LIME

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Lime is an important chemical with numerous chemical, industrial, and environmental uses in the United States. Some evidence of its use as a lime mortar has been found at a site in what is now eastern Turkey dating between 7,000 and 14,000 years ago. More definite evidence of its use in mortars in the Near East and in the former Yugoslavia dates from 8,000 years ago. In Tibet, it was used to stabilize clays in the construction of the pyramids of Shersi 5,000 years ago. The ancient Egyptians used lime as an ingredient in mortar and plaster. The Chinese, Greek, Roman, and other ancient civilizations used lime for construction, agriculture, bleaching, and tanning (Oates, 1998, p. 3-4). Its uses began expanding with the advent of the industrial revolution, but it remained primarily a construction commodity until the rapid growth of the chemical process industries at the beginning of the 20th century. In the early 20th century, more than 80% of the lime consumed in the United States was used in construction, but at present [2001] more than 85% is used in chemical and industrial applications.

The term lime as used throughout this chapter refers primarily to six chemicals produced by the calcination of high-purity calcitic or dolomitic limestone followed by hydration where necessary. There are two high-calcium forms—high-calcium quicklime (calcium oxide, CaO) and high-calcium hydrated lime [calcium hydroxide, $Ca(OH)_2$]. There are four dolomitic forms—dolomitic quicklime (CaO•MgO), dolomitic hydrate type N [$Ca(OH)_2$•MgO] and dolomitic hydrate type S [$Ca(OH)_2$•$Mg(OH)_2$], and refractory dead-burned dolomite. Lime also can be produced from a variety of calcareous materials, such as aragonite, chalk, coral, marble, and shell. It also is regenerated (produced as a byproduct) by paper mills, carbide plants, and water-treatment plants. Regenerated lime, however, is beyond the scope of this report.

Production

Lime is a basic chemical that was produced as quicklime at 101 plants in 32 States and Puerto Rico (table 2). At the end of 2001, hydrated lime was being produced at 13 separate hydrating facilities (including 2 plants where the kilns had been shut down but hydrate was manufactured from quicklime produced offsite). In four States with no quicklime production, hydrating plants used quicklime shipped in from other States. There were also a small number of slurry plants where lime was converted to liquid form prior to sale. Principal producing States were, in descending order of production, Missouri, Alabama, Ohio, Kentucky, Texas, and Pennsylvania.

Domestic production data for lime are derived by the U.S. Geological Survey (USGS) from a voluntary survey of U.S. operations. The survey is sent to primary producers of quicklime and hydrate, but not to independent hydrators that purchase quicklime for hydration so as to avoid double counting. Quantity data are collected for 28 specific and general end uses, and value data are collected by type of lime, such as high calcium or dolomitic. Because value data are not collected by end use, value data shown in table 4 are determined by calculating the average value per metric ton of quicklime sold or used for each respondent and then multiplying it by the quantity of quicklime that the respondent reported sold or used for each end use. The table lists the total quantity sold or used for an end use and the total value of the quicklime and hydrate sold or used for that end use calculated as described above. The same methodology is used to calculate the value of hydrate sold and used in table 5.

The USGS maintains a list of operations classified as producing or idle; in 2001, there were 112 operations listed. One of these operations was not surveyed at the producer's request, and estimates are made by using reported prior-year production figures or other industry data. Five of the listed operations were idle in 2001. Of the 106 operations to which the 2000 annual survey request was sent, 82 responded to the survey, representing 95% of the total sold or used by producers. Production data for the 24 nonrespondents were estimated based on prior-year production figures and other commodity data.

Total lime sold or used by domestic producers in 2001 decreased by about 700,000 metric tons (t) (770,000 short tons) to 18.9 million metric tons (Mt) (20.8 million short tons) compared with 2000 (table 1). Production included the commercial sale or captive consumption of quicklime, hydrated lime, and dead-burned refractory dolomite. These products were valued at $1.16 billion. Commercial sales decreased by 478,000 t (527,000 short tons) to 17.0 Mt (18.7 million short tons), while captive consumption decreased by 137,000 t (151,000 short tons) to 1.90 Mt (2.10 million short tons).

Several acquisitions were made during 2001. Mississippi Lime Co. acquired the Springfield, MO, lime plant of Ash Grove Cement Co. Products produced at the plant include quicklime, Type S building lime, and food-grade hydrated lime (National Lime Association, 2001b). Mississippi Lime also announced plans to invest in new kiln capacity for specialty lime and will be investing in state-of-the-art rotary kiln technology at its Ste. Genevieve plant. This investment will feature the most current production and environmental controls available (Mississippi Lime, [undated]§[1]). Graymont Ltd. acquired Con-Lime Inc., a quicklime and calcium carbonate producer located near Bellefonte in Centre County, PA. The plant was added to the Graymont (PA) Inc. operations of Graymont Ltd. (National Lime Association, 2001a). Chemical

[1]References that include a section twist (§) are found in the Internet References Cited section.

Lime Co., which is the largest producer of hydrated lime in the United States, acquired the Florida Crushed Stone Co. hydrating plant in Brooksville, FL. This plant complements Chemical Lime's southeastern network of three lime plants in Alabama and two distribution terminals in Florida.

In a rather complicated case, on December 11, the U.S. Federal Trade Commission (FTC) as a condition of the merger between Lafarge S.A. and Blue Circle Industries plc approved the proposed divestiture of Blue Circle's Calera, AL, lime plant to Peak Investments LLC. The consent order first required Blue Circle to obtain total ownership of the lime plant, which was operating as a joint venture with Chemical Lime. Lafarge already had a joint-venture interest in Carmeuse North America. If the divestiture had not been required, the FTC estimated that Carmeuse and Chemical Lime Co. would have controlled 85% of the lime market in the southeastern United States. The Calera plant will operate under the name Southern Lime Co. (U.S. Federal Trade Commission, 2001§).

Plant closures included actions by Chemical Lime, Northwest Alloys, Inc., and LTV Steel Corp. Chemical Lime mothballed its Virginia plant #2 but continued to use the hydrator. At the end of the year, the company also idled its Douglas, AZ, plant, which provided lime primarily for the mining industry. Northwest Alloys, a magnesium metal producer in Addy, WA, that produced dolomitic lime for captive use, closed on October 1 owing to high production costs and unfavorable market conditions (Alcoa Inc., 2001§). LTV Corp., along with 48 subsidiaries, filed voluntary petitions for relief under chapter 11 of the U.S. Bankruptcy Code on December 29, 2000. On December 7, 2001, the U.S. Bankruptcy Court issued an order authorizing the implementation of an asset protection plan (APP). The APP included the shutdown and sale of all integrated steel assets. This included the LTV lime plant at Grand River, OH (LTV Corp., 2002§).

