A N N U A L   R E P O R T

LIME

By M. Michael Miller

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LIME

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COVER PHOTO:
Five-port Rumford kiln, built in 1804 and modified in 1817, Rüdersdorf, Germany. The kiln was part of a group of five built between 1788 and 1835 of which only two remain. The two remaining kilns are part of an open-air museum covering 27 hectares (67 acres) displaying historical buildings and lime kilns from various technological generations. (Photo courtesy of the National Lime Association, Arlington, VA.)

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LIME

By M. Michael Miller

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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, more than 80% of lime consumed in the United States went for construction uses, but now more than 90% of lime is consumed for chemical and industry uses.

Lime is a basic chemical that ranked fifth in total production in the United States in 1993. It is produced in 33 States and Puerto Rico, and its major uses are in steelmaking; pulp and paper manufacturing; construction; and the treatment of water, sewage, and smokestack emissions.

Total lime sold or used by domestic producers, excluding that from Puerto Rico, increased by about 733,000 metric tons (808,000 short tons) to 16.9 million tons (18.7 million short tons) in 1993. Production included the commercial sale or captive production of quicklime, hydrated lime, and dead-burned refractory dolomite. These products were valued at more than $977 million. Commercial sales increased by 795,000 tons (876,000 short tons) to a record high of 15.1 million tons (16.6 million short tons), while captive production decreased by 62,000 tons (68,000 short tons) from 1992 levels. *(See table 1.)*

DOMESTIC DATA COVERAGE

To comply with Federal law and Executive Order 12770, the U.S. Bureau of Mines (USBM) has decided on the following transition plan for the mandated conversion of the remaining commodity publications not currently being reported in metric units. For the 1993 Commodity Annual Reports and 1994 Mineral Industry Surveys, all data will be published in metric units with an additional total line showing traditional English units. Beginning with the 1994 Commodity Annual Reports and the 1995 Mineral Industry Surveys, all data will be published in metric units only.

Domestic production data for lime are developed by the USBM from two separate, voluntary surveys of U.S. operations. The survey used to prepare this report is the annual "Lime" survey. Of the 118 operations to which the annual survey request was sent, 105 responded, representing 89% of the total sold or used by producers shown in table 2. Production for eight nonrespondents was provided based on the monthly survey. Production for five nonrespondents was estimated using reported prior-year production figures.

BACKGROUND

Definitions and Specifications[1]

Lime is a manufactured product made by calcining limestone (calcium carbonate or a combination of calcium and magnesium carbonate) or other calcium carbonate materials at temperatures ranging from 980° C to 1,300° C (1,800° F to 2,400° F). It is never found in a natural state. The calcination process drives off the carbon dioxide, forming calcium oxide (quicklime). The subsequent addition of water creates calcium hydroxide (hydrated or slaked lime). The term "lime" is a general term that includes the various chemical and physical forms of quicklime and hydrated lime. It may be high calcium, magnesian, or dolomitic. Quicklime is calcium oxide (CaO) with no water of crystallization. Hydrate is hydrated calcium oxide, or calcium hydroxide [$Ca(OH)_2$], and contains 24% combined water. Dead-burned refractory dolomite is dolomite that has been calcined at 1,540° C to 1,730° C (2,800° F to 3,150° F). All of these products are called lime.

Quicklime is commercially available by the carload, in bulk, or in paper bags, in the following standard sizes:

1. *Lump Lime*—the product exceeds 6.4 centimeters (2.5 inches) in diameter. Although sizes can vary, the typical size is 13 by 20 centimeters (5 by 8 inches). This largest size of quicklime is strictly a product of vertical kilns.

2. *Crushed or Pebble Lime*—the product ranges in size from 0.64 centimeter to 5.72 centimeters (0.25 inch to 2.25 inches), but the specific product size is more precise. This size has traditionally been a product of rotary kilns, but is now available from vertical kilns as either a primary product or as a result of crushing lump lime.

3. *Ground Lime*—the product is generally ground from larger size material. A typical product size passes nearly 100% through a No. 8 sieve and 40% to 60% through a No. 100 sieve.

4. *Pulverized Lime*—the product is the result of further grinding. A typical product size passes nearly 100% through a No. 20 sieve and 85% to 95% through a No. 100 sieve. This is usually a secondary product and is produced by intense grinding and classification.

5. *Pelletized Lime*—the pellets or briquets are of uniform 2.5-centimeter (1-inch) size, molded from quicklime fines. Hydrated lime is shipped in bulk tank trucks, rail cars, and in 23-kilogram (50-pound) paper bags. As a result of the hydration process, it is of fine particle size. A typical product size passes 85% or more through a No. 200 sieve, and a few special applications may require a product passing 95% to 98% through a No. 325 sieve.

Because of the differences in limestones, a rigid standardization of lime material specifications is impossible. Few plants manufacture lime with exactly the same properties; as a result, lime specifications are by necessity quite general in their provisions.

Technology[2]

Lime manufacture involves three main processes: stone preparation, calcination, and hydration. Stone preparation involves quarrying or mining (including drilling, blasting, and conveying broken stone), crushing, and screening to provide the proper size kiln feed. Care is taken to avoid contamination with undesirable impurities, such as iron oxide, silica, and alumina. Although most lime manufacturers produce their own stone, some purchase the stone for kiln feed from commercial limestone producers.

Calcination is a simple chemical reaction. It is the addition of heat to limestone to cause thermal decomposition in which the coproducts of CaO (quicklime) and CO_2 (carbon dioxide) are formed. This process is performed in a kiln, of which there are a wide variety of systems in use. The two basic kiln designs are rotary and vertical (or shaft). There are a few other miscellaneous designs, but the majority of commercial kilns are of rotary or vertical design. A rotary kiln is a long cylindrical kiln with a refractory lining, inclined at a slight angle, rotated at a slow speed, and fired by fuel at the lower end. The calcareous raw material (kiln feed) is fed into the upper end and calcined at about 1,100° C (2,000° F) during its travel through the kiln to form quicklime, which is discharged at the lower end. The calcination temperature depends on size and composition of kiln feed and the type of desired product. The carbon dioxide is driven off as a gas and normally exits the system with the stack gas.

