LIME

By M. Michael Miller

Lime is an important chemical with hundreds of chemical, industrial, and environmental uses in the United States. Its history probably dates back at least 4,000 to 6,000 years. The ancient Egyptians utilized lime as an ingredient in mortar and plaster. The Greeks, Romans, and Chinese utilized lime for construction, agriculture, bleaching, and tanning. 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. At the turn of the century, over 80% of lime consumed in the United States went for construction uses, but now over 90% of lime is consumed for chemical and industrial uses.

Lime is a basic chemical that was produced in 33 States and Puerto Rico, and its major uses were in steelmaking, flue gas desulfurization (FGD), pulp and paper manufacturing, construction, water purification, and ore concentration in the mining industry.

Total lime sold or used by domestic producers, excluding that from Puerto Rico, increased by about 600,000 metric tons (660,000 short tons) to 19.1 million tons (21.0 million short tons) in 1996. Production included the commercial sale or captive consumption of quicklime, hydrated lime, and dead-burned refractory dolomite. These products were valued at more than $1.14 billion. Commercial sales increased by 500,000 tons (550,000 short tons) to a record high of 16.9 million tons (18.6 million short tons), and captive consumption was essentially unchanged at 2.17 million tons (2.39 million short tons). *(See table 1.)*

Production

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. They are (1) quicklime, calcium oxide (CaO); (2) hydrated lime, calcium hydroxide [$Ca(OH)_2$]; (3) dolomitic quicklime ($CaO \bullet MgO$); two types of dolomitic hydrate, (4) type N [$Ca(OH)_2 \bullet MgO$] and (5) type S [$Ca(OH)_2 \bullet Mg(OH)_2$]; and (6) dead-burned dolomite. Nondolomitic quicklime and hydrated lime are also called high-calcium lime. Lime also can be produced from a variety of other calcareous materials such as aragonite, chalk, coral, marble, and shell. Lime is also regenerated; that is, produced as a byproduct, by paper mills, carbide plants, and water treatment plants; however, regenerated lime is beyond the scope of this report.

Domestic production data for lime are developed by the U.S. Geological Survey from two separate, voluntary surveys of U.S. operations. The survey used to prepare this report is the annual "Lime" survey. Of the 107 operations to which the annual survey request was sent, 102 responded, representing 89% of the total sold or used by producers shown in table 2. Production for two nonrespondents was provided based on the monthly survey. Production for eight other nonrespondents was estimated using reported prior-year production figures.

In 1996, 57 companies produced lime from limestone or dolomite. Leading producing companies, in descending order, were Chemical Lime Co., with two plants each in Alabama, Arizona, Nevada, and Texas and one each in Idaho, Missouri, and Utah and two hydrating plants in California; Dravo Lime Co., with two plants in Kentucky, one plant in Alabama, and a hydrating plant in Louisiana; Mississippi Lime Co. in Missouri; Marblehead Lime Co., with two plants in Illinois and one each in Indiana and Michigan (although one of the Illinois plants and the Michigan plant closed during the year); Continental Lime Inc., with one plant each in Montana, Nevada, Utah, and Washington; Global Stone Corp., with one plant each in Michigan, Oklahoma, Tennessee, and Virginia; Martin Marietta Magnesia Specialties in Ohio; APG Lime Co., with one plant each in Texas and Virginia; Bellefonte Lime Co., with two plants in Pennsylvania; and U.S. Lime & Minerals, Inc., with one plant each in Arkansas, Pennsylvania, and Texas. These 10 companies operated 35 lime plants and 3 separate hydrating plants and accounted for 74% of commercial sales and 68% of total lime production.

Domestic lime plant capacity is based on 365 days minus the average number of days for maintenance times the average 24-hour capacity of quicklime production, including quicklime converted to hydrated lime, and reported in short tons per year. In 1996, there were 36 commercial lime companies operating 64 lime plants; excluding combined captive and commercial producers, hydrating plants, and Puerto Rico. Capacity data were available from 28 commercial companies operating 52 plants. Based on the available data, the U.S. lime industry operated at 80% of capacity in 1996. This is a decrease from the 88% operating rate for 1995. The decrease in capacity utilization is the result of capacity additions outstripping production increases and a slightly different mix of reporting companies. Capacity utilization would be slightly lower if the capacity of several idle or mothballed plants were factored into the calculations.

On a regional basis, capacity utilization ranged from 65% to 88%. In the Middle Atlantic Region (plants in eastern and central Pennsylvania, West Virginia, and northern Virginia) capacity utilization was 80%, based on data from seven companies operating nine plants. In the Southeast Region (plants in Alabama, eastern Tennessee, and southern Virginia) capacity utilization was 84%, based on five companies operating six plants. The utilization rate was probably higher in the Southeast. Incomplete data were reported for a sixth company estimated to be operating at near capacity levels, so the data were left out of the calculations. In the Eastern Midwest Region (plants in Michigan, northern Kentucky, Ohio, and western Pennsylvania) capacity utilization was 88%, based on five companies operating six plants. In the Western Midwest Region (plants in Illinois, Indiana, Iowa, Missouri, and Wisconsin) capacity utilization was 65%, based on 8 companies operating 10 plants. In the South Central Region (plants in Arkansas, Louisiana, Oklahoma, and Texas) capacity utilization was 78%, based on seven companies operating nine plants. In the Western Region (plants in Arizona, Colorado, Idaho, Montana, Nevada, Oregon, South Dakota, Utah, and Washington) capacity utilization was 87%, based on 6 companies operating 12 plants. *(See tables 2 and 3.)*

The lime industry continued to add capacity in 1996. Capacity additions were reported at plants in Ohio, Nevada, and Virginia, totaling 904,000 tons (997,000 short tons). Partially offsetting this new capacity was the closure of Marblehead Lime's Thornton plant in Illinois and its Brennan plant in Michigan. These closures accounted for about 557,000 tons (614,000 short tons) of annual production capacity. From 1993 through 1996, the lime industry added over 2.8 million tons (3.1 million short tons) of new capacity, while losing 765,000 tons (843,000 short tons) of capacity. The lost capacity was the result of the closure of Warner Lime Co. in 1993, Marine Magnesium Co. in 1994, and the two Marblehead Lime plants in 1996. Substantial amounts of additional new capacity are planned for 1997 and 1998.