As was the case in 2000, some plants or individual kilns were shut down temporarily during 2001 owing to the high price of natural gas. Whereas the average wellhead price of gas was $2.16 per thousand cubic feet from 1996 to 1999, it increased to $3.69 per thousand cubic feet in 2000 and to $4.12 per thousand cubic feet in 2001. Prices did, however, begin to drop during the summer of 2001, and in the third quarter they averaged $3.06 per thousand cubic feet, and in the fourth quarter, $2.51 per thousand cubic feet. As a result, gas-fired kilns were restarted during the second half of 2001.

In Pennsylvania, the Belgian Lhoist Group acquired Baker Refractories, a producer of dolomitic refractories and dead-burned dolomite headquartered in York, PA. Baker was merged with Wülfrath Refractories, the refractories division of Lhoist, and will operate under the name LWB Refractories. Sales administration and customer service for the Americas will be handled by LWB Refractories Co., York, PA. (Lhoist Group, 2001§). Carmeuse sold the quarry operations associated with its Pennsylvania Lime, Inc., subsidiary but retained the two lime plants at Annville and Hanover, PA.

At yearend, the top 10 companies were, in descending order of production, Carmeuse North America; Chemical Lime; Graymont; Mississippi Lime; Global Stone Corp.; Martin Marietta Magnesia Specialties, Inc.; U.S. Lime & Minerals; Vulcan Materials Co.; LTV Steel Co., Inc.; and Ispat Inland Inc. These companies operated 45 lime plants and 6 separate hydrating plants and accounted for 85% of the combined commercial sales of quicklime and hydrated lime and 77% of total lime production.

Environment

The most common fuel used to produce lime in the United States is coal with coke a distant second. Emissions generated in the combustion of coal and other fuels make the lime industry subject to regulation under the Clean Air Act (CAA). The U.S. Environmental Protection Agency (EPA) is preparing regulations to govern emissions of hazardous air pollutants from lime plants. These regulations, known as the lime MACT (maximum achievable control technology), are expected to target emissions of metallic hazardous air pollutants, hydrochloric acid, and particulate matter. Of concern to the lime industry are the costs and obligations expected for additional monitoring and reporting and the costs of replacing scrubbers with bag houses. In December 2001, the EPA announced it would convene a panel under the Small Business Regulatory Enforcement Act (SBREA) to evaluate measures to reduce the cost of these regulations, which would be extremely burdensome to small lime companies (National Lime Association, 2001d). In April 2002, the SBREA panel recommended significant changes to the draft MACT rules, which will likely be published as proposed rules in summer 2002 (National Lime Association, 2002).

Consumption

The breakdown of consumption by major end uses (table 4) was as follows: 35% for metallurgical uses, 27% for environmental uses, 24% for chemical and industrial uses, 13% for construction uses, and 1% for refractory dolomite. Captive lime accounted for about 10% of consumption and was used mainly in the production of steel in basic oxygen furnaces, sugar refining, and magnesia and magnesium production. Almost all data on captive lime consumption, excluding the sugar industry, are withheld to protect company proprietary information. As a result, table 4 lists the total quantity and value of lime by end use. End uses with captive consumption are listed in footnote 4 of the table. Values assigned to specific end uses in table 4 should not be construed as being price specific to that market. The USGS does not collect value data by end use, and the values shown in tables 4 and 5 are derived, in general, from average lime values. The market values shown are simply designed to show the relative value of the market.

In steel refining, quicklime is used as a flux to remove impurities, such as phosphorus, silica, and sulfur. Dolomitic lime is often substituted for a fraction of the high-calcium lime to extend refractory life. Dolomitic quicklime is also used as a flux in the manufacture of glass. The steel industry accounted for about 29% of all lime consumed in the United States. Because of a slowing economy, increased steel imports, low prices, and large legacy burdens (pension and retirement benefits owed to retirees), the U.S. steel industry was under a great deal of economic stress. For the year, raw steel production was down by 11.5% compared with 2000, and a number of companies had declared bankruptcy, including Bethlehem Steel Corp. and LTV Steel Corp. Lime consumption by the iron and steel industry was 5.46 Mt (6.02 million short tons), an 11.2% decrease compared with that of 2000.

In response to a spate of steel company bankruptcies (18 in the past 3 years) and complaints by steel companies of unfair trade practices, the U.S. International Trade Commission (ITC) initiated a section 201 investigation. Under section 201 of the Trade Act of 1974, domestic industries seriously injured or threatened with serious injury by increased imports may petition the ITC for import relief. The ITC determines whether an article is being imported in such increased quantities that it is a substantial cause of serious injury or threat thereof to the U.S. industry. If the ITC makes an affirmative determination, it recommends to the President relief that would prevent or remedy the injury and facilitate industry adjustment to import competition. The President makes the final decision whether to provide relief and the amount of relief. On December 7, the ITC announced the recommendations and views on remedies that its members would forward to the President in its global safeguard investigation regarding imports of steel. These recommendations included tariffs on various types of steel for a period of 4 years that ranged from 20% to 40%. On March 5, 2002, the President imposed tariffs for 3 years ranging from 8% to 30% on various types of imported steel, excluding imports from free-trade partners. Effective March 20, 2002, in the first year, slab steel imports in excess of 4.9 Mt would get a 30% tariff; finished flat products, hot-rolled and cold-finished bar, and tin mill products, a 30% tariff; and six other categories, 8% to 15% tariffs. The tariffs will decrease in each of the subsequent years (Thelen Reid & Priest LLP, 2002§).

In nonferrous metallurgy, lime is used in the beneficiation of copper ores to neutralize the acidic effects of pyrite and other iron sulfides and to maintain the proper pH in the flotation process. Lime is used to process alumina and magnesia, to extract uranium from gold slimes, to recover nickel by precipitation, and to control the pH of the sodium cyanide solution used to leach gold and silver from the ore. Such leaching processes are called dump leaching when large pieces of ore are involved, heap leaching when small pieces of ore are involved, and carbon-in-pulp cyanidation when the ore is leached in agitated tanks. Dump and heap leaching involve crushing the ore, mixing it with lime for pH control and agglomeration, and stacking the ore in heaps for treatment with cyanide solution. Lime is used to maintain the pH of the cyanide solution at a level between 10 and 11 to maximize the recovery of precious metals and to prevent the creation of hydrogen cyanide. Lime consumed for these various uses is included in table 4 under the category "Other nonferrous metallurgy."