Vertical kilns are short, wide, vertical cylinders lined with refractory materials. They are usually circular in cross section, typically with a diameter of 3 to 4 meters (9 to 14 feet) and a height of 15 to 21 meters (50 to 70 feet). They are the most widely employed type in the world, especially in Europe. A vertical kiln is divided into four distinct zones where specific parts of the manufacturing process take place. They are, from top to bottom: (1) stone storage zone, (2) preheating zone, (3) calcining zone, and (4) cooling and discharge zone.

Examples of other kiln designs are the rotary hearth kiln and the fluosolids kiln. The rotary hearth design consists of a preheater, circular hearth, and cooler, all refractory lined. Stone is placed on the hearth and rotated through a heating chamber. In the fluosolids kiln, fine-sized stone is densely suspended by air and hot gases in the preheating and calcining zone of a vertical heated chamber. It can be operated at lower temperatures because of the fine stone size. The quicklime product is the most highly reactive of any commercial lime.

Byproducts and Coproducts

Most lime companies mine their own limestone or dolomite for kiln feed. Some companies also produce as a separate coproduct crushed and pulverized stone. If practical and if markets exist, byproduct fines from the kiln feed preparation process and fugitive lime dust from different stages of the lime production process also may be marketed. Precipitated calcium carbonate (PCC) is produced as a coproduct at three commercial lime plants by combining quicklime with byproduct carbon dioxide recovered from the kiln. Byproduct carbon dioxide is recovered for use in the carbonation step of sugar refining.

Substitutes

Limestone is a low-cost substitute for lime for many uses such as agriculture, fluxing, and flue gas desulfurization (FGD). Limestone contains less reactive material, is slower to react, and may have other disadvantages compared to lime, depending on the use. Calcined gypsum is an alternative material in industrial plasters and mortars. Cement, lime kiln dust, and fly ash are potential resources as substitutes for some construction uses of lime. Alkalis such as caustic soda, soda ash, sodium bicarbonate, sodium sulfate, and magnesium hydroxide are substitutes used in the neutralization stage of water treatment.

Economic Factors

Prices.—Traditionally, lime has been a low-priced commodity. Its average value, as reported to the USBM on an f.o.b. plant basis, ranged from $4 to $15 per short ton from 1910 to 1970. It was only in the 1970's, when energy prices escalated, that lime values showed a progressive and dramatic increase. This steady increase continued into the 1980's, although at a slower pace. In 1987, lime decreased in value for the first time since 1968. When comparing values since 1973, based on constant 1993 dollars, two trends become evident. From 1973 to 1979, values increased every year and were up a total of 49%. From 1979 to 1991, values decreased every year and were down a total of 30%.

Average values for quicklime sold are only available for the past 9 years. During that period the average actual value has been reasonably stable, ranging from $51.10 to $55.48 per ton ($46.36 to $50.33 per short ton). During the past 4 years, the values have been essentially flat.

The average values for hydrated lime sold for the same period have been less stable. The average actual value has ranged from $63.65 to $82.62 per ton ($57.74 to $74.95 per short ton). During the past 5 years, however, the values have been relatively stable. *(See figures 1, 2, 3, and 4.)*

Costs.—Production costs in lime manufacture can be divided, in descending order, into the following categories: energy (mainly fuel costs), kiln feed, dust collection, depreciation, direct labor, and miscellaneous. The ranking may differ from plant to plant, and most of the categories display a great range in costs from one plant to another. The difference in ranking and the range in costs are accounted for by such variables as distance from fuel sources; thermal efficiency of individual kilns; whether kiln feed is quarried, mined underground, or purchased; electrical energy rates; and age of the plant.[3]

Tariffs.—In the Harmonized Tariff Schedule of the United States, quicklime, slaked lime (hydrate), and hydraulic lime are listed under 2522.10, 2522.20, and 2522.30, respectively. Imports are free from countries with most-favored-nation (MFN) status, Mexico, and Canada. Non-MFN countries have tariffs of 0.2¢ per kilogram (about $2.20 per short ton) for quicklime, 0.3¢ per kilogram (about $3.31 per short ton) for slaked lime, and 0.2¢ per kilogram (about $2.20 per short ton) for hydraulic lime.

ANNUAL REVIEW

Legislation and Government Programs

Under authority of the Clean Water Act, as amended, the Environmental Protection Agency (EPA) released its final regulations establishing standards for the use of disposal of sewage sludge. The regulations provide requirements for sewage sludge applied to the land for a beneficial purpose, for sewage sludge disposed of on surface disposal sites, and for sewage sludge when incinerated. In section 503.32 of the Clean Water Act, an acceptable alternative for reduction of pathogens in sewage sludge is to raise the pH of the sewage sludge to above 12 for 72 hours. In appendix B to part 503—Pathogen Treatment Processes, lime stabilization is mentioned under Processes To Significantly Reduce Pathogens, where it states that "Sufficient lime is added to the sewage sludge to raise the pH of the sewage sludge to 12 after 2 hours of contact."[4]

The EPA finalized all or portions of five core regulations for the Acid Rain Program of title IV of the Clean Air Act, as amended. The regulations addressed General Provisions and Permits, the Allowance System, Continuous Emissions Monitoring, Excess Emissions, and Administrative Appeals. "Title IV of the Act requires EPA to establish an Acid Rain Program and a national emissions cap of 8.11 million metric tons (8.95 million short tons) per year on electric utility SO_2 emissions to be implemented in two phases. Phase I (beginning in 1995) requires the 110 highest-emitting utility plants to meet an intermediate SO_2 emissions limitation. By the year 2000 (in which Phase II begins) virtually all other utility units with output capacity greater than 25 megawatts and all new utility units will be required to meet emissions limitations as well. Total annual SO_2 emissions will be reduced by 9.1 million metric tons (10 million tons) below 1980 levels beginning in the year 2000, a reduction of total SO_2 emissions of approximately 40%."[5]

Phase I requirements have already translated into increased lime demand for flue gas desulfurization. In 1993, lime consumption for this use increased by 16% when compared with 1992 levels and 18% when compared with 1990 levels. The large increase in 1993 is probably explained by the lag time between passage of the Clean Air Act and installation of new SO_2 scrubbers at utility powerplants seeking to comply with Phase I.

