indmin.com/>.)
- Lismore, Siobhan, 2013b, IM lithium round-up 4–11 June 2013: Industrial Minerals, June 11. (Accessed June 14, 2013, via <http://www.indmin.com/>.)
- Lismore-Scott, Siobhan, 2013, Bolivia opens doors to first lithium carbonate pilot plant: Industrial Minerals, January 4. (Accessed January 10, 2013, via <http://www.indmin.com/>.)
- Lithium Americas Corp., 2012, Managements' discussion and analysis for the three and six month periods ended August 31, 2012: Toronto, Ontario, Canada, Lithium Americas Corp., 20 p. (Accessed October 15, 2012, via <http://www.lithiumamericas.com/investors/financial-statements/>.)
- Lithium Americas Corp., 2014, Lithium Americas announces co-operation agreement with POSCO: Toronto, Ontario, Canada, Lithium Americas Corp. press release, January 17. (Accessed January 21, 2014, at <http://www.lithiumamericas.com/2014/01/lithium-americas-announces-co-operation-agreement-with-posco/>.)
- Merchant Research & Consulting Ltd., 2014, Global lithium consumption to grow 9.5% yoy through 2020, according to in-demand report by Merchant Research & Consulting: Birmingham, United Kingdom, Market Publishers Ltd. press release, April 18. (Accessed April 25, 2014, at <http://www.prweb.com/release/2014/04/prweb11776318.htm>.)
- Merriman, David, 2012, Investment and expansion along the lithium supply chain in China: Lithium Asia Conference 2012, 3d, Chengdu, China, September 27–28, presentation, 30 p.
- Merriman, David, 2014, More motion, less e-motion—Is 2014 the year lithium regains its traction?: Lithium Supply & Markets 2014, 6th, Montreal, Quebec, Canada, May 20–22, presentation, 32 p.
- Navigant Research, 2013, Lithium ion batteries for electric vehicles will reach \$22 billion in annual market value by 2020: Boulder, CO, Navigant Research press release, January 22. (Accessed June 3, 2013, at <http://www.navigantresearch.com/newsroom/lithium-ion-batteries-for-electric-vehicles-will-reach-22-billion-in-annual-market-value-by-2020>.)
- Nemaska Lithium Inc., 2014, Nemaska increases mineral resource at Whabouchi: Quebec, Quebec, Canada, Nemaska Lithium Inc. press release, January 28. (Accessed February 21, 2014, at <http://nemaskaexploration.mwnewsroom.com/press-releases/nemaska-increases-mineral-resource-at-whabouchi-tsx-venture-nmx-201401280924315001>.)
- Orocobre Ltd., 2013, Construction update on the Olaroz lithium project: Brisbane, Queensland, Australia, Orocobre Ltd. press release, December 19. (Accessed January 15, 2014, at http://www.orocobre.com.au/PDF/ASX_19Dec13_Olaroz_Construction_Update.pdf.)
- Oyama, Satoru, 2011, Smart grids spur massive demand for lithium ion batteries: El Segundo, CA, iSuppli Corp. press release, September 23. (Accessed January 18, 2012, at <http://www.isuppli.com/Semiconductor-Value-Chain/News/Pages/Smart-Grids-Spur-Massive-Demand-for-Lithium-Ion-Batteries.aspx>.)
- Patersons Securities Ltd., 2013, Galaxy Resources Limited: Perth, Western Australia, Australia, Paterson Securities Ltd., December 3. (Accessed January 8, 2014, at http://www.galaxyresources.com.au/documents/PatersonsGXY_Initiation131203.pdf.)
- Pike Research, 2010, Lithium ion batteries to lead the market for short-duration energy storage ancillary services: Boulder, CO, Pike Research press release, September 13. (Accessed September 15, 2010, at <http://www.pikeresearch.com/newsroom/lithium-ion-batteries-to-lead-the-market-for-short-duration-energy-storage-ancillary-services>.)
- Pike Research, 2012, Prices for lithium ion batteries will fall by more than one-third by 2017, helping to drive EV adoption: Boulder, CO, Pike Research press release, March 12. (Accessed March 13, 2012, at <http://www.pikeresearch.com/newsroom/prices-for-lithium-ion-batteries-will-fall-by-more-than-one-third-by-2017-helping-to-drive-ev-adoption-2>.)
- Pistilli, Melissa, 2013a, Lithium hydroxide production in Quebec—Interview with Nemaska Lithium: Vancouver, British Columbia, Canada, Lithium Investing News, April 29. (Accessed May 1, 2013, at <http://lithiuminvestingnews.com/7259/lithium-hydroxide-production-quebec-nemaska-rockwood-pegmatite-carbonate-china-sqm/>.)
- Pistilli, Melissa, 2013b, POSCO's lithium brine processing technology could be a game changer: Vancouver, British Columbia, Canada, Lithium Investing News, April 4. (Accessed April 4, 2013, at <http://lithiuminvestingnews.com/7146/posco-lithium-brine-processing-technology-extraction-li3-energy-simbol-chile-signumbox/>.)
- RB Energy, Inc., 2014, RB Energy reports 2013 results and provides an operational update: Vancouver, British Columbia, Canada, RB Energy, Inc. press release, March 31. (Accessed April 18, 2014, at http://www.rb-e.com/news-releases.asp?ReportID=645183&_Type=News-Releases&_Title=RB-Energy-Reports-2013-Results-And-Provides-An-Operational-Update.)
- Reed Resources Ltd., 2013, Mt. Marion—Breakthrough test work results: West Perth, Western Australia, Australia, Reed Resources Ltd. press release, December 2. (Accessed December 9, 2013, at <http://www.reedresources.com/announce-blog.php?id=808>.)