Lime usage in nonferrous metallurgy (mainly concentration of copper and gold ores, aluminum and bauxite processing, and magnesium production) decreased by nearly 11% in 2001. The reasons for this decrease were clear—U.S. mine production of copper and gold decreased by about 7%, aluminum production decreased by 28%, and magnesium producer Northwest Alloys closed its plant during the year (Amey, 2002; Edelstein, 2002; Plunkert, 2002).

The tailings that result from the recovery of precious metals may contain elevated levels of cyanides. Lime is used to recover cyanides in such treatment processes as Cyanisorb, alkaline chlorination, and sulfur dioxide/air.

In the environmental sector, lime is used in the softening and clarification of municipal potable water and to neutralize acid-mine and industrial discharges. In sewage treatment, lime's traditional role is to control pH in the sludge digester, which removes dissolved and suspended solids that contain phosphates and nitrogen compounds. Lime also aids clarification and in destroying harmful bacteria. More recently, the largest use in sewage treatment has been to stabilize the resulting sewage sludges. Sewage sludge stabilization, also called biosolids stabilization, reduces odors, pathogens, and putrescibility of the solids. Lime stabilization involves mixing quicklime with the sludge to raise the temperature and pH of the sludge to minimum levels for a specified period of time. Lime consumption for all sludge treatment increased by nearly 3% compared with that in 2000.

In flue gas desulfurization (FGD) systems serving electric utility and industrial plants and incinerators, lime is used to react with sulfur oxides in the flue gas and is used to stabilize the resulting sludge before disposal. In 2001, the overall FGD market was unchanged compared with 2000. There was a small decrease in the consumption of lime by coal-fired powerplants, which reported a 6% decrease in electricity generation in 2001. Additionally, some coal-fired powerplants experienced downtime while installing selective catalytic reduction units for control of nitrogen oxide emissions.

The decrease in the powerplant FGD market was balanced by an increase in FGD-lime sales to incinerators, which increased by 42%. This market received a boost from the promulgation by the EPA of new standards under section 129 of the CAA regulating emissions of cadmium, carbon monoxide, dioxins/furans, fine and total particulate matter, hydrogen chloride, lead, mercury, oxides of nitrogen, and sulfur dioxide from commercial and industrial solid waste incinerators. The emissions limit for sulfur dioxide is 20 parts per million by dry volume. Examples of potentially regulated entities are manufacturers of chemicals, electronic equipment, lumber and wood furniture, and wholesale trade and durable goods. The new standards went into effect January 30, 2001 (U.S. Environmental Protection Agency, 2000).

Lime is used by the pulp and paper industry in the basic Kraft pulping process where wood chips and an aqueous solution (called liquor) of sodium hydroxide and sodium sulfide are heated in a digester. The cooked wood chips (pulp) are discharged under pressure along with the spent liquor. The pulp is screened, washed, and sent directly to the paper machine or for bleaching. Lime is sometimes used to produce calcium hypochlorite bleach for bleaching the paper pulp. The spent liquor is processed through a recovery furnace where dissolved organics are burned to recover waste heat and sodium sulfide and sodium carbonate are recovered. The recovered sodium sulfide and sodium carbonate are diluted with water and then treated with slaked lime to recausticize the sodium carbonate into sodium hydroxide (caustic soda) for reuse. The byproduct calcium carbonate is recalcined in a lime kiln to recover lime for reuse. The paper industry also uses lime as a coagulant aid in the clarification of plant process water. Rather surprisingly, lime consumption in the pulp and paper market increased by about 3% in 2001. This was despite the lagging economy, which led to a downturn in advertising and reduced industrial activity, and caused the steepest decline in the paper industry since 1975 (Van Savage, 2001). Assuming the data are accurate, the increase in lime consumption may have simply meant that less calcium carbonate was recycled by paper companies thus requiring additional purchases from lime producers.

Lime is used to make precipitated calcium carbonate (PCC), a specialty filler used in premium-quality coated and uncoated papers, paint, and plastics. The most common PCC production process used in the United States is the carbonation process. Carbon dioxide is bubbled through milk-of-lime, a suspension of hydrated lime in water, to form a precipitate of calcium carbonate and water. The reaction conditions determine the size and shape of the resulting PCC crystals. Lime use for PCC production decreased by 4% compared with that of 2000.

Lime is used, generally in conjunction with soda ash, for softening plant process water. This precipitation process removes bivalent soluble calcium and magnesium cations (and to a lesser extent ferrous iron, manganese, strontium, and zinc), that contribute to the hardness of water. This process also reduces carbonate alkalinity and dissolved solids content.

The chemical industry uses lime in the manufacture of alkalies. Quicklime is combined with coke to produce calcium carbide, which is used to make acetylene and calcium cyanide. Lime is used to make calcium hypochlorite, citric acid, petrochemicals, and other chemicals.

In sugar refining, milk-of-lime is used to raise the pH of the product stream, precipitating colloidal impurities. The lime itself is then removed by reaction with carbon dioxide to precipitate calcium carbonate. The carbon dioxide is obtained as a byproduct of lime production.

In construction, hydrated lime and quicklime are used to stabilize fine-grained soils in place of materials that are employed as subbases, such as hydraulic clay fills or otherwise poor-quality clay and silty materials obtained from cuts or borrow pits. Lime also is used in base stabilization, which includes upgrading the strength and consistency properties of aggregates that may be judged unusable or marginal without stabilization. Common applications for lime stabilization included the construction of roads, airfields, building foundations, earthen dams, and parking areas. Lime sales for soil stabilization topped 1.5 Mt, which was an alltime record for this market sector and an increase of more than 20% compared with 2000. The Texas market continued to be the largest consumer of stabilization lime, and coupled with sales within the nearby States of Arkansas, Louisiana, Mississippi, and Oklahoma, the Texas lime producers accounted for 896,000 t or nearly 60% of the total U.S. market.

In road paving, hydrated lime is used in hot mix asphalt to act as an antistripping agent. Stripping is generally defined as a loss of adhesion between the aggregate surface and the asphalt cement binder in the presence of moisture. Lime also is used in cold in-place recycling for the rehabilitation of distressed asphalt pavements. Existing asphalt pavement is pulverized by using a milling machine, and a hot lime slurry is added along with asphalt emulsion. The cold recycled mix is placed and compacted by using conventional paving equipment, which produces a smooth base course for the new asphalt surface. In 2001, sales of lime for use in asphalt increased by 13% compared with 2000. The asphalt and soil stabilization markets owe much of their prosperity to the increased funding for transportation projects legislated by the Transportation Equity Act for the 21st Century (TEA-21). Since passage in 1998, the expenditures have increased from $17.4 billion in 1998 to $25.9 billion in 2001 (U.S. Federal Highway Administration, 2002§).