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 ($CaO \cdot MgO$); two types of dolomitic hydrate, (4) type N [$Ca(OH)_2 \cdot MgO$] and (5) type S [$Ca(OH)_2 \cdot Mg(OH)_2$]; and (6) dead-burned dolomite. Nondolomitic quicklime and hydrated lime may be called high-calcium lime. Lime can be produced from a variety of calcareous materials such as aragonite, chalk, coral, marble, and shell. Lime also is 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.

Total U.S. lime production from limestone, including that of Puerto Rico, increased by 4.5% compared to that of 1992. Commercial lime sold by producers increased by 5.5%, and captive lime used by producers decreased by 3.3%.

In 1993, 69 companies produced lime. Leading producing companies, in descending order, were Dravo Lime Co., with two plants in Kentucky and one plant in Alabama; Mississippi Lime Co. in Missouri; Marblehead Lime Co., with two plants in Illinois and one each in Indiana and Michigan; Chemstar Inc., with two plants each in Arizona, California, and Nevada and one each in Idaho and Utah; Continental Lime Inc., with one plant each in Montana, Nevada, Utah, and Washington; Allied Lime Co., with two plants in Alabama; Martin Marietta Magnesia Specialties in Ohio; APG Lime Co., with one plant each in Texas and Virginia; Texas Lime Co., with two plants in Texas; and Chemical Lime Inc., with two plants in Texas. These 10 companies operated 28 plants and accounted for 58% of total lime production. *(See tables 2 and 3.)*

Continued changes in the industry were

reflected by announcements of restructuring, name changes, sales, closures, plant openings, construction plans, and large utility FGD contracts. Mississippi Lime Co. restructured itself and formed North American Lime Co., which includes Mississippi Co. (Ste. Genevieve, MO), Bluff City Minerals Co. LP (Alton, IL), Eastern Ridge Lime Co. LP (Ripplemead, VA), and Prairie du Rocher Lime Co. LP (Prairie du Rocher, IL).[6] Prairie du Rocher Lime Co. LP is a new lime plant under construction in Illinois about 13 kilometers (8 miles) north of Mississippi Lime's Ste. Genevieve operations. Effective October 1, 1993, Ohio Lime Co. changed its name to Redland Ohio Inc. to reflect the acquisition of its parent Steetley PLC by Redland PLC in 1992.[7] Tenn Luttrell Co., Luttrell, TN, was sold by Penn Virginia Corp. to Global Stone Corp., Vancouver, British Columbia, Canada, for a reported $24.15 million. Subsequent to the sale, Tenn Luttrell announced plans to install two 300-ton-per-day (330-short-ton) Cimprogetti vertical kilns, one due on-stream in mid-1995 and the second in mid-1997.[8] Warner Co., a long-established producer of dolomitic lime products in southeastern Pennsylvania, closed and was put up for sale by its parent company Chemical Waste Management.[9] Early in the year, Wyoming Lime Producers started up its lime plant at Frannie, WY, and began producing from its 363-ton-per-day (400 short tons) Kennedy Van Saun preheater rotary. Wyoming Lime Producers is a part of Dakota Coal Co., which is in turn a subsidiary of Basin Electric Power Cooperative.[10] Western Lime & Cement Co. completed installation of a second preheater rotary kiln at its lime plant in Green Bay, WI. The new kiln went on-line in early summer 1993.[11] Dravo Lime Co. was awarded the contract to supply lime for FGD to the General James M. Gavin power station in southeastern Ohio. The 15-year contract will require about 408,000 tons per year (450,000 short tons) of magnesium-enhanced lime beginning in 1995. To meet the demand, Dravo plans to expand production capacity at its Maysville and Black River Divisions in Kentucky.[12] *(See table 4.)*

Consumption and Uses

Lime was consumed in every State. The breakdown of consumption by major end uses was as follows: 64% for chemical and industrial uses, 25% for environmental uses, 10% for construction uses, and 2% for refractory dolomite. Captive lime was used mainly in sugar refining and in the production of steel in basic oxygen furnaces.

In steel refining, quicklime was used as a flux to remove impurities such as phosphorus, silica, and sulfur. Dolomitic lime was 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 steel industry increased by nearly 3% to 5.1 million tons (5.6 million short tons) and 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. 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 dangerous hydrogen cyanide gas.

In the environmental sector, lime was used in the softening and clarification of municipal potable water. In sewage treatment, lime was used 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. Lime was used to neutralize acid mine and industrial discharges. In FGD systems serving utility and industrial plants, lime was used to react with sulfur oxides in the flue gas. Lime was used to stabilize sludge from desulfurization plants before disposal.

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 was used to make precipitated calcium carbonate (PCC), a specialty pigment 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 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 cyanide. Lime was used to make calcium hypochlorite, citric acid, petrochemicals, and other chemicals.

In sugar refining, milk-of-lime, a suspension of hydrated lime in water, 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. 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.