In regional industry news, in the Southeast, A.P. Green Industries Inc. and SCANA Corp. announced a joint venture to build a new 180,000-ton-per-year (200,000-short-ton-per-year) lime plant at Charleston, SC. SCANA is an energy-based holding company and A.P. Green mines, processes, manufactures, and distributes specialty minerals and mineral-based products in both the United States and international markets. The plant will operate as Palmetto Lime LLC in conjunction with A.P. Green's subsidiary APG Lime. The plant is expected to start up in late 1997 with plans to double capacity by the year 2000. The plant is intended to serve FGD, pulp and paper, steel, and water purification markets (A.P. Green Industries Inc., 1996b). A.P. Green Industries also announced that it had reached an agreement in principle to acquire the Virginia lime plant and limestone reserves of Eastern Ridge Lime LP, an affiliate of Mississippi Lime. The Eastern Ridge operation will become part of APG Lime's Virginia operation. Eastern Ridge's Ripplemead lime plant will be designated as Plant #2 and its limestone production will be integrated with APG Lime's production (A.P. Green Industries Inc., 1996a). The startup of Global Stone Tenn Luttrell Inc.'s new vertical shaft kiln at its plant in Tennessee was delayed from 1996 to 1997. Reasons given for the delay were weather related construction delays and design deficiencies (Global Stone Corp., 1996a, b).

Blue Circle Cement Co. began work on a $40 million project to modernize and expand its lime plant in Calera, AL. When completed in late 1997, annual plant capacity will increase by 60% from 227,000 tons per year (250,000 short tons per year) to 363,000 tons per year (400,000 short tons per year). The project includes installation of a new Kennedy Van Saun 1,000-ton-per-day (1,100-short-ton-per-day) preheater rotary kiln, modernization of the hydrator system, and improvements to the quarry, storage, and load-out facilities (Blue Circle Cement Co., 1996).

Chemical Lime announced plans to build processing plants and storage terminals at deep water ports in Charleston, SC, and Tampa, FL. Lime initially will be shipped by rail from the company's Eastern Division plants in Alabama and Missouri, and later by water from a new lime plant to be built in the Caribbean scheduled for startup in 1998. Products intended for distribution will include high-calcium and dolomitic quicklime, blended products, and slurried products (Chemical Lime Co., 1996). Chemical Lime also began construction of a new lime plant at its O'Neal limestone quarry near Calera, AL. The new plant will operate a 1,225-ton-per-day (1,350-short-ton-per-day) preheater rotary kiln and is scheduled for startup during 1997.

In the Middle Atlantic Region, the two Pennsylvania lime plants of Wimpey Minerals PA Inc. changed hands twice during 1996. First, Wimpey Minerals became part of Tarmac America Inc., as a result of an asset swap between parent company George Wimpey Plc and Tarmac America. Then, as part of a plan finalized in December 1996, Tarmac America sold the Annville and Hanover lime plants and the Annville limestone quarry acquired from Wimpey to Carmeuse Pennsylvania, a division of Carmeuse Chimie Minerale of Belgium (Rock Products, 1997). Global Stone's subsidiary Global Stone Chemstone Inc. successfully restarted two idle vertical shaft kilns at its Strasburg, VA, plant (Global Stone Corp., 1996a). Also in 1996, Global Stone purchased the principal assets of the high-calcium limestone operation of Redland Genstar Inc., located near the Global Stone Chemstone lime operation. The Redland Genstar facility produces approximately 318,000 tons (350,000 short tons) per year of high-purity limestone products. The new property was to be merged with the Global Stone Chemstone facility (Global Stone Corp.,

1996b). W.S. Frey Co. installed a second rotary kiln at its plant near Clearbrook, VA. The new kiln has a capacity of about 363 tons per day (400 short tons per day).

In the Midwest Region, Marblehead Lime closed its Brennan plant in Michigan and mothballed its Thornton plant in Illinois. Martin Marietta Magnesia Specialties Inc. received ISO 9002 certification for its Manistee, MI, and Woodville, OH, facilities. This is a quality assurance certification for production of all products produced at these facilities (National Lime Association, 1996). In addition, the company completed phase I of its capacity expansion project at its Woodville, OH, plant. The Ohio plant produces dolomitic quicklime for use at the company's magnesia plant in Manistee, MI, and sells to steel and related markets. Phase I increased lime plant capacity to about 700,000 tons per year (775,000 short tons per year). Dravo Lime's Black River Division in Carntown, KY, also received ISO 9002 certification in 1996 (Sommer, 1996). Vulcan Materials Co. started construction of a new dolomitic lime plant at an existing dolomite quarry near Manteno, Kankakee County, IL. Startup of the first straight rotary kiln was scheduled for the spring of 1997. Vulcan's McCook lime plant in Cook County, IL, was converted from dolomitic lime production to high-calcium lime production. The company was unable to access reserves at its McCook quarry, because of zoning difficulties, and had to start bringing in limestone from offsite to continue lime production.

In the South-Central Region, Chemical Lime restarted production at its Marble Falls, TX, plant, which had been idle since 1993.