In the traditional building sector, quicklime is used to make calcium silicate building products, such as sand-lime brick and autoclaved aerated concrete (AAC). AAC offers the advantage of producing building materials that can be cut, drilled, and nailed like wood but with the advantages of a concrete product.

Hydrated lime is used in the traditional building sector where it still is used in plaster, stucco, and mortars to improve durability. In the late 1970s, this market consumed over 500,000 tons per year of lime. The recession of 1982 to 1983 had disastrous impacts on all construction markets, but whereas other construction materials recovered in the years following the recession, lime did not. It was not until 1997 that lime consumption in this sector began to exhibit strong annual growth, and although it still has not reached the level of consumption reported in 1979, hydrated lime for building uses has increased by 46% since 1997. In 2000, the market was driven by increased expenditures for residential and nonresidential building construction, while in 2001, the market was driven by increased expenditures for residential and public building construction. According to data released by the U.S. Census Bureau, the combined spending on construction of residential and public buildings increased by 7% compared with 2000. The use of hydrated lime in traditional building uses increased by more than 10% in 2001.

A small amount of hydrated lime (estimated to be less than 2% of total building uses) also is used on the renovation of old structures built with lime-based mortars, which were standard before the development of portland cement-based mortars. Modern portland cement-based mortars are incompatible with old lime mortars.

A new niche market for hydrated lime has been developed by Alistagen Corp., which has commercialized the antimicrobial lime-based paint developed a few years ago by researchers at the Southwest Research Institute in San Antonio, TX. The new product, called Caliwel, uses calcium hydroxide as the antimicrobial ingredient in its formulation. Calcium hydroxide has been used for centuries as a germ-fighting agent in commercial and domestic environments and in hospitals (especially before antibiotics). Its antimicrobial effectiveness is caused by increasing the pH, or alkalinity, to a level that is incompatible with the life of microorganisms. Normally, calcium hydroxide loses its effectiveness against microbes within days due to its rapid breakdown upon exposure to air. This new product microencapsulates the calcium hydroxide, safely stabilizes its effective properties, and preserves its naturally occurring antimicrobial potency while resisting degradation long after it has been applied (Alistagen Corp., [undated]§).

Dead-burned dolomite, also called refractory lime, is used as a component in tar-bonded refractory brick used in basic oxygen furnaces. Hydrated lime is used to produce silica refractory brick used to line industrial furnaces.

Prices

The average values per metric ton of lime, rounded to three significant figures, are listed in table 8. The values are reported in dollars per metric ton with accompanying conversions into dollars per short ton. For accuracy, the conversions were made from the unrounded metric value and, as a result, may not be an exact conversion of the rounded values. All value data for lime are reported by type of lime produced—high-calcium quicklime, high-calcium hydrate, dolomitic quicklime, dolomitic hydrate, and dead-burned dolomite. Emphasis is placed on the average value per metric ton of lime sold.

In 2001, despite attempts made by some of the commercial lime companies to raise prices (primarily because of higher fuel costs), the average for all types of lime sold increased only slightly to $61.50 per ton ($55.80 per short ton). In the commercial sector, the average value per ton of high-calcium quicklime, dolomitic quicklime, and dead-burned dolomite all increased, but high-calcium and dolomitic hydrate values decreased. Hydrate sales increased by 25% (roughly 500,000 t) and it appears that lime companies were willing to accept smaller margins because of the large increase in total hydrate sales.

Although there were some announcements of price increases, it was difficult for lime companies to push through significant price increases owing to competition, excess capacity, and long-term contracts. In addition, lime suppliers were often pressured by large, economically troubled customers, such as steel companies, to provide lower prices.

Foreign Trade

The United States exported and imported quicklime, hydrated lime (slaked lime), hydraulic lime, and calcined dolomite (dolomitic lime). Combined exports of lime (table 6) were 95,800 t (106,000 short tons) valued at $11.9 million, with 85% exported to Canada, 11% exported to Mexico, and the remaining 4% going to various other countries. Combined imports of lime (table 7) were 115,000 t (127,000 short tons) valued at $15.1 million, with 91% coming from Canada, 8% coming from Mexico, and the remaining 1% from various countries.

Data on exports of hydraulic lime may be questionable. There is only one known producer of hydraulic lime in the United States, and with exports totaling 10,000 t in 2000 and 13,100 t in 2001, it is likely that what is being classified as hydraulic lime is in fact portland cement (or some other hydraulic cement product). Chemically, hydraulic lime and portland cement are quite similar.

No tariffs are placed on imports of hydraulic lime, quicklime, and slaked lime from countries with normal trade relations (NTR) with the United States. There is a 3% ad valorem tariff on imports of calcined dolomite from NTR countries.

World Review

With the exception of industrialized nations with good data collection, accurate lime data for many countries are difficult to acquire. The variations in quality, types of lime, production technologies, and industries manufacturing lime and the frequent confusion with limestone data make accurate reporting of world lime data (table 9) extremely difficult and certainly incomplete. The following is a brief discussion of new construction in specific countries.

Australia.—Svedala Industries AB and Blue Circle Southern Cement Ltd. achieved a notable engineering feat by building a 520-metric-ton-per-day (t/d) limestone preheater in a fully operational lime plant (Marulan, New South Wales), and then rolling it into place. Construction and installation of a preheater normally requires the complete shutdown of the lime plant for about 8 weeks. In this case, the kiln was shut down for only 20 days during installation, which involved reinstalling conveyor belts and adapting the kiln to the new preheater (World Cement, 2001a).

Iluka Resources Ltd. closed its lime subsidiary Westlime (WA) Ltd.'s lime plant at Dongara. The Westlime facility came online in December 1997 producing lime from limesands but has suffered from technical difficulties and declining regional markets (Industrial Minerals, 2001b).

Australian lime producer David Mitchell Ltd., in cooperation with limestone producer Frost Enterprises Pty., undertook a feasibility study into establishing a new 100,000-metric-ton-per-year lime plant in the Gladstone area of Queensland. If it is completed, the lime plant will market lime to the mining and chemical industries in Queensland (Industrial Minerals, 2001a).

Austria.—In June, VOEST-ALPINE Stahl GmbH commissioned a 250-t/d natural-gas-fired Maerz PFR shaft kiln at its lime plant at Steyrling. The kiln is designed to produce soft-burned lime and, like the other three kilns at the plant, will supply lime to VOEST-ALPINE steel plants at Linz and Donawitz (Maerz Ofenbau AG, 2001b§).