Begun in 1992, a tour demonstrating the manufacture and use of autoclaved cellular concrete (ACC) blocks continued in 1993. ACC or autoclaved aerated concrete is a common concrete building material in Europe and other parts of the world. The tour planned to visit eight utility companies to demonstrate the production of ACC blocks using fly ash and to show how the blocks can be used. The demonstrations were aimed at builders, architects, building inspector, masons, developers, and others. The raw material mix in this ACC product contained 20% lime, although other autoclaved aerated concretes may utilize portland cement instead.

Specific patented manufacturing processes differ, but the process involved in the demonstration tour used sand or fly ash, lime, portland cement, aluminum powder, and water. These raw materials were mixed together and the resulting slurry poured into molds. This slurry expands and hardens, at which point it is cut into blocks or panels and then autoclaved for 12 hours. The resulting materials are lightweight, fire resistant, provide good thermal and sound insulation, and have good structural properties.[13] *(See table 5.)*

Prices

The average value of lime sold or used by producers, as reported to the USBM on an f.o.b. plant basis, decreased in 1993 to $57.83 per ton ($52.46 per short ton). Average values per ton were $56.11 ($50.90 per short ton) for chemical and industrial lime, $58.15 ($52.75 per short ton) for environmental lime, $63.34 ($57.46 per short ton) for construction lime, $73.42 ($66.61 per short ton) for agricultural lime, and $83.17 ($75.45 per short ton) for refractory dolomite.

The average value of quicklime sold decreased to $55.02 per ton ($49.91 per short ton). Average values per ton were $54.32 ($49.28 per short ton) for chemical and industrial lime, $55.54 ($50.39) for environmental lime, $54.74 ($49.66 per short ton) for construction lime, $111.40 ($101.06 per short ton) for agricultural lime, and $81.18 ($73.65 per short ton) for refractory dead-burned dolomite.

The average value of hydrated lime sold decreased to $67.84 per ton ($61.54 per short ton). Average values per ton were $64.28 ($58.31 per short ton) for chemical lime, $70.63 ($64.07 per short ton) for environmental lime, $67.52 ($61.25 per short ton) for construction lime, and $72.55 ($65.82 per short ton) for agricultural lime.

Transportation

The following is a clarification of the Department of Transportation regulations covering the transportation of hazardous materials (HRM-181), 49 CFR 171-180. The regulations refer only to lime (calcium oxide) shipped by air. The listing "UN 1910, Quicklime, Calcium Oxide" is to be used only on air shipments. For standard truck, rail, or barge shipments, the term "Quicklime, Calcium Oxide" is proper.[14]

Foreign Trade

According to the Bureau of the Census, exports of lime increased by 18% to 69,045 tons (76,109 short tons). Imports of lime increased by 4% to 200,587 tons (221,109 short tons). Most U.S. trade was with Canada and Mexico, which together accounted for nearly 100% of the U.S. exports and imports of lime. Canada was the major trading partner, receiving 74% of U.S. exports and shipping 95% of U.S. imports. *(See tables 6 and 7.)*

World Review

Canada.—Preliminary figures for 1993 put Canada's production at 2.45 million tons (2.70 million short tons) at a value of $201 million. This consisted of 2.26 million tons (2.49 million short tons) of quicklime valued at $181 million and 0.186 million tons (0.205 million short tons) of hydrated lime valued at $19.3 million.

European Union.[15]—The overall economy has depressed lime demand in most traditional markets, such as steel and construction. There was some variation in individual country markets. Eastern Germany's construction boom has increased demand for lime, mainly for production of sand-lime brick and aerated concrete products. Road and rail construction projects in France and Germany have increased demand for lime for soil stabilization. Lime demand for PCC production has grown in Scandinavia.

As environmental regulations have grown more stringent, the demand for lime has increased for various environmental uses. Lime usage has encountered difficulties in water treatment owing to sludge disposal restrictions that increase total treatment costs. The utility FGD market has grown some, but most FGD systems are limestone based. In addition, nuclear power and natural gas play a more significant role in Europe's current and future power generation plans. Some growth potential is seen in FGD treatment of incinerator gases.

Germany.—German consumption has been increasing in recent years but production has remained relatively flat. The increased demand has been met primarily by imports from the Czech Republic, Slovak Republic, and the former U.S.S.R.[16]

In 1993, Rheinisch-Westfälische Kalkwerke AG (RWK) transferred its business operations to a newly formed company called RWK Kalk AG. RWK Kalk AG was merged with Belgium's Lhoist Group's French and Czech operations to form Chaufourneries de Hergenrath SA. The new company will operate six plants in Germany, five in France, and one in the Czech Republic.[17]

United Kingdom.[18]—The lime industry continued to be impacted by the European recession, with both capacity utilization and profits at low levels. Buxton Lime Industries Ltd. is the largest producer, operating lime plants at Hindlow and Tundstead. Other United Kingdom producers included Singleton Birch Ltd., Tilcon Ltd., and British Steel PLC. Totternhoe Lime & Stone Co. Ltd. discontinued quicklime production in early 1993 and now purchases quicklime and hydrates it for regional customers. Owing to poor market conditions, the joint venture between Tilcon Ltd. and the Calcitherm-Carmeuse Group of Belgium has been put on hold. The two companies had announced in 1991 plans to construct lime production facilities and to market quicklime and hydrated lime in the United Kingdom. *(See table 8.)*

Current Research

Research by a group at the University of Western Australia has demonstrated a process for destroying polychlorinated biphenyls (PCB's) and other toxic organic compounds utilizing a conventional ball mill and quicklime. The organic compound is fed along with quicklime into a mill containing 12-millimeter-diameter (0.5-inch-diameter) steel balls. The milling process converts almost all of the organic material into carbon, calcium chloride, and calcium hydroxide. In laboratory tests, a pure sample of PCB mixed with quicklime was milled for 12 hours and produced a mixture containing only 5 parts per million of PCB. The codeveloper, Australian mining company CRA Ltd., will commercialize the process.[19]