In the Western Region, Chemical Lime added a new 1,225-ton-per-day (1,350-short-ton-per-day) preheater rotary kiln at its Apex lime plant near Las Vegas, NV. Continental Lime added a third kiln at its Pilot Peak plant near Wendover, NV. The new kiln is a preheater rotary with an annual capacity of about 910 tons per day (1,000 short tons per day) (McCaffrey and Robinson, 1996).

Consumption

Lime was consumed in every State, with the largest consuming States being, in descending order, Ohio, Indiana, Pennsylvania, Texas, and Michigan. Some States produce significantly more lime than is consumed within its own boundaries, for example, Alabama, Virginia, and Wisconsin. *(See tables 2 and 4.)*

The breakdown of consumption by major end uses was as follows: 62% for chemical and industrial uses, 28% for environmental uses, 8% for construction uses, and 1% for refractory dolomite. Captive lime accounted for about 11% of consumption and was used mainly in the production of steel in basic oxygen furnaces, in sugar refining, and in magnesia production. Almost all data on captive lime consumption, excluding the sugar industry, are withheld to protect company proprietary information. As a result, table 5, "Lime sold or used by producers in the United States, by use," has been revised to simply show the total quantity and value of lime by end use. End uses with captive consumption are listed in footnote 4 of the table.

In steel refining, quicklime was used as a flux to remove impurities such as phosphorus, silica, and sulfur. Dolomitic lime was often substituted for a fraction of the high-calcium lime to extend refractory life. Dead-burned dolomite, also called refractory lime, was used as a component in tar-bonded refractory brick used in basic oxygen furnaces. Lime consumption by the iron and steel industry increased by nearly 3% to 5.7 million tons (6.3 million short tons), even though U.S. raw steel production was essentially unchanged at 95 million tons (105 million short tons). Most of the increase in lime consumption was in electric arc furnace consumption. The steel industry accounted for about 30% of all lime consumed in the United States.

In nonferrous metallurgy, lime was used in the beneficiation of copper ores to neutralize the acidic effects of pyrite and other iron sulfides and maintain the proper pH in the flotation process. Lime consumption for copper ore concentration increased by nearly 7% in 1996. It was used to process alumina and magnesia, to extract uranium from gold slimes, and in the recovery of nickel by precipitation. It was used in gold and silver recovery operations to control the pH of the sodium cyanide solution used to leach the 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 pH level between 10 and 11 to maximize precious-metals recovery and to prevent the creation of hydrogen cyanide gas. Lime consumption for concentration of gold, lead, silver, zinc, and other noncopper ores increased by 31% to 794,000 tons (875,000 short tons).

The tailings that result from the recovery of precious metals may contain elevated levels of cyanides. Three of the four major treatment processes (Cyanisorb, alkaline chlorination, and SO_2/air) used to recover these cyanides use lime in the process. In the environmental sector, lime was used in the softening and clarification of municipal potable water. Lime was used to neutralize acid mine and industrial discharges. In FGD systems serving utility and industrial plants and incinerators, lime was used to react with sulfur oxides in the flue gas and was used to stabilize the resulting sludge before disposal. In 1996, the FGD market continued to display solid growth with lime consumption up nearly 5% to 2.82 million tons (3.11 million short tons).

In sewage treatment, lime's traditional role was to control

pH in the sludge digester, which removes dissolved and suspended solids that contain phosphates and nitrogen compounds. It also aided clarification and killing of bacteria. More recently, the largest use in sewage treatment has been to stabilize the resulting sewage sludges. Sewage sludge stabilization, also called biosolids stabilization, has as its goal the reduction of odors, pathogens, and putrescibility of the solids. In lime stabilization, the basic process involves mixing quicklime with the sludge to raise the temperature and pH of the sludge to minimum levels for a specified period of time.

The paper industry used lime as a coagulant aid in the clarification of plant process water. It was used, generally in conjunction with soda ash, for softening plant process water. This is a precipitation process to remove bivalent soluble calcium and magnesium cations (and to a lesser extent manganese, ferrous iron, zinc, and strontium), which contribute to the hardness of water. This process also reduces carbonate alkalinity and dissolved solids content.

In the basic Kraft pulping process, 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 where 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. Lime consumption decreased by 11% reflecting the pulp and paper industry's improving process efficiencies.

Lime was used to make precipitated calcium carbonate (PCC), a specialty filler used in premium-quality coated and uncoated papers. 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.

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

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

Dolomitic quicklime was used as a flux in the manufacture of glass. Quicklime was used to make calcium silicate building products such as sand-lime brick; hydrated lime was used to produce silica refractory brick.

In construction, lime was used for soil stabilization to upgrade clay soils into satisfactory base and subbase materials. Common applications included the construction of roads, airfields, building foundations, earthen dams, and parking areas. Quicklime was used in autoclaved aerated concrete to produce building materials that could be cut, drilled, and nailed like wood, but with the advantages of a concrete product. Hydrated lime was used with fly ash to make a base material, in asphalt mixes to act as an antistripping agent, and in plaster, stucco, and mortar to improve durability. *(See tables 5 and 6.)*

Prices

The average values per ton of lime rounded to three significant figures are discussed 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.

The average value of lime sold or used by producers, on an f.o.b. plant basis, increased only slightly in 1996 to $59.80 per ton ($54.30 per short ton). Average values per ton were $56.90 ($51.60 per short ton) for chemical and industrial lime, $60.20 ($54.60 per short ton) for environmental lime, $75.30 ($68.30 per short ton) for construction lime, $82.50 ($74.80 per short ton) for agricultural lime, and $88.80 ($80.60 per short ton) for refractory dolomite.

The average value of quicklime sold was essentially unchanged at $57.00 per ton ($51.70 per short ton). The average value per ton sold decreased slightly for chemical and industrial lime to $56.30 ($51.00 per short ton). The average value per ton sold for environmental lime increased by 8% to $57.70 ($52.40 per short ton). The average value per ton sold for construction lime decreased by 6% to $54.80 ($49.70 per short ton). The average value per ton of refractory dead-burned dolomite sold decreased by 6% to $89.40 ($81.10 per short ton). Almost no quicklime was sold as aglime.