Finland.—SMA Saxo Mineral Oy (a subsidiary of SMA Svenska Mineral AB) placed an order with Maerz Ofenbau AG for a turnkey installation of a 425- to 525-t/d Maerz Finelime kiln. The kiln will be located in Tornio and is expected to begin commercial production in November 2002 (Maerz Ofenbau AG, 2001a§).

Greece.—Balkan A.T.C.I.C. is building a complete lime plant designed by Cimprogetti S.p.A., featuring one 150-t/d Twin-D double shaft regenerative kiln, one 5-metric-ton-per-hour (t/hr) hydration unit, and the latest generation Cim-Digipack digital packing machine. The complete plant will be operated and controlled by means of the dedicated Cim-Issy 32 software, which has been specifically developed by Cimprogetti for the lime industry. The Balkan A.T.C.I.C. lime plant is due to come onstream in 2002 (Cimprogetti S.p.A., 2001§).

Italy.—Terruzzi Fercalx S.p.A. has taken over all the construction and sales activities for the Beckenbach annular shaft kiln, which was invented in 1960 by Beckenbach Ofenbau GmbH of Germany. The Beckenbach kiln is widely used with more than 300 installations worldwide. Acquisition of the patents and the construction and operating knowledge for this kiln technology complements Terruzzi Fercalx's product line which includes its two-way and three-way pressure system vertical shaft lime kilns (ZKG International, 2002).

Malaysia.—QualiCal Srl delivered a complete lime plant to Unichamp Minerals Snd Bhd, including a Synthesis 300-t/d shaft kiln and a 15-t/hr QualiHydro plant, which is the company's modular solution for hydration, classification, and grinding. The Synthesis twin shaft kiln is designed to produce high- or medium-reactivity quicklime to meet the needs of the iron, chemical, and building industries (GLP Research, 2002).

Saudi Arabia.—Saudi Dolomite Company Ltd., commissioned a Maerz-RCE vertical shaft kiln in May 2001. The 120-t/d kiln was designed for production of medium- and hard-burned dolomitic lime (World Cement, 2001b).

United Kingdom.—On April 1, the Government introduced a climate change tax on energy used by industry designed to reduce CO_2 emissions. Pursuant to the agreement between the European member states as signees of the Kyoto Protocol, the United Kingdom (U.K.) has a target to reduce greenhouse gas emissions by 12.5% by 2008 to 2012, relative to the 1990 base year. In addition, the U.K. Government has set a domestic target for reduction of CO_2 emissions by 20% compared with the same base year. The Government realized that this adversely affects the competitiveness of certain energy intensive industries such as the lime industry. It has, therefore, entered into a negotiated energy efficiency agreement with the lime industry, which calls for agreed upon reduced energy usage amounts in exchange for an 80% reduction in the tax levy. The U.K. lime industry has agreed to reduce energy consumption by 7.8% by 2010 (Oates, 2002).

Current Research and Technology

Merichem Co., Houston, TX, has patented a new kind of lime kiln and demonstrated the technology in pilot plant studies. The kiln is believed to provide an economical process to calcine waste fines routinely generated during the crushing and screening processes. The basis of the new kiln, called the SPS PyroReactor, is an externally fired ceramic tube. The new kiln consists of a group of horizontally mounted stationary ceramic tubes which are heated externally by conventional combustion gases. Conventional preheating and feed mechanisms introduce the fines into a hopper at one end of the tubes. Slowly rotating ceramic screws inside each tube convey the fines through them and out the other end. Hot combustion gases do not contact the fines, thus avoiding such problems as excessive dust carryover, hard burning, and contamination of the lime with impurities derived from the combustion fuel.

The next phase of testing will require the construction and testing of a single-tube prototype kiln unit about 38 centimeters in diameter and 7 meters in length and capable of producing 12.5 t/d. The commercial plant concept is to combine multiple batteries of these prototype-sized tubes to achieve the production capacity required. The system also provides the potential of producing a salable purified carbon dioxide byproduct, and because the combustion gases never contact the limestone or quicklime, the gases exit the furnace dust free and with heat energy sufficient to cogenerate electricity as another byproduct (Willis and Price, 2002).

A circulating fluidized bed FGD system has been used on a limited scale in the United States since 1995, and has been in commercial use in Europe since 1987. The system is being marketed in the United States by Lurgi Lentjes North America, Inc., and employs a circulating fluidized bed of fly ash and scrubber byproduct to achieve a high particle density. Hydrated lime injected into the circulating bed adsorbs sulfur dioxide and trioxide with efficient utilization of the lime, due to its high residence time in the circulating bed. Fine particles entering the system are agglomerated into larger particles through collision with the bed particles and then can be captured by a conventional electrostatic precipitator or baghouse. This technology is believed to be suitable for simultaneous control of multiple pollutants such as mercury, acid gases, fine particulate matter, and other hazardous air pollutants. The U.S. Department of Energy has selected this technology for a demonstration project on a 100-megawatt generating unit (Toher, 2002).

In November, the National Lime Association hosted a seminar on lime in asphalt and soil stabilization. The seminar included presentations on laboratory and field research in such areas as multifunctional benefits of hydrated lime in asphalt mixtures, life cycle analysis of asphalt mixtures, and mixture design and testing protocol for soil stabilization. There were also presentations describing case studies such as the Houston airport expansion (National Lime Association, 2001c).

Outlook

Although lime has many uses, a handful of uses tend to make up the bulk of consumption. The following discussion will touch on some of the major markets and their specific conditions.

As 2002 progresses, lime demand by the steel industry is expected to increase as the economy strengthens and import quotas are reached, triggering the import tariffs. Because the tariffs are only for 3 years and decrease in successive years, the turnaround might be short lived. Industry consolidation through mergers and acquisitions will be necessary to improve the economic health of the steel industry, but when and how much of this will occur will depend to a great deal on whether the steel industry can get relief from its legacy burdens. The companies with these large financial burdens are undesirable takeover or merger targets.

Phase II of the Clean Air Act Amendments (CAAA), which went into effect January 1, 2000, remains the driving force behind potential growth in the FGD market. The costs of lime-based scrubbers have decreased significantly over the years and display more favorable economics and efficiencies especially for the smaller units regulated under phase II. Regulations covering emissions from small municipal incinerators and waste-to-energy incinerators also favor the use of lime scrubbers.

When phase II went into effect, it was thought that the real boost to lime sales for FGD would be slow in coming owing to an excess of emission allowances accumulated during phase I of the CAAA and the low prices for emissions allowances. It was thought that it would likely take until 2005 for the scrubber market to really start seeing the demand increase from the phase II regulation. The timing of this increase depends on the price and availability of emission allowances under the current regulations. There are parts of the CAAA, such as the fine particulate matter standard, that, if regulated, could boost the FGD market because much of the fine particulates are sulfates.