- Rockwood Holdings, Inc., 2013, Rockwood lithium increases prices for butyllithium and other organometallic products: Princeton, NJ, Rockwood Holdings, Inc. press release, October 1. (Accessed October 3, 2013, at http://www.rockwoodspecialties.com/rock_english/news/pr_2013_10a.asp.)
- Rockwood Holdings, Inc., 2014a, 2013 annual report: Princeton, NJ, Rockwood Holdings, Inc., April, 166 p. (Accessed May 1, 2014, at http://www.rockwoodspecialties.com/rock_english/media/pdf_files/RockAnnlRept_13.pdf.)
- Rockwood Holdings, Inc., 2014b, Maximizing shareholder value—Investor presentation, March 2014: Princeton, NJ, Rockwood Holdings, Inc. corporate presentation, October 1. (Accessed April 4, 2014, at http://www.rockwoodspecialties.com/rock_english/media/pdf_files/March_2014_Investor_PrPresentati.pdf.)
- Rockwood Lithium GmbH, 2014, Application areas: Frankfurt, Germany, Rockwood Lithium GmbH. (Accessed August 11, 2014, at <http://www.rockwoodlithium.com/applications/>.)
- Rodinia Lithium Inc., 2013, Rodinia Lithium provides processing update on progress at Diabillos: Toronto, Ontario, Canada, Rodinia Lithium Inc. press release, June 11. (Accessed June 15, 2013, at http://www.rodinialithium.com/news/index.php?&content_id=185.)
- Roskill Information Services Ltd., 2013, Lithium—Market outlook to 2017 (12th ed.): London, United Kingdom, Roskill Information Services Ltd., April, 426 p.
- Roskill's Letters from Japan, 2013, Lithium—Fall in lithium carbonate consumption in lithium ion batteries: London, United Kingdom, Roskill's Letters from Japan, no. 443, July, p. 1–2.
- Sociedad Química y Minera de Chile S.A., 2014, Annual report—2013: Santiago, Chile, Sociedad Química y Minera de Chile S.A., April, 290 p. (Accessed May 8, 2014, at http://ir.sqm.com/files/doc_financials/annual_report/memoria%20SQM%20INGLES%202013_Total.pdf.)
- Syrett, Laura, 2013a, Global lithium producers reveal progress ahead of Q3 earnings: Industrial Minerals, October 22. (Accessed October 23, 2013, via <http://www.indmin.com/>.)
- Syrett, Laura, 2013b, Price briefing 9–15 August: Industrial Minerals, August 16. (Accessed August 20, 2013, via <http://www.indmin.com/>.)
- Syrett, Laura, 2014, Chinese new year fails to boost mineral markets: Industrial Minerals, no. 557, February, p. 50–51.
- Talison Lithium Pty Ltd., 2012, Annual information form for the year ended June 30, 2012: Perth, Western Australia, Australia, Talison Lithium Pty Ltd., 77 p. (Accessed October 20, 2012, via <http://www.talisonlithium.com>.)
- Talison Lithium Pty Ltd., 2013, Kwinana lithium chemicals plant: Perth, Western Australia, Australia, Talison Lithium Pty Ltd. corporate presentation, November 25, 17 p.
- Tesla Motors, Inc., 2013, Tesla Motors, Inc. third quarter 2013 financial results Q&A conference call: Palo Alto, CA, Tesla Motors, Inc. webcast, November 5. (Accessed June 25, 2014, at <http://www.media-server.com/m/p/786ftzc9>.)
- Tesla Motors, Inc., 2014, Planned 2020 gigafactory production exceeds 2013 global production: Palo Alto, CA, Tesla Motors, Inc., February 26, 6 p. (Accessed March 3, 2014, at http://www.teslamotors.com/sites/default/files/blog_attachments/gigafactory.pdf.)
- Tohani, Malavika, 2013, Global lithium-ion battery market—Growth trends and application analysis: Mountain View, CA, Frost & Sullivan Ltd., 16 p. (Accessed February 22, 2013, via <http://www.slideshare.net>.)
- U.S. Department of Energy, 2013, 2012 annual progress report—Energy storage R&D: U.S. Department of Energy, 685 p. (Accessed April 17, 2013, at <http://energy.gov/eere/vehicles/fy-2012-progress-report-energy-storage-rd>.)
- Vaccaro, Anthony, 2013, Orocobre set to make a mark in lithium: The Northern Miner, v. 99, no. 8, April 8–14, p. 1, 11.
- von Boxberg, Henning, 2014, Power tools—Bosch innovation creates markets: Leinfelden, Germany, Robert Bosch GmbH press conference transcript, March 19. (Accessed April 1, 2014, at http://www.bosch-presse.de/presseforum/details.htm?txtID=6688&tk_id=112.)
- Wheatley, Frank, 2012, Global trends & the lithium market: Lithium Supply & Markets 2012, 4th, Buenos Aires, Argentina, January 23–25, presentation, 21 p.