The average value of hydrated lime increased by 10% to $79.60 per ton ($72.20 per short ton). Average values per ton sold increased by 6% for chemical and industrial lime to $69.10 ($62.60 per short ton), by 5% for environmental lime to $74.20 ($67.30 per short ton), by 16% for construction lime to $89.80 ($81.40 per short ton), and by nearly 4% for agricultural lime to $81.60 ($74.00 per short ton).

Foreign Trade

Exports of lime were about 50,000 tons (55,000 short

tons), a decrease of nearly 31% compared with 1995. Exports went predominantly to Canada (73%), Jamaica (12%), and Mexico (7%). Imports of lime decreased by more than 9% to 262,000 tons (289,000 short tons). The United States imported quicklime, hydrated lime, and hydraulic lime, with nearly 83% coming from Canada and the remaining 17% coming from Mexico.

Current Research and Technology

Dravo Lime was awarded a grant by the Ohio Department of Development, Coal Development Office to test its magnesium-enhanced, lime scrubbing process in conjunction with Tecogen Corp.'s Tecolytic nitrogen oxide corona conversion process. The project calls for the capture of nitrogen oxide and sulfur dioxide from the gas stream in a wet scrubber system and monitoring the effects of the process variables on the removal efficiencies of sulfur dioxide and nitrogen dioxide. The process will produce a byproduct that can be used as fertilizer. The testing of these two technologies will be at Cinergy's Miami Fort Station (The Globe Online, 1996).

The U.S. Department of Energy awarded a contract to the University of Pittsburgh School of Engineering Center for Energy Research to evaluate the use of byproducts from advanced sulfur-removal systems in the treatment of metal-laden hazardous wastes. Lime is used in the scrubber systems at coal-fired powerplants to remove sulfur dioxide from flue gases. The residue from these scrubber systems contains unreacted lime and some useful chemicals formed when lime and sulfur dioxide react. The study will evaluate the use of 4 byproducts from sulfur removal systems to treat 10 characteristic metal-laden wastes. The goal is to stabilize the hazardous materials in the waste to allow the resulting nonhazardous waste to be disposed in landfills accepting nonhazardous wastes. Dravo Lime Co. is one of the two principal subcontractors on the project and will be responsible for sampling and analyzing the byproducts (University of Pittsburgh, 1996).

Adelaide Brighton Ltd., a major Australian cement and lime producer, and the University of Adelaide previously demonstrated the concept of precessing jet technology as applied in Gyro-Therm burners in rotary kilns producing cement clinker, alumina, and zinc oxide. The technology has now been applied to rotary kiln production of lime utilizing natural gas as the fuel. Natural gas burns cleaner than other kiln fuels, but provides poor heat transfer to the kiln charge. This means that more fuel has to be burned to transfer the same amount of heat to the kiln charge. The technology uniquely mixes the natural gas fuel and the surrounding air in the kiln so the gas burns in a fuel-rich area within the flame envelope despite the general oxygen-rich environment of the kiln. The results are improvements in production and fuel efficiencies and a significant reduction in nitrogen oxide emissions (Manias, Balendra, and Retallack, 1996).

Outlook

Lime has dozens of end uses in the chemical, industrial, and construction industries, but over 65% of consumption comes from six major markets: steel, flue gas desulfurization, water purification, pulp and paper, soil stabilization, and precipitated calcium carbonate.

Steelmaking is still the largest single end use for lime. U.S. steel production should continue at or near current levels as long as the economy stays out of a recession. In the long term, lime consumption will likely decrease because of industry changes in raw materials and flux usage, the latter includes greater use of flux pellets and hot metal desulfurization.

The FGD market continued to grow in 1996 with demand up by nearly 5%. The future continues to look promising for this market. Following recent trends and considering current market forces, the FGD market is expected to grow at a slightly faster rate than the overall lime market. During the period 1997-99, sales are expected to increase by about 5% annually. This would put 1999 FGD sales at between 3.25 to 3.30 million tons (3.58 to 3.64 million short tons). Phase II of the Clean Air Act Amendments, which takes effect January 1, 2000, and regulates small utility generating units, should provide an additional boost to lime sales after 1999. Lime scrubbers display favorable efficiencies and economics for these small units. Regulations covering small municipal incinerators and waste to energy incinerators also favor the use of lime scrubbers. Quantifying the increased demand generated by Phase II and other emissions regulations is difficult, but some industry projections have forecast FGD demand at 5 million tons (5.5 million short tons) by 2002. Major FGD lime producers are investing in research and development to lower the capital and operating costs associated with lime scrubbing and to produce salable byproducts. The goal of such research ultimately is to provide environmentally sound and economic technologies designed attract customers from powerplants currently utilizing limestone scrubbers or low-sulfur coal.

Soil stabilization sales increased by 20% in 1996, setting a new record by topping the million ton level. The soil stabilization market fluctuates depending on the level of highway and related types of construction, the weather, and competition from competing products like cement. Surprisingly, the use of lime in asphalt paving decreased by 35% in 1996 and has declined 42% since 1994. This has been touted as a growth market by the lime industry and this decrease is puzzling.

Demand in lime's traditional pulp and paper market decreased by 11% in 1996, as pulp and paper producers are regenerating more lime from their carbonate sludge for environmental and cost reasons. The market will remain a

large, mature market for lime, but growth is expected to be flat at best. The PCC market increased by 14% in 1996, and should continue to grow as PCC attempts to expand into the groundwood paper and paper coating markets. Anticipated growth in the PCC market is expected to be particularly strong in the Southeastern United States.