There have been proposals to revise the CAA that would reduce the number of powerplants that are required to install pollution control equipment and would extend the compliance deadline to 2018. Some environmental groups have argued that the new plan would allow for lower reductions than required by the current law. If such revisions were to go into effect, the size of increases in the FGD market may be smaller and the timing of such increases may not take place until the next decade.

The proposed fiscal year 2003 transportation budget includes a 27% decrease in funding for State and local highway programs. The TEA-21 contains a revenue aligned budget authority (RABA) provision, which ties the funding level to the Federal Highway Trust Fund revenue stream. The decrease in RABA is a result of fewer than estimated fiscal year 2001 tax receipts going into the trust fund and revenue estimates for fiscal year 2003 that are lower than those estimated in TEA-21. Such a decrease in funding would affect every State's highway programs for the next 7 years because it would set a new, lower baseline amount upon which reauthorization would be based. Highway proponents, however, are looking for ways to increase funding for highway programs. The soil stabilization and asphalt markets will be adversely affected if there is a large decrease in funding for highway programs.

The traditional building markets (masonry and finishing lime) have shown unexpected growth in recent years despite the poor economy. The strong real estate and building markets have been one of the major factors (along with consumer spending) that made the 2001 recession mild. With the economy slowly improving, sales of hydrated lime for these markets is expected to continue to grow.

In summary, the economy appears to be slowly recovering, which should help significant chemical and industrial markets, such as steel, pulp and paper, precipitated calcium carbonate, magnesia, glass, and the numerous smaller niche markets, plus the traditional building markets. Overall, it appears that 2002 will see a small increase in lime production and consumption compared with 2001, with better results expected in 2003. However, the nonferrous metallurgy market continues to decline, and the lime industry still has overcapacity problems, suffers from stagnant prices, and has pending MACT regulations looming.

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TABLE 1
SALIENT LIME STATISTICS 1/

(Thousand metric tons, unless otherwise specified) 2/

	1997	1998	1999	2000	2001
United States: 3/					
Number of plants	106	107	108	107	107
Sold or used by producers:					
High-calcium quicklime	14,300	14,800	14,100	14,300 r/	13,700
Dolomitic quicklime	2,900	2,740	3,000	3,000 r/	2,580
Total	17,300	17,500	17,100	17,300	16,200
High-calcium hydrated lime	1,820	1,950	2,010	1,550	2,030
Dolomitic hydrated lime	352	383	298	421	447
Total	2,170	2,330	2,310	1,970	2,470
Dead-burned dolomite 4/	300	300	300	200	200
Grand total	19,700	20,100	19,700	19,600	18,900
Value 5/ thousands	$1,200,000	$1,210,000 r/	$1,190,000	$1,190,000	$1,160,000
Average value per ton	$61.00	$60.30 r/	$60.40	$60.60	$61.30
Lime sold	17,300	17,800	17,300	17,500	17,000
Lime used	2,420	2,320	2,320	2,040	1,900
Exports: 6/					
Quantity	80	56	59	73	96
Value thousands	$9,550	$9,110	$8,270	$9,960	$11,900
Imports for consumption 6/					
Quantity	276	231	140	113	115
Value thousands	$26,500	$22,700	$15,700	$13,500	$15,100
Consumption, apparent 7/	19,900	20,300	19,800	19,600	19,000
World, production	118,000 r/	117,000 r/	116,000	118,000 r/	118,000 e/

e/ Estimated. r/ Revised.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ To convert metric tons to short tons, multiply metric tons by 1.10231.
3/ Excludes regenerated lime; includes Puerto Rico.
4/ Data rounded to no more than one significant digit to avoid disclosing company proprietary data.
5/ Selling value, f.o.b. plant, excluding cost of containers.
6/ U.S. Census Bureau.
7/ Defined as sold or used plus imports minus exports.

TABLE 2

LIME SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY STATE 1/ 2/

	2000					2001				
State	Plants	Hydrated (thousand metric tons)	Quicklime 3/ (thousand metric tons)	Total (thousand metric tons)	Value (thousands)	Plants	Hydrated (thousand metric tons)	Quicklime 3/ (thousand metric tons)	Total (thousand metric tons)	Value (thousands)
Alabama	5	111	1,840	1,950	$121,000	5	128	1,910	2,030	$127,000
Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming	20	273	2,480	2,750	161,000	20	307	2,360	2,670	162,000
California, Oregon, Washington	10	54	490	544	38,800	10	64	365	429	31,300
Illinois, Indiana, Missouri	9	316	3,570	3,890	224,000	9	310	3,390	3,700	216,000
Iowa, Nebraska, South Dakota	4	W	W	254	16,600	4	W	W	252	16,100
Kentucky, Tennessee, West Virginia	5	117	2,390	2,510	139,000	5	106	2,230	2,330	134,000
Ohio	8	121	1,730	1,850	106,000	8	119	1,780	1,900	114,000
Pennsylvania	7	180	1,170	1,350	93,900	7	205	1,070	1,280	86,500
Texas	7	316	1,280	1,600	105,000	7	736	869	1,610	108,000
Wisconsin	4	150	469	619	37,000	4	157	460	617	36,900
Other 4/	28 r/	333 r/	2,170 r/	2,240 r/	144,000 r/	28	341	2,030	2,120	131,000
Total	107	1,970	17,600	19,600	1,190,000	107	2,470	16,500	18,900	1,160,000

r/ Revised. W Withheld to avoid disclosing company proprietary data; included with "Other."

1/ Excludes regenerated lime.

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

3/ Includes dead-burned dolomite.

4/ Includes Arkansas, Georgia, Louisiana, Massachusetts, Michigan, Minnesota, North Dakota, Oklahoma, Puerto Rico, South Carolina, Virginia, and data indicated by the symbol W.

TABLE 3

LIME SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY RANGE OF PRODUCTION 1/ 2/

	2000			2001		
Range of production	Plants	Quantity (thousand metric tons)	Percentage of total	Plants	Quantity (thousand metric tons)	Percentage of total
Less than 25,000 tons	22	327 r/	2	21	268	1
25,000 to 100,000 tons	28	1,510 r/	8	29	1,440	8
100,000 to 200,000 tons	24	3,370	17	21	2,700	14
200,000 to 300,000 tons	14	3,390	17	14	3,160	17
300,000 to 400,000 tons	6	2,040	10	7	1,890	10
400,000 to 600,000 tons	7	3,530	18	7	2,990	16
More than 600,000 tons	6	5,400	28	8	6,500	34
Total	107	19,600	100	107	18,900	100

r/ Revised.