In Germany, Solvay Umweltchemie GmbH has run pilot plant tests on a process to dispose of asbestos fibers by dissolving ground asbestos in a 40% solution of hydrofluoric acid. When the reaction is complete, the solution is neutralized by adding 20% hydrated lime. The estimated disposal costs in a commercial plant are expected to be competitive with current techniques that require cement fixing before final disposal.[20]

In Canada, research funded by the Ministère de l'Environment du Quebéc, Environment Canada-St. Lawrence Centre, and Groupe Olymel, was conducted on the use of lime to treat slaughterhouse sludge wastes for land application. The slaughterhouses produce a sludge waste generated by the use of a dissolved air flotation process for pretreatment of their wastewater. This sludge contains pathogens (bacteria, viruses, protozoa, and parasitic worms), heavy metals, and other contaminants. In a bench experiment, lime was applied to samples of the sludge at various concentrations, with the best results coming from the application of 150 kilograms (331 pounds) of calcium oxide equivalent per ton dry weight of sludge. This allows the maintenance of a pH of 12 or greater for several weeks. The experiment resulted in a major reduction of pathogens, heavy-metal content, and offensive odors. The resulting product was deemed suitable for application to agricultural land.[21]

OUTLOOK

Lime has dozens of end uses in the chemical, industrial, and construction industries. Steelmaking is still the largest single end use for lime, accounting for 30% of consumption. The steel industry's consumption of lime increased by nearly 3% when compared with 1992 levels. Steel output increased by more than 5% in 1993 and should continue to increase modestly in the short term as economic growth continues. Integrated steel mills operated at 96% of capacity in 1993 and are forecast to operate at 97% of capacity in 1994 and 98% of capacity in 1995. Consumption of lime by the steel industry has been relatively flat in the recent past, but the growing economy should translate into increased lime consumption for the next few years.

Construction markets, primarily for the soil stabilization, grew by about 25% in 1993. Barring long periods of bad weather, the construction markets should continue a strong showing. Soil stabilization and asphalt paving should be the driving forces in the construction markets.

The FGD market showed a dramatic increase in 1993 and is expected to show even greater growth in next few years. The deadline for Phase I compliance with the Clean Air Act Amendments is January 1, 1995, which means utility companies will have to have their compliance strategies in place by the end of 1994. Three midwestern powerplants have announced their plans to use lime in newly installed scrubbers beginning in 1995. These plants alone will consume about 725,000 to 815,000 tons (800,000 to 900,000 short tons) per year. This will mean an increase of 40% to 45% above current FGD consumption levels. Additional growth is expected from the utility industry, and longer term increases could materialize from the use of lime in dry scrubbers used with small nonutility boilers. Consumption of lime for FGD will likely top 3 million tons (3.3 million short tons) in the next 3 to 5 years, and increase even more when Phase II of the Clean Air Act Amendments goes into effect.

Other environmental markets as a whole were up nearly 4%, spurred by acid-water neutralization's surprising 35% increase. The sewage treatment market grew by nearly 6%, which probably reflects the expected growth in the sewage sludge stabilization market. The only significant environmental market that exhibited a drop was the water purification market, which decreased by 3%. Despite occasional variations in yearly consumption patterns, the individual environmental markets should remain strong, with the greatest potential for growth in sewage sludge stabilization.

Both the traditional pulp and paper market and precipitated calcium carbonate increased in 1993. In pulp mills, lime is used for water treatment and to causticize waste sodium carbonate solution to regenerate sodium hydroxide (caustic soda). Paper industry analysts project a 2.7% increase in paper production and a 3.2% increase in paperboard production in 1994. Demand for paper depends on the health of the economy and the strength of the U.S. dollar against foreign currencies. The weakening of the U.S. dollar against foreign currencies may slow imports and increase exports of paper products, increasing production even more. Increased consumption of paper products, driven by a stronger U.S. economy, should translate into greater consumption of lime for precipitated calcium carbonate production.

Lime consumption by the gold industry decreased significantly in 1993. Gold production is forecasted to remain flat over the next 2 to 3 years and then increase by about 5%. The gold boom may be over owing to the changed political climate and growing antimining sentiments, but current mining and mines in development should continue to provide a solid regional market.

The three chemical caustic soda plants constructed in recent years have been shut down owing to low prices. When operating, one plant purchases 100% of required lime and the other two regenerate lime, needing only to purchase makeup lime. Some forecasts now call for caustic soda supplies to tighten and for prices to climb back to the $250 to $300 level. As a result, the chemical caustic plants may reopen in late 1994 or in 1995. In addition to the three companies with idle plants, other companies have been considering building chemical caustic plants. The chemical caustic industry could still develop into a regional market for lime, but it will depend entirely on the price of caustic.

A couple of years ago, a major manufacturer of propylene oxide had proposed replacing caustic soda with hydrated lime in the dehydrochlorination stage of the production process. The company shelved the proposal with the precipitous drop in caustic soda prices. With the expected rise in caustic soda prices, the proposal may be dusted off and reconsidered. If the company proceeded with the substitution, it would require about 450,000 tons (500,000 short tons) of hydrated lime per year.

A small boost to the Mississippi River region market is expected by the end of 1994 when Vicksburg Chemical Co. begins production of potassium carbonate (K_2CO_3) at its new plant at Vicksburg, MS. The plant will utilize a patented ion-exchange process where potassium chloride, quicklime, and carbon dioxide will be used to produce K_2CO_3 and calcium chloride. The plant will require about 10,000 tons (11,000 short tons) of lime per year.

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[18]Pages 35-36 of work cited in footnote 5.

[19]Chemical Engineering. Milling Destroys PCBs and Other Chlorinated Organics. Chementator. V. 101. No. 6, June 1994, p. 23.