Overall, commercial lime sales are expected to grow at about 3% per year over the next several years. The only major market force on the horizon is Phase II of the Clean Air Act Amendments, which may boost FGD sales after the year 2000.

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[1]Prior to January 1996, published by the U.S. Bureau of Mines.

TABLE 1
SALIENT LIME STATISTICS 1/

(Thousand metric tons unless otherwise specified) 2/

		1992	1993	1994	1995	1996
United States: 3/						
Number of plants		112	112	109 r/	107 r/	108
Sold or used by producers						
Quicklime		13,700	14,200	14,800	15,800	16,500
Hydrated lime		2,230	2,250	2,290	2,390 r/	2,280
Dead-burned dolomite		302	315	300	308	271
Total		16,200	16,700	17,400	18,500	19,100
Value 4/	thousands	$950,000	$965,000	$1,020,000	$1,100,000	$1,140,000
Average value per ton		$58.60 r/	$57.60 r/	$58.80 r/	$59.20 r/	$59.80
Lime sold		14,300	14,900	15,500	16,400 r/	16,900
Lime used		1,890	1,870	1,910	2,180	2,170
Exports 5/		59	69	74	72	50
Value	thousands	$7,540	$7,830	$7,800	$8,490	$5,600
Imports for consumption 5/		193	201	204	289	262
Value	thousands	$15,000	$13,300	$13,100	$20,200	$19,400
Consumption, apparent 6/		16,300	16,900	17,500	18,700	19,300
World: Production		125,000 r/	123,000 r/	120,000 r/	121,000 r/	121,000 e/

e/ Estimated. r/ Revised.

1/ Data are rounded to 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. Excludes Puerto Rico.

4/ Selling value, f.o.b. plant, excluding cost of containers.

5/ Bureau of the Census.

6/ 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/

State	1995 Plants	1995 Hydrated (thousand metric tons)	1995 Quicklime (thousand metric tons)	1995 Total (thousand metric tons)	1995 Value (thousands)	1996 Plants	1996 Hydrated (thousand metric tons)	1996 Quicklime (thousand metric tons)	1996 Total (thousand metric tons)	1996 Value (thousands)
Alabama	4	183	1,550	1,730	$105,000	4	196	1,660	1,860	$116,000
Arizona, Nevada, Utah	8	240	1,570	1,810	109,000	8	183	1,870	2,060	122,000
California	6	W	W	228	15,600	7	W	W	209	17,800
Colorado, Montana, Wyoming	10	5	340	346	21,600	10	18	321	340	33,000
Idaho, Oregon, Washington	7	23	643	667 r/	48,400	7	11	596	606	28,500
Illinois, Indiana, Missouri	8	451	3,000	3,450	188,000	9	451	3,250	3,700	205,000
Iowa, Nebraska, South Dakota	5	W	W	233	14,200	4	W	W	245	25,600
Kentucky, Tennessee, West Virginia	5	127	2,260	2,390	130,000	5	135	2,360	2,490	137,000
Michigan	9	38	615	653	34,600	9	3	581	584	30,300
Ohio	9	W	W	1,920	114,000 r/	8	W	W	2,020	107,000
Pennsylvania	8	256	1,390	1,640	107,000	8	276	1,250	1,530	105,000
Texas	6	526	843	1,370	85,800	7	462	894	1,360	86,300
Virginia	5	132	598	730 r/	41,900	5	124	642	766	45,700
Wisconsin	4	124	444	568	33,900	4	121	430	551	32,000
Other 3/	13	285 r/	2,890 r/	796 r/	48,200 r/	13	298	2,960	788	50,500
Total	107	2,390	16,100	18,500	1,100,000	108	2,280	16,800	19,100	1,140,000

r/ Revised. W Withheld to avoid disclosing company proprietary data; included with "Other."
1/ Excludes regenerated lime. Includes Puerto Rico.
2/ Data are rounded to three significant digits; may not add to totals shown.
3/ Includes Arkansas, Louisiana, Massachusetts, Minnesota, North Dakota, Oklahoma, Puerto Rico, and data indicated by the symbol W.

TABLE 3
LIME SOLD OR USED BY PRODUCERS IN THE UNITED STATES, 1/ BY RANGE OF PRODUCTION 2/

Range of production	1995 Plants	1995 Quantity (thousand metric tons)	1995 Percent of total	1996 Plants	1996 Quantity (thousand metric tons)	1996 Percent of total
Less than 10,000 tons	6	35	(3/)	13	82	(3/)
10,000 to 25,000 tons	17	232	1	13	210	1
25,000 to 50,000 tons	11	326	2	8	235	1
50,000 to 100,000 tons	18	1,330	7	16	1,070	6
100,000 to 200,000 tons	22	2,890	16	23	2,920	15
200,000 to 400,000 tons	22	5,850	32	22	5,720	30
More than 400,000 tons	11	7,870	42	13	8,860	46
Total	107	18,500	100	108	19,100	100

1/ Excludes regenerated lime. Includes Puerto Rico.
2/ Data are rounded to three significant digits; may not add to totals shown.
3/ Less than 1/2 unit.