1/ Excludes regenerated lime. Includes Puerto Rico.

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

TABLE 4
LIME SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE 1/ 2/

(Thousand metric tons and thousand dollars) 3/

Use	2000 Quantity 4/	2000 Value	2001 Quantity 4/	2001 Value
Chemical and industrial:				
Fertilizer (aglime and fertilizer)	48	3,540	24	1,760
Glass	84	5,060	66	3,820
Paper and pulp	802	48,400	827	49,800
Precipitated calcium carbonate	1,200	72,900	1,150	72,700
Sugar refining	867	53,000	789	45,200
Other 5/	1,670	110,000	1,730	115,000
Total	4,670	293,000	4,590	288,000
Metallurgical:				
Steel and iron:				
Basic oxygen furnaces	4,000	229,000	3,260	194,000
Electric arc furnaces	1,840	111,000	1,960	117,000
Other	300	17,900	250	14,000
Total	6,150	358,000	5,460	325,000
Nonferrous metals:				
Aluminum and bauxite	181	11,100	146	9,140
Other 6/	1,120	55,200	1,020	52,000
Total	1,310	66,300	1,170	61,200
Total metallurgical	7,450	424,000	6,630	386,000
Construction:				
Asphalt	345	27,300	390	30,800
Building uses	437	43,900	467	45,300
Soil stabilization	1,270	80,500	1,530	96,600
Other	14	1,350	18	1,280
Total	2,070	153,000	2,400	174,000
Environmental:				
Flue gas sulfur removal:				
Utility powerplants	2,990	158,000	2,920	158,000
Incinerator	139	9,020	198	12,900
Other	31	2,120	36	2,710
Total	3,160	169,000	3,160	174,000
Sludge treatment:				
Sewage	225	14,100	216	13,600
Other (industrial, hazardous, etc.)	92 r/	5,690	110	8,910
Total	317 r/	19,800	326	22,500
Water treatment:				
Acid mine drainage	103	6,650	78	5,110
Drinking water	958	59,600	961	59,000
Waste water	424	28,300	410	26,800
Total	1,490 r/	94,600	1,450	91,000
Other	155	10,700	167	8,680
Total environmental	5,120	294,000	5,100	296,000
Refractories (dead-burned dolomite)	200 7/	21,900 8/	200 7/	19,000 8/
Grand total	19,600	1,190,000	18,900	1,160,000

r/ Revised.
1/ Excludes regenerated lime. Includes Puerto Rico.
2/ Data are rounded to no more than three significant digits; may not add to totals shown.
3/ To convert metric tons to short tons, multiply metric tons by 1.10231.
4/ Quantity includes lime sold and used, where "used" denotes lime produced for internal company use for magnesia, paper and pulp, precipitated calcium carbonate, basic oxygen furnaces, mason's lime, and refractories.
5/ Magnesia is included in this category to avoid disclosing company proprietary data.
6/ Includes ore concentration (copper, gold, etc.), magnesium, and other.
7/ Data rounded to one significant digit to avoid disclosing company proprietary data.
8/ Values are estimated based on average value per ton of dead-burned dolomite for each year.

TABLE 5
HYDRATED LIME SOLD OR USED IN THE UNITED STATES, BY END USE 1/ 2/

(Thousand metric tons and thousand dollars) 3/

Use	2000 Quantity 4/	2000 Value	2001 Quantity 4/	2001 Value
Chemical and industrial	431	37,000	476	39,300
Construction:				
Asphalt paving	325	26,200	351	28,700
Building uses	411	42,300	454	44,500
Soil stabilization	237	17,600	589	41,700
Other	10	1,140	12	897
Total	983	87,200	1,410	116,000
Environmental:				
Flue gas treatment (FGT):				
Incinerators	25	1,860	29	2,170
Industrial boilers and other FGT	37	2,730	43	3,340
Utility powerplants	47	3,490	39	2,930
Total	109	8,080	111	8,440
Sludge treatment:				
Sewage	28	2,280	41	2,790
Other	17	1,470	14	1,070
Total	45	3,750	55	3,860
Water treatment:				
Acid mine drainage	54	3,620	63	4,240
Drinking water	143	11,900	154	12,500
Wastewater	150	11,300	142	10,400
Total	347	26,800	359	27,200
Other	33	2,580	44	3,230
Metallurgy	19	1,650	23	1,790
Grand total	1,970	167,000	2,470	200,000

1/ Excludes regenerated lime. Includes Puerto Rico.
2/ Data are rounded to no more than three significant digits; may not add to totals shown.
3/ To convert metric tons to short tons, multiply metric tons by 1.10231.
4/ Quantity includes hydrated lime sold or used, where "used" denotes lime produced for internal company use in building, chemical and industrial, and metallurgical sectors.

TABLE 6
U.S. EXPORTS OF LIME, BY TYPE 1/

Type	2000 Quantity (metric tons) 2/	2000 Value 3/	2001 Quantity (metric tons) 2/	2001 Value 3/
Calcined dolomite:				
Brazil	217	$95,800	--	--
Canada	2,490	553,000	7,610	$1,850,000
Israel	103	25,500	73	8,420
Japan	90	27,800	--	--
Mexico	197	36,800	242	71,300
Netherlands	149	40,000	--	--
Taiwan	772	162,000	--	--
Vietnam	368	108,000	--	--
Other 4/	265	88,300	280	169,000
Total	4,650	1,140,000	8,210	2,100,000
Hydraulic lime:				
Canada	9,680	1,170,000	12,900	1,350,000
New Zealand	206	72,900	62	21,200
Other 5/	130	91,400	182	103,000
Total	10,000	1,330,000	13,100	1,470,000
Quicklime:				
Argentina	6,590	1,280,000	--	--
Canada	31,000	3,280,000	55,500	5,580,000
Costa Rica	428	63,800	443	92,300
Mexico	12,400	1,390,000	10,200	1,260,000
Russia	200	19,100	--	--
Other 6/	132	202,000	78	45,200
Total	50,700	6,230,000	66,200	6,990,000

See footnotes at end of table.