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TABLE 1
SALIENT LIME STATISTICS

(Thousand metric tons unless otherwise specified)[1]

		1989	1990	1991	1992	1993
United States:[2]						
Number of plants		115	113	112	112	112
Sold or used by producers:						
Quicklime		13,154	13,392	13,191	[r]13,665	14,266
Hydrated lime		2,040	2,098	2,168	[r]2,232	2,353
Dead-burned dolomite		365	342	308	302	315
Total[3]		15,560	15,832	15,667	[r]16,199	16,932
Total	thousand short tons	17,152	17,452	17,270	[r]17,856	18,664
Value[4]	thousands	$852,113	$901,549	$890,482	$949,674	$977,079
Average value per ton		$54.76	$56.94	$56.84	$58.63	$57.71
Lime sold		13,622	14,014	13,848	[r]14,306	15,101
Lime used		1,937	1,818	1,819	1,893	1,831
Exports[5]		29	49	47	59	69
Imports for consumption[5]		[r]197	157	158	193	201
Consumption, apparent[6]		15,530	15,940	15,778	[r]16,333	17,064
World: Production		[r]139,946	[r]135,592	[r]131,598	[r]125,955	[e]124,395

[e]Estimated. [r]Revised.

[1]To convert metric tons to short tons multiply metric tons by 1.10231 or divide metric tons by 0.907185.

[2]Excludes regenerated lime. Excludes Puerto Rico.

[3]Data may not add to totals shown because of independent rounding.

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

[5]Bureau of the Census.

[6]Calculated by sold or used plus imports minus exports.

TABLE 2

LIME SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY STATE[1]

State	1992 Plants	1992 Hydrated[2] (thousand metric tons)	1992 Quicklime[2] (thousand metric tons)	1992 Total[2 3] (thousand metric tons)	1992 Value (thousands)	1993 Plants	1993 Hydrated[2] (thousand metric tons)	1993 Quicklime[2] (thousand metric tons)	1993 Total[2 3] (thousand metric tons)	1993 Value (thousands)
Alabama	4	156	1,298	1,454	$82,619	4	178	1,447	1,625	$89,457
Arizona, Nevada, Utah	9	168	[r]1,350	[r]1,518	88,889	8	199	1,410	1,610	72,354
California	10	[r]47	[r]207	254	18,072	9	22	171	193	14,751
Colorado, Montana, Wyoming	9	—	363	363	21,709	10	—	369	369	24,168
Idaho, Oregon, Washington	8	[r]63	[r]422	[r]486	35,672	8	17	547	565	40,915
Illinois, Indiana, Missouri	8	490	[r]2,675	[r]3,165	[r]174,458	8	455	2,734	3,189	175,165
Iowa, Nebraska, South Dakota	5	W	W	250	15,222	5	W	W	235	14,428
Kentucky, Tennessee, West Virginia	5	109	1,689	1,797	100,963	5	129	1,725	1,854	104,929
Michigan	8	27	[r]549	577	31,253	8	25	572	596	30,926
North Dakota	3	—	[r]100	[r]100	4,288	3	—	101	101	4,512
Ohio	9	W	W	1,670	96,739	9	W	W	1,699	100,721
Pennsylvania	9	256	1,250	1,506	94,543	9	286	1,248	1,535	95,377
Puerto Rico	1	27	—	27	3,717	1	27	—	27	3,653
Texas	7	495	842	1,337	83,359	8	627	978	1,604	103,274
Virginia	5	124	[r]639	764	40,271	5	117	639	756	40,039
Wisconsin	4	110	363	[r]472	26,579	4	116	395	511	30,880
Other[3]	9	[r]187	[r]2,220	[r]488	[r]35,042	9	181	2,244	489	35,183
Total[2]	113	[r]2,259	13,967	[r]16,226	953,391	113	2,380	14,581	16,959	980,732
Total thousand short tons	XX	[r]2,490	15,396	[r]17,886	XX	XX	2,624	16,073	18,694	XX

[r]Revised. W Withheld to avoid disclosing company proprietary data; included with "Other." XX Not applicable.
[1]Excludes regenerated lime. Includes Puerto Rico.
[2]To convert metric tons to short tons multiply metric tons by 1.10231 or divide metric tons by 0.907185.
[3]Data may not add to totals shown because of independent rounding.
[4]Includes Arkansas, Louisiana, Massachusetts, Minnesota, Oklahoma, and data indicated by the symbol W.

TABLE 3

LIME SOLD OR USED BY PRODUCERS IN THE UNITED STATES,[1] BY RANGE OF PRODUCTION

Range of production	1992 Plants	1992 Quantity[2] (thousand metric tons)	1992 Percent of total	1993 Plants	1993 Quantity[2] (thousand metric tons)	1993 Percent of total
Less than 10,000 tons	11	[r]74	([3])	10	70	([3])
10,000 to 25,000 tons	21	351	2	20	330	2
25,000 to 50,000 tons	14	[r]490	3	11	340	2
50,000 to 100,000 tons	14	910	6	22	1,623	10
100,000 to 200,000 tons	23	2,892	18	17	2,138	13
200,000 to 400,000 tons	21	5,423	33	22	5,489	32
More than 400,000 tons	9	6,086	38	11	6,970	41
Total[4]	113	[r]16,226	100	113	16,959	100
Total thousand short tons	XX	[r]17,886	XX	XX	18,694	XX

[r]Revised. XX Not applicable.
[1]Excludes regenerated lime. Includes Puerto Rico.
[2]To convert metric tons to short tons multiply metric tons by 1.10231 or divide metric tons by 0.907185.
[3]Less than 1/2 unit.
[4]Data may not add to totals shown because of independent rounding.