TABLE 4
DESTINATION OF SHIPMENTS OF LIME SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY STATE 1/ 2/

(Thousand metric tons) 3/

	1995			1996		
	Quicklime	Hydrated lime	Total	Quicklime	Hydrated lime	Total
Alabama	545	46	591	645	54	699
Alaska	5	(4/)	5 r/	1	(5/)	1
Arizona	322	59 r/	381	338	41	380
Akransas	203 r/	27	231	275	28	303
California	285	78	363	358	65	423
Colorado	142	35	176	148	36	184
Connecticut	19	3	23	18	4	22
Delaware	38	6	44	69	7	76
District of Columbia	17	15	32	31	5	36
Florida	400	25	426	398	33	432
Georgia	241	79	320	249	70	318
Hawaii	(4/)	(5/)	(5/)	--	--	--
Idaho	219 r/	3	221 r/	146	5	151
Illinois	506	164	670	507	157	665
Indiana	1,460	32	1,490	1,600	31	1,630
Iowa	64	27	91	59	29	89
Kansas	74	23	97	105	19	124
Kentucky	444 r/	36	480 r/	469	33	502
Louisiana	318	107	425	431	120	551
Maine	3 r/	(4/)	3 r/	3	(5/)	3
Maryland	160	17	177	250	18	269
Massachusetts	145	12	157	144	12	156
Michigan	914	30	944	937	22	959
Minnesota	334	20	354	337	19	357
Mississippi	219	31	250	166	22	188
Missouri	135	60	195	132	50	182
Montana	139	19	158	126	34	160
Nebraska	54	11	65	53	10	63
Nevada	494	48	542	658	43	702
New Hampshire	2	(4/)	2	(5/)	(5/)	(5/)
New Jersey	154	23	177	219	33	253
New Mexico	127	38	165	118	28	147
New York	87	28	116	74	28	102
North Carolina	199	56	256	202	64	266
North Dakota	282	3	285	278	3	281
Ohio	2,220	177	2,390	2,330	145	2,470
Oklahoma	131	10	141	119	15	134
Oregon	155	25	180	156	17	174
Pennsylvania	1,630	174	1,800 r/	1,360	183	1,540
Rhode Island	2	1	3	2	1	3
South Carolina	255	42	298	259	42	301
South Dakota	24	3	27	25	4	30
Tennessee	211	52	262	211	58	269
Texas	802	511	1,310	774	446	1,220
Utah	303	27	331	297	17	315
Virginia	228	46	274	262	45	308
Washington	279	15	294	320	5	325
West Virginia	750 r/	48	799 r/	736	61	797
Wisconsin	144	40	184	112	43	156
Wyoming	186	18	204	233	23	256
Total	16,100	2,350	18,400	16,700	2,230	19,000
Puerto Rico	(4/)	18 r/	18 r/	(5/)	14	14
Canada	55	14	69 r/	55	6	61
Other 6/	23 r/	6	29 r/	31	25	56
Total	78 r/	38 r/	115 r/	86	46	132
Grand total	16,100	2,390	18,500	16,800	2,280	19,100

r/ Revised.
1/ Excludes regenerated lime.
2/ Data are rounded to three significant digits; may not add to totals shown.
3/ To convert metric tons to short tons multiply metric tons by 1.10231.
4/ Revised to zero.
5/ Less than 1/2 unit.
6/ Includes other countries and U.S. possessions.

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

(Thousand metric tons and thousand dollars) 3/

Use	1995		1996	
	Quantity 4/	Value	Quantity 4/	Value
Agriculture:	21	1,650	26	2,170
Chemical and industrial:				
Alkalies	72	3,050	72	3,070
Aluminum and bauxite	148	8,940	237	14,800
Food products, animal or human	13	910	25	1,580
Glass	156	8,510	159	8,930
Oil well drilling	23	1,490	26	2,020
Oil and grease	13	618	15	759
Ore concentration, other	605	31,600	794	38,800
Paper and pulp	1,020	61,600	908	54,500
Petrochemicals	28	4,230	23	4,230
Precipitated calcium carbonate	677	37,000	773	40,000
Steel:				
Basic oxygen furnaces	4,150 r/	237,000	4,030	226,000
Electric arc furnaces	952 r/	55,000	1,140	66,300
Argon oxygen decarburization	105	5,720	117	7,270
Ladle desulfurization, iron or steel	105	4,900	213	15,600
Other	263 r/	15,600 r/	226	12,800
Total steel:	5,570	318,000 r/	5,730	328,000
Sugar refining	826 r/	52,200	655	34,600
Tanning	19	1,180	23	1,380
Other chemical and industrial 5/	2,290 r/	138,000 r/	2,350	138,000
Total	11,500	668,000	11,800	671,000
Construction:				
Asphalt paving	210 r/	13,700	137	13,700
Finishing lime	82	8,790	71	9,340
Mason's lime	194	15,700	226	18,300
Soil stabilization	889	55,900	1,070	67,800
Other	92	10,300	71	9,820
Total	1,470	104,000	1,580	119,000
Environmental:				
Acid water, mine or plant	329 r/	21,000 r/	421	26,800
Flue gas sulfur removal	2,690 r/	141,000	2,820	164,000
Industrial solid waste treatment	61	3,740	38	3,290
Industrial wastewater treatment	60 r/	3,710 r/	64	4,580
Scrubber sludge solidification	68	3,830	86	5,740
Sewage treatment	554 r/	33,700	463	30,500
Water purification	1,160	67,800	1,170	70,400
Other	350 r/	19,700	368	21,800
Total	5,270 r/	294,000	5,440	327,000
Refractory lime (dead-burned dolomite)	308	28,100	271	24,100
Grand total	18,500	1,100,000	19,100	1,140,000

r/ Revised.

1/ Excludes regenerated lime. Includes Puerto Rico.

2/ Data are rounded to 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 alkalies, copper ore concentration, paper and pulp, precipitated calcium carbonate, basic oxygen furnaces, mason's lime, and refractory lime (dead-burned dolomite).

5/ Includes calcium carbide, citric acid, copper ore concentration, magnesia from seawater or brine, magnesium metal, metallurgy, and unspecified uses.