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

- Historical Statistics for Mineral and Material Commodities in the United States. Data Series 140.
- Lithium. Ch. in Mineral Commodity Summaries, annual.
- Lithium. International Strategic Minerals Inventory Summary Report, Circular 930–I, 1990.
- Lithium (Li). Ch. in Metal Prices in the United States Through 2010, Scientific Investigations Report 2012–5188, 2013.
- Lithium Resources and Requirements by the Year 2000. Professional Paper 1005, 1976.

Other

- Lithium. Ch. in Minerals Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.
- Lithium. U.S. Bureau of Mines Information Circular 9102, 1986.

TABLE 1
SALIENT LITHIUM STATISTICS¹

(Metric tons of contained lithium)

	2009	2010	2011	2012	2013
United States:					
Production	W	W	W	W	870 ²
Exports ³	919	1,410	1,310	1,300	1,230
Imports ³	1,890	1,960	2,850	2,760	2,210
Consumption ^c	1,300	1,100	2,000 ⁴	2,000 ⁴	1,800
Rest of world, production ⁵	20,300	28,000 ^r	32,900 ^r	34,200 ^r	33,300 ^c

^cEstimated. ^rRevised. W Withheld to avoid disclosing company proprietary data.

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

²Source: Rockwood Holdings, Inc., 2013 annual report, p.16.

³Compounds. Source: U.S. Census Bureau.

⁴Rounded to one significant figure to avoid disclosing company proprietary data.

⁵Mineral concentrate, lithium carbonate, lithium chloride, and lithium hydroxide.

TABLE 2
U.S. EXPORTS OF LITHIUM CHEMICALS, BY COMPOUND AND COUNTRY¹

Compound and country	2012		2013	
	Gross weight (metric tons)	Value ² (thousands)	Gross weight (metric tons)	Value ² (thousands)
Lithium carbonate:				
Bangladesh	19	\$45	--	--
Belgium	12	113	8	\$58
Canada	23	140	20	117
China	51	367	16	91
Dominican Republic	14	49	--	--
Germany	810	4,920	828	5,030
India	41	163	37	109
Japan	37	194	55	248
Korea, Republic of	20	133	22	111
Mexico	10	40	(3)	4
Singapore	17	82	3	23
Other	10	67	19	85
Total	1,060	6,310	1,010	5,870
Total content	200	XX	190	XX
Lithium carbonate, U.S.P.:⁴				
Canada	8	50	--	--
India	44	1,130	45	1,530
Israel	2	63	2	63
Mexico	132	129	343	379
United Kingdom	11	166	--	--
Other	3	67	1	40
Total	201	1,600	391	2,020
Total content	38	XX	73	XX
Lithium hydroxide:				
Argentina	96	660	144	1,210
Australia	54	446	71	586
Belgium	496	2,980	626	3,980
Brazil	--	--	7	36
Canada	230	1,350	206	1,170
Chile	19	101	18	119
China	82	613	89	650
Colombia	64	494	52	390
Egypt	73	523	160	1,130
Germany	468	3,050	757	5,370
India	43	359	533	3,560
Japan	3,990	32,800	2,130	16,300
Korea, Republic of	132	1,100	106	876
Mexico	39	495	67	560
Peru	20	162	9	63
Russia	--	--	100	681
Saudi Arabia	36	245	113	777
Singapore	66	706	22	305
South Africa	2	206	3	403
Taiwan	281	2,010	317	2,380
Thailand	206	1,390	208	1,470
Trinidad and Tobago	--	--	5	50
Tunisia	--	--	18	123
Turkey	5	408	--	--
United Arab Emirates	--	--	40	278
Venezuela	12	132	23	208
Vietnam	8	64	16	128
Other	10	270	9	681
Total	6,440	50,500	5,850	43,500
Total content	1,060	XX	966	XX