TABLE 6--Continued
U.S. EXPORTS OF LIME, BY TYPE 1/

	2000		2001	
Type	Quantity (metric tons) 2/	Value 3/	Quantity (metric tons) 2/	Value 3/
Slaked lime (hydrate):				
Bahamas, The	551	89,300	2,190	382,000
Canada	7,040	1,070,000	5,500	841,000
Philippines	151	17,300	91	11,000
Other 7/	91	81,700	554	132,000
Total	7,830	1,260,000	8,330	1,370,000
Grand total	73,200	9,960,000	95,800	11,900,000

-- Zero.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ To convert metric tons to short tons, multiply metric tons by 1.10231.
3/ Declared free alongside ship valuation.
4/ Includes Australia, Chile, Ecuador, Egypt, Germany, Haiti, India, the Republic of Korea, New Zealand, South Africa, Taiwan, Uruguay, and Venezuela.
5/ Includes Argentina, The Bahamas, Chile, Guadeloupe, Guatemala, Haiti, Israel, Italy, Japan, Mexico, Spain, the United Kingdom, and Venezuela.
6/ Includes The Bahamas, Barbados, the Dominican Republic, France, Germany, the Republic of Korea, Kuwait, Panama, Slovenia, Trinidad and Tobago, the United Arab Emirates, and the United Kingdom.
7/ Includes Angola, Antigua, Mexico, and Taiwan.

Source: U.S. Census Bureau.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF LIME, BY TYPE 1/

	2000		2001	
Type	Quantity (metric tons) 2/	Value 3/	Quantity (metric tons) 2/	Value 3/
Calcined dolomite:				
Canada	15,700	$2,750,000	11,100	$3,020,000
Mexico	--	--	20	3,310
Other 4/	404	310,000	650	210,000
Total	16,200	3,060,000	11,800	3,230,000
Hydraulic lime:				
Canada	1	3,460	59	27,600
Mexico	--	--	275	42,400
Other 5/	--	--	184	88,600
Total	1	3,460	518	159,000
Quicklime:				
Canada	68,200	6,770,000	87,600	9,540,000
Mexico	701	81,400	750	84,100
Other 6/	246	272,000	172	208,000
Total	69,200	7,120,000	88,500	9,840,000
Slaked lime (hydrate):				
Canada	12,400	1,210,000	5,840	623,000
Mexico	15,400	1,880,000	8,660	1,060,000
Other 7/	119	196,000	113	193,000
Total	27,900	3,290,000	14,600	1,870,000
Grand total	113,000	13,500,000	115,000	15,100,000

-- Zero.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ To convert metric tons to short tons, multiply metric tons by 1.10231.
3/ Declared "cost, insurance, and freight" (c.i.f.) valuation.
4/ Includes China, Germany, Italy, the Republic of Korea, Spain, and Switzerland.
5/ Includes Belgium, France, Italy, and the United Kingdom.
6/ Includes Australia, Belgium, China, Italy, Japan, Switzerland, Thailand, and the United Kingdom.
7/ Includes Belgium, France, Germany, Japan, Monserrat, and the United Kingdom.

Source: U.S. Census Bureau.

TABLE 8
LIME PRICES 1/

Type	2000 Dollars per metric ton	2000 Dollars per short ton	2001 Dollars per metric ton	2001 Dollars per short ton
Sold and used:				
Quicklime	57.50	52.10	58.10	52.70
Hydrate	85.00	77.10	80.70	73.20
Dead-burned dolomite	88.90	80.60	84.00	76.20
Average all types	60.60	55.00	61.30	55.70
Sold:				
High-calcium quicklime	57.80 r/	52.40 r/	57.90	52.60
Dolomitic quicklime	56.60 r/	51.40 r/	58.70	53.20
Average quicklime	57.60	52.30	58.00	52.70
High-calcium hydrate	80.20	72.70	76.70	69.60
Dolomitic hydrate	102.90	93.30	99.20	90.00
Average hydrate	85.10	77.20	80.80	73.30
Dead-burned dolomite	89.70	81.40	92.30	83.80
Average all types	60.90	55.20	61.50	55.80

r/ Revised.
1/ Average value per ton, on an f.o.b. plant basis, including cost of containers.

TABLE 9
QUICKLIME AND HYDRATED LIME, INCLUDING DEAD-BURNED DOLOMITE: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Thousand metric tons)

Country 3/	1997	1998	1999	2000	2001 e/
Australia e/	1,500	1,500	1,500	1,500	1,500
Austria e/	2,000 r/	2,000	2,000	2,000	2,000
Belgium e/	1,750	1,750	1,750	1,750	1,750
Brazil	6,469 r/	6,229 r/	6,137 r/	6,273 r/	6,270
Bulgaria	849 r/	1,000 r/ e/	1,068 r/	1,388 r/	1,100
Canada	2,477	2,514	2,565 r/	2,547 r/	2,550
Chile e/	1,000	1,000	1,000	1,000	1,000
China e/	20,500	21,000	21,500	21,500	22,000
Colombia e/	1,300	1,300	1,300	1,300	1,300
Czech Republic	1,217	1,151	1,142 r/	1,202 r/	1,200
France e/	2,360	2,400	2,500 r/	2,500 r/	2,400
Germany e/	7,600	7,000 r/	6,440 r/	6,850 r/ 4/	7,000
Iran	2,500 e/	2,737	2,138	2,200 e/	2,000
Italy e/ 5/	3,500	3,500	3,500	3,500	3,500
Japan (quicklime only)	8,104	7,646	7,594	8,106 r/	8,100
Mexico e/	6,500 4/	6,500	6,500	6,500	6,500
Poland	2,516	2,406	2,299 r/	2,376 r/	2,200
Romania	1,688 r/	1,813 r/	1,623 r/	1,480 r/	1,700
Russia e/ 6/	7,626 4/	7,000	7,000	8,000	8,000
South Africa (sales)	1,585	1,523	1,419 r/	1,391 r/	1,606
Spain e/	1,500 r/	1,500 r/	1,500 r/	1,500 r/	1,500
Turkey 7/	1,170	1,066	975 r/	914 r/	900
United Kingdom e/	2,500	2,500	2,500	2,500	2,500
United States (sold or used by producers) 8/	19,700	20,100	19,700	19,600	18,900 4/
Vietnam	1,066	939	1,026	1,024	1,100
Other e/	8,880 r/	9,210 r/	9,000 r/	9,450 r/	9,300
Total	118,000 r/	117,000 r/	116,000	118,000 r/	118,000

e/ Estimated. r/ Revised.
1/ World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.
2/ Table includes data available through April 6, 2002.
3/ In addition to the countries listed, Argentina, Iraq, Pakistan, Syria, and several other nations produce lime, but output data are not reported; available general information is inadequate to formulate reliable estimates of output levels.
4/ Reported figure.
5/ Includes hydraulic lime.
6/ Total industrial and construction production as reported by Russia.
7/ Lime produced for steel production; does not include the widespread artisanal production of lime for whitewash and sanitation purposes.
8/ Includes Puerto Rico.