TABLE 6
HYDRATED LIME SOLD OR USED IN THE UNITED STATES, BY END USE 1/ 2/

(Thousand metric tons and thousand dollars) 3/

Use	1995		1996	
	Quantity 4/	Value	Quantity 4/	Value
Agriculture	20	1,580	26	2,080
Chemical and industrial:				
Oil and grease	13	618	14	704
Paper and pulp	8	554	6	441
Other 5/	463	30,500	395	26,400
Total	484	31,700	415	27,500
Construction:				
Asphalt paving	207	13,500	134	13,500
Finishing lime	82	8,790	71	9,340
Mason's lime	190	15,400	225	18,200
Soil stabilization	455	30,500	456	34,000
Other	91	10,300	70	9,760
Total	1,030	78,500	956	84,800
Environmental:				
Acid water, mine or plant	131	8,880	195	13,100
Industrial solid waste treatment	20	1,530	16	1,530
Industrial wastewater treatment	28	1,790	32	2,440
Sewage treatment	237	16,900	199	15,000
Water purification	288	20,500	264	19,600
Other	81	5,270	104	8,510
Total	784	54,800	811	60,100
Metallurgy 6/	77	4,420	71	7,910
Grand total	2,390	171,000	2,280	182,000

1/ Excludes regenerated lime. Includes Puerto Rico.

2/ Data are rounded to 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 for mason's lime and metallurgical uses listed in footnote 6.

5/ Includes alkalies, citric acid, food products (animal or human,) glass, oil well drilling, petrochemicals, precipitated calcium carbonate, sugar refining, tanning and unspecified uses.

6/ Includes aluminum and bauxite, basic oxygen furnace, copper ore concentration, electric arc furnace, other iron or steel, other ore concentration, wire drawing and unspecified metallurgical uses.

TABLE 7
QUICKLIME AND HYDRATED LIME, INCLUDING DEAD-BURNED DOLOMITE: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Thousand metric tons)

Country 3/	1992	1993	1994	1995	1996 e/
Australia e/	1,500	1,500	1,500	1,500	1,500
Austria	1,716	1,811	1,850	1,800 e/	1,800
Belgium e/	1,871 4/	1,750	1,750	1,800	1,800
Brazil e/	5,240 r/ 4/	5,700	5,700	5,700	5,700
Canada	2,380	2,380	2,390 e/	2,398 r/	2,491 p/
Chile (hydraulic) e/	1,300	1,300	1,250	1,006 4/	1,050
China e/	19,000	19,500	19,500	20,000	20,000
Colombia e/	1,300 r/	1,300 r/	1,300 r/	1,300 r/	1,300
Czech Republic 5/	XX	1,147	1,206	1,186	1,200
Czechoslovakia 6/	3,000 e/	XX	XX	XX	XX
France	3,000 e/	3,000 e/	3,015	2,940 r/	3,000
Germany	7,542	7,483	8,511	8,000 e/	8,000
Italy e/ 7/	3,600	3,600	3,500	3,500	3,500
Japan (quicklime only)	8,049	7,958	7,712	7,871	7,670
Mexico e/	6,500	6,500	6,500	6,580 4/	6,600
Poland	2,526	2,584	2,516	2,526 r/	2,500
Romania	1,738	1,738	1,621	1,747	1,700
Slovakia 5/	XX	1,070	1,000 e/	1,000 e/	1,000
South Africa (sales)	1,738	1,599	1,597	1,743 r/	1,691 4/
Turkey 8/	1,582	1,767 r/	1,800 e/	1,800 e/	1,800
U.S.S.R. e/ 9/	23,000	20,000	16,000	16,000	15,000
United Kingdom e/	2,500	2,500	2,500	2,500	2,500
United States, including Puerto Rico (sold or used by producers)	16,200	16,800	17,400	18,500	19,100 4/
Other e/	8,953	8,538	8,678	8,913	8,908
Total	125,000	123,000 r/	120,000 r/	121,000 r/	121,000

e/ Estimated. p/ Preliminary. r/ Revised. XX Not applicable.

1/ World totals, U.S. data, and estimated data are rounded to three significant digits; may not add to totals shown.

2/ Table includes data available through May 20, 1997.

3/ Lime is produced in many other countries besides those included in the total. Argentina, Iraq, Pakistan, and Syria are among the more important countries for which official data are not available. Venezuela does not report production of lime, which is thought to be produced in very small amounts on individual farms.

4/ Reported figure.

5/ Formerly part of Czechoslovakia; data were not reported separately until 1993.

6/ Dissolved Dec. 31, 1992.

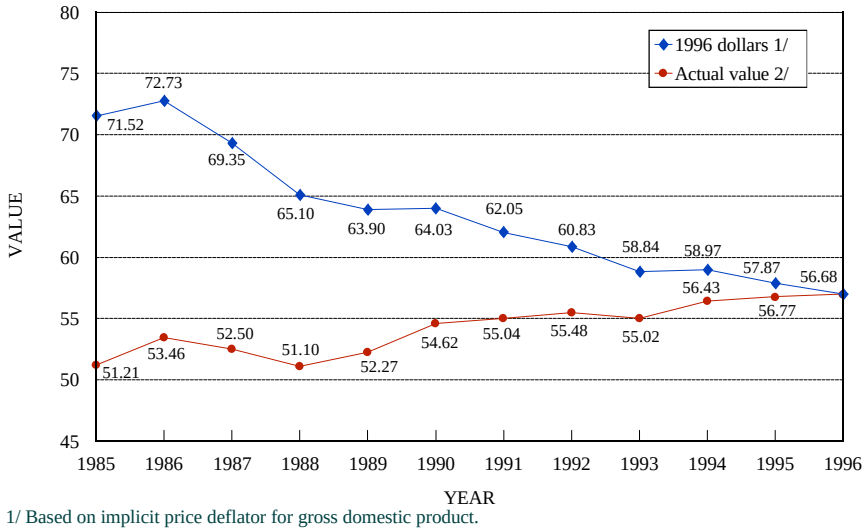
7/ Includes hydraulic lime.