See footnotes at end of table.

TABLE 2—Continued
U.S. EXPORTS OF LITHIUM CHEMICALS, BY COMPOUND AND COUNTRY¹

XX Not applicable. -- Zero.

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

²Free alongside ship values.

³Less than ½ unit.

⁴Pharmaceutical-grade lithium carbonate.

Source: U.S. Census Bureau.

TABLE 3
U.S. IMPORTS FOR CONSUMPTION OF LITHIUM CHEMICALS, BY COMPOUND AND COUNTRY¹

Compound and country	2012		2013	
	Gross weight (metric tons)	Value ² (thousands)	Gross weight (metric tons)	Value ² (thousands)
Lithium carbonate:				
Argentina	5,620	\$23,900	4,670	\$20,400
Chile	7,250	29,400	5,790	24,700
China	299	1,650	52	150
Japan	29	80	--	--
Other	(3) ³	3	5	26
Total	13,200	55,100	10,500	45,300
Total content	2,480	XX	1,980	XX
Lithium carbonate, U.S.P.:⁴				
India	34	740	45	1,080
Italy	--	--	(3)	4
Total	34	740	45	1,080
Total content	6	XX	8	XX
Lithium hydroxide:				
Belgium	--	--	154	857
Chile	1,450	9,460	1,130	6,530
China	115	682	38	272
Finland	6	31	--	--
Germany	(3)	5	(3)	10
Japan	(3)	3	3	45
Norway	15	33	13	28
United Kingdom	49	274	(3)	2
Other	3	84	7	44
Total	1,640	10,600	1,340	7,790
Total content	271	XX	221	XX

¹Revised. XX Not applicable. -- Zero.

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

²Customs value.

³Less than ½ unit.

⁴Pharmaceutical-grade lithium carbonate.

Source: U.S. Census Bureau.

TABLE 4
LITHIUM MINERALS AND BRINE: WORLD PRODUCTION, BY COUNTRY^{1,2}

(Metric tons)

Country ³	2009	2010	2011	2012	2013 ^e
Argentina, subsurface brine:					
Lithium carbonate	8,574 ^r	11,178 ^r	10,000 ^e	9,700 ^{r,e}	9,500
Lithium chloride	4,279 ^r	6,644 ^r	4,480 ^{r,e}	4,350 ^{r,e}	4,200
Australia, spodumene	197,482	295,000	421,391 ^r	456,921	421,000
Brazil, concentrates	15,929	15,733	7,820	7,084 ^r	8,000
Canada, spodumene ^e	10,000	--	--	--	--
Chile, subsurface brine:					
Lithium carbonate	25,154	44,025	59,933	62,002 ^r	52,358 ⁴
Lithium chloride	2,397	3,725	3,864	4,145 ^r	4,091 ⁴
Lithium hydroxide	2,987	5,101	5,800	5,447 ^r	4,197 ⁴
China, carbonate ^{e,5}	20,000	21,000	22,000	24,000	25,000
Portugal, lepidolite	37,359	40,109	37,534	20,698 ^r	38,000
United States, carbonate	W	W	W	W	4,600 ⁶
Zimbabwe, amblygonite, eucryptite, lepidolite, petalite, and spodumene ^e	50,000	47,000 ⁴	48,000 ⁴	53,000 ⁴	50,000

^eEstimated. ^rRevised. W Withheld to avoid disclosing company proprietary data. -- Zero.

¹Includes data available through May 14, 2014.

²Estimated data are rounded to no more than three significant digits.

³In addition to the countries listed, other nations may produce small quantities of lithium minerals, but output is not reported, and no valid basis for estimating production levels.

⁴Reported figure.

⁵Produced from subsurface brine and concentrates.

⁶Source: Rockwood Holdings, Inc., 2013 annual report, p. 16.