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

(Thousand metric tons)[2]

State	1992 Quicklime	1992 Hydrated lime	1992 Total[3]	1993 Quicklime	1993 Hydrated lime	1993 Total[3]
Alabama	580	22	601	661	47	708
Alaska	—	2	2	5	1	6
Arizona	302	41	343	321	47	368
Akransas	110	23	133	124	25	149
California	333	88	421	343	67	410
Colorado	141	28	169	156	32	189
Connecticut	19	4	23	22	2	24
Delaware	8	2	10	17	2	19
District of Columbia	19	23	42	8	8	16
Florida	387	20	407	400	22	422
Georgia	219	72	291	216	86	302
Hawaii	([4])	([4])	([4])	—	([4])	([4])
Idaho	[r]113	40	[r]153	162	2	163
Illinois	496	165	660	504	161	664
Indiana	1,320	31	1,350	1,404	31	1,435
Iowa	59	26	85	56	25	81
Kansas	73	28	101	89	21	110
Kentucky	355	38	393	374	39	414
Louisiana	230	98	328	228	86	313
Maine	([4])	([4])	([4])	4	([4])	4
Maryland	107	13	121	124	17	141
Massachusetts	159	13	172	143	12	155
Michigan	868	35	903	879	32	911
Minnesota	293	17	310	284	17	300
Mississippi	173	13	186	187	16	204
Missouri	140	62	203	166	58	223
Montana	159	13	172	122	9	131
Nebraska	57	12	69	54	10	65
Nevada	[r]321	25	[r]345	415	36	451
New Hampshire	—	([4])	([4])	2	([4])	2
New Jersey	123	17	139	115	20	135
New Mexico	130	29	159	130	52	182
New York	78	24	102	87	26	113
North Carolina	181	42	222	202	43	245
North Dakota	230	7	237	250	3	253
Ohio	1,664	119	1,783	1,743	139	1,882
Oklahoma	113	10	124	120	9	129
Oregon	141	22	163	130	18	148
Pennsylvania	1,525	206	1,731	1,537	203	1,740
Rhode Island	6	1	7	8	1	9
South Carolina	185	23	209	191	48	239
South Dakota	21	1	22	19	1	20
Tennessee	192	56	247	193	48	241
Texas	844	505	1,349	925	613	1,538
Utah	[r]279	18	[r]297	263	21	284

See footnotes at end of table.

TABLE 4—Continued

DESTINATION OF SHIPMENTS OF LIME SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY STATE[1]

(Thousand metric tons)[2]

State	1992			1993		
	Quicklime	Hydrated lime	Total[3]	Quicklime	Hydrated lime	Total[3]
Virginia	172	41	213	205	56	261
Washington	215	17	232	231	12	243
West Virginia	467	60	527	421	52	473
Wisconsin	135	44	179	136	43	179
Wyoming	r148	18	r167	124	15	140
Total[3]	13,888	r2,216	r16,104	14,500	2,335	16,835
Puerto Rico	(4)	22	22	—	21	21
Canada	49	14	63	55	16	71
Other[5]	30	7	37	25	8	32
Total[3]	80	43	122	80	45	124
Grand total[3]	r13,967	r2,259	r16,226	14,581	2,380	16,959
Grand total thousand short tons	r15,396	r2,490	r17,886	16,073	2,624	18,694

rRevised.

1Excludes regenerated lime.

2To convert metric tons to short tons multiply metric tons by 1.10231 or divide metric tons by 0.907185.

3Data may not add to totals shown because of independent rounding.

4Less than 1/2 unit.

5Includes other countries and U.S. possessions.

TABLE 5

LIME SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE[1]

(Thousand metric tons and thousand dollars)[2]

Use	1992				1993			
	Sold	Used	Total[3]	Value	Sold	Used	Total[3]	Value
Agriculture	26	—	26	1,867	19	—	19	1,429
Chemical and industrial:								
Alkalies	W	W	155	8,249	W	W	129	6,201
Aluminum and bauxite	157	—	157	9,314	157	—	157	9,095
Copper ore concentration	W	W	W	23,086	W	W	W	20,198
Food products, animal or human	20	—	20	1,516	25	—	25	1,943
Glass	108	—	108	5,639	109	—	109	6,646
Oil well drilling	12	—	12	737	17	—	17	1,064
Oil and grease	35	—	35	3,107	46	—	46	4,616
Ore concentration, other	367	—	367	20,341	293	—	293	16,902
Paper and pulp	W	W	1,022	57,706	W	W	1,185	69,275
Petrochemicals	56	—	56	4,366	60	—	60	4,870
Precipitated calcium carbonate	W	W	386	21,253	473	9	481	25,937
Steel:								
Basic oxygen furnaces	W	W	3,833	206,648	W	W	3,527	191,431
Electric arc furnaces	805	—	805	47,001	1,207	—	1,207	61,611
Argon oxygen decarburization	88	—	88	4,827	96	—	96	5,236
Ladle desulfurization, iron or steel	95	—	95	[r]5,371	116	—	116	6,379
Other	[r]178	—	[r]178	[r]9,169	193	—	193	11,001
Total steel:	1,166	W	4,999	273,016	1,612	W	5,139	275,658
Sugar refining	27	610	637	37,408	33	669	701	44,595
Tanning	[r]19	—	[r]19	1,279	21	—	21	1,476
Other[4]	[r]7,012	1,128	[r]2,743	[r]145,381	6,321	956	2,438	117,492
Total[3]	8,979	1,737	10,717	612,336	9,167	1,634	10,801	605,968
Construction:								
Asphalt paving	98	—	98	5,661	117	—	117	6,844
Finishing lime	51	—	51	3,901	46	—	46	3,459
Mason's lime	([5])	([5])	136	10,018	([5])	([5])	164	11,237
Soil stabilization	856	—	856	53,280	1,111	—	1,111	68,852
Other	[r]175	—	[r]175	18,726	193	—	193	12,923
Total[3]	([5])	([5])	[r]1,317	[r]91,587	([5])	([5])	1,631	103,315
Environmental:								
Acid water, mine or plant	279	2	281	17,027	377	2	378	23,283
Flue gas sulfur removal	1,545	—	1,545	[r]86,771	1,787	—	1,787	100,163
Industrial solid waste treatment	41	—	41	2,399	34	—	34	1,964
Industrial wastewater treatment	51	—	51	3,047	39	—	39	2,318
Scrubber sludge solidification	54	—	54	3,031	53	—	53	2,985
Sewage treatment	467	1	468	29,548	491	2	494	30,682
Water purification	1,060	—	1,060	60,995	1,028	—	1,028	61,281
Other	[r]365	—	[r]365	19,554	361	17	378	21,126
Total[3]	3,863	3	3,866	222,371	4,171	([5])	4,191	243,802
Refractory lime (dead-burned dolomite)	([5])	([5])	302	25,230	([5])	([5])	315	26,218
Grand total[3]	[r]14,333	1,893	[r]16,226	953,391	15,128	1,831	16,959	980,732
Grand total thousand short tons	[r]15,799	2,087	[r]17,886	XX	16,676	2,018	18,694	XX