8/ Data are lime produced for steel production and do not include the widespread artisanal production of lime for whitewash and sanitation purposes.

9/ Dissolved in Dec. 1991. Total production of the former U.S.S.R.; information is inadequate to formulate reliable estimates for individual countries.

FIGURE 1

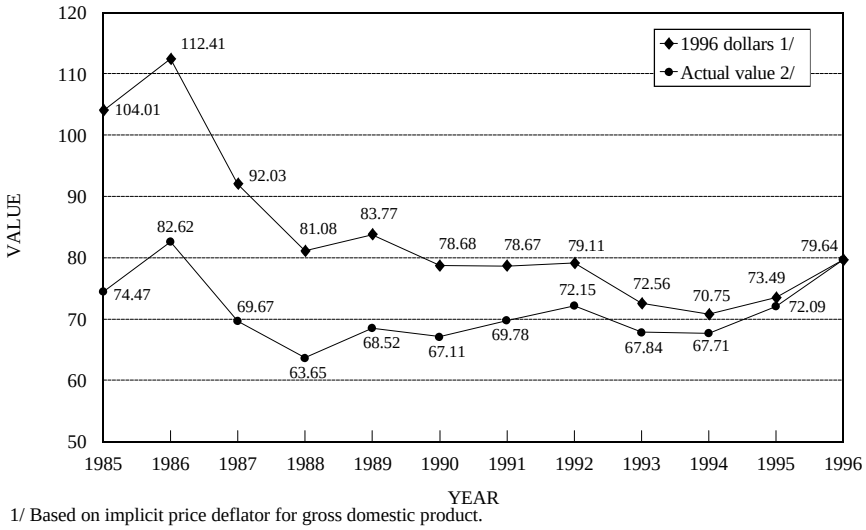
TIME-VALUE RELATIONSHIPS FOR QUICKLIME SOLD
(Dollars per metric ton)



1/ Based on implicit price deflator for gross domestic product.
2/ Value of lime sold as prepared for shipment, f.o.b. plant.

FIGURE 2

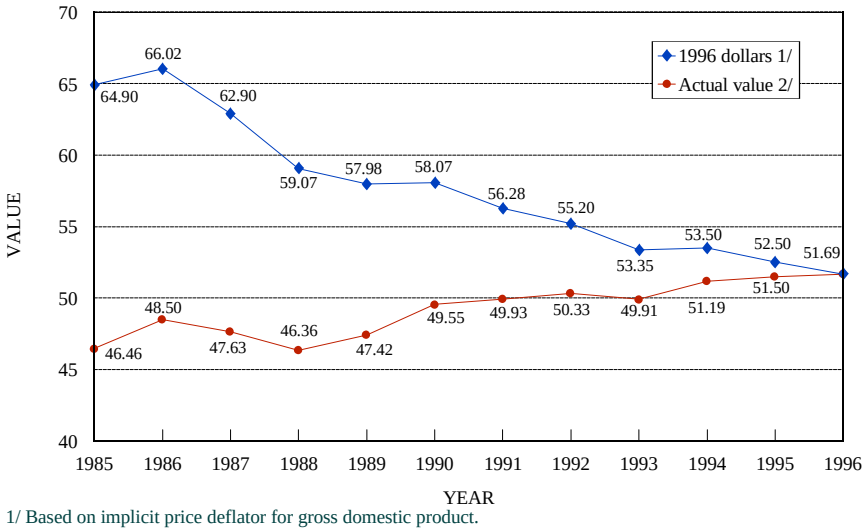
TIME-VALUE RELATIONSHIPS FOR HYDRATED LIME SOLD
(Dollars per metric ton)



1/ Based on implicit price deflator for gross domestic product.
2/ Value of lime sold as prepared for shipment, f.o.b. plant.

FIGURE 3

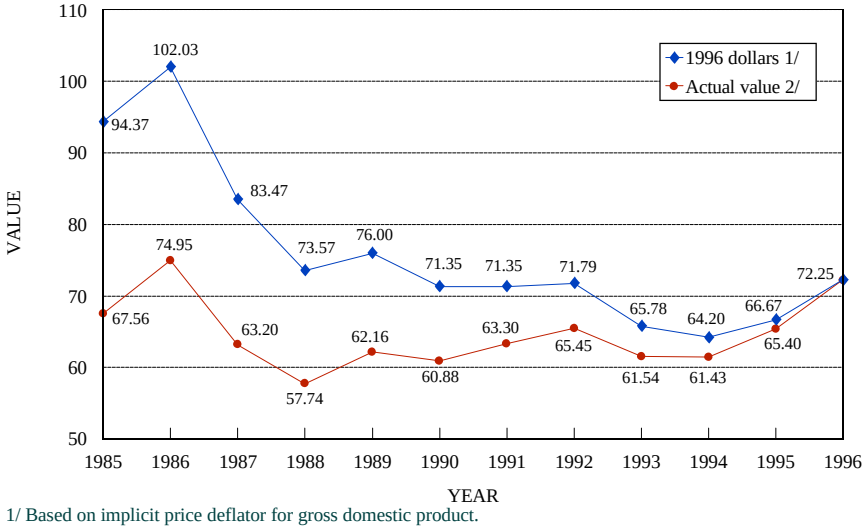
TIME-VALUE RELATIONSHIPS FOR QUICKLIME SOLD
(Dollars per short ton)



1/ Based on implicit price deflator for gross domestic product.
2/ Value of lime sold as prepared for shipment, f.o.b. plant.

FIGURE 4

TIME-VALUE RELATIONSHIPS FOR HYDRATED LIME SOLD
(Dollars per short ton)



1/ Based on implicit price deflator for gross domestic product.
2/ Value of lime sold as prepared for shipment, f.o.b. plant.