[r]Revised. W Withheld to avoid disclosing company proprietary data. XX Not applicable.

[1]Excludes regenerated lime. Includes Puerto Rico.

[2]To convert metric tons to short tons multiply metric tons by 1.10231 or divide metric tons by 0.907185.

[3]Data may not add to totals shown because of independent rounding.

[4]Includes briquetting, brokers, calcium carbide, chrome, citric acid, commercial hydrators, desiccants, ferroalloys, fiberglass, glue, insecticides, magnesia from seawater or brine, magnesium metal, metallurgy, pelletizing, pharmaceuticals, rubber, silica brick, soap, and uses indicated by symbol W in "Chemical and industrial" lime only.

[5]Withheld to avoid disclosing company proprietary data; included in "Grand total."

TABLE 6

U.S. EXPORTS OF LIME

	Quantity[1] (metric tons)	Value[2] (thousands)
1989	29,249	$3,893
1990	48,842	6,145
1991	46,891	6,058
1992	58,513	7,540
1993	69,045	7,825

[1]To convert metric tons to short tons multiply metric tons by 1.10231 or divide metric tons by 0.907185.
[2]F.a.s. value.

Source: Bureau of the Census.

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF LIME

	Quicklime		Hydrated lime		Total[1]	
	Quantity[2] (metric tons)	Value[3] (thousands)	Quantity[2] (metric tons)	Value[3] (thousands)	Quantity[2] (metric tons)	Value[3] (thousands)
1989	136,825	$7,841	60,629	$4,127	197,454	$11,968
1990	98,725	6,222	58,396	4,171	157,122	10,392
1991	110,384	7,227	47,399	3,841	157,784	11,068
1992	151,918	11,322	40,877	3,661	192,795	14,983
1993	155,119	9,998	45,468	3,301	200,587	13,299

[1]Data may not add to totals shown because of independent rounding.
[2]To convert metric tons to short tons multiply metric tons by 1.10231 or divide metric tons by 0.907185.
[3]Customs value.

Source: Bureau of the Census.

TABLE 8
QUICKLIME AND HYDRATED LIME, INCLUDING DEAD-BURNED DOLOMITE: WORLD PRODUCTION, BY COUNTRY[1]

(Thousand metric tons)

Country[2]	1989	1990	1991	1992	1993[e]
Algeria (hydraulic)	27	32	61	[r] [e]62	62
Australia[e]	1,500	1,500	1,500	1,500	1,500
Austria	1,622	1,637	[e]1,600	[r]1,716	1,700
Belgium	1,968	2,076	2,021	[r]1,871	1,750
Belize[e]	[3]1	1	1	1	1
Bosnia-Herzegovina[e]	—	—	—	[r]50	50
Botswana	—	([4])	([4])	[e]([4])	([4])
Brazil[e]	[e]5,730	5,700	[r]5,700	[r]5,700	5,700
Bulgaria	[r]1,538	[r]1,557	[r]1,034	[r] [e]1,000	1,000
Burundi	([4])	([4])	([4])	[r]([4])	([4])
Canada	2,552	[r]2,341	[r]2,375	[r]1,456	1,495
Chile (hydraulic)[e]	1,300	1,300	1,200	1,300	1,300
China[e]	15,966	17,000	18,500	19,000	19,500
Colombia[e]	1,300	1,300	1,300	[r] [e]671	700
Congo	([4])	([4])	([4])	[r]([4])	([4])
Costa Rica[e]	10	[r]13	[3]9	9	10
Croatia[e]	—	—	—	[r]200	200
Cuba[e]	180	180	180	160	180
Cyprus (hydrated)	7	7	7	[r]6	6
Czech Republic[5]	—	—	—	—	2,500
Czechoslovakia[6]	3,346	3,120	3,230	[e]3,000	—
Denmark (sales)	[r]131	[r]134	[r]156	[r]163	160
Dominican Republic[e]	18	4	—	—	—
Egypt[e]	95	68	[3]749	749	749
Ethiopia	([4])	([4])	([4])	[e]([4])	([4])
Fiji	[e]2	—	—	—	—
Finland (sales)	224	225	225	[r]241	250
France[e]	[3]3,084	3,000	3,000	3,000	3,000
Germany:					
Eastern states	3,407	[e]3,000	—	—	—
Western states	7,033	6,893	—	—	—
Total	10,440	[e]9,893	7,532	[r]7,542	7,500
Guadeloupe[e]	5	5	5	5	5
Guatemala[e]	[3]79	75	[r]72	70	70
Hungary	878	831	[r]571	[r]446	300
India[e]	790	800	[r]820	850	860
Iran[e]	650	650	650	650	650
Ireland	111	112	110	[r]110	100
Israel	[e]180	230	208	[e]208	208
Italy[e] [7]	3,900	3,850	[r]3,800	3,600	3,600
Jamaica[e]	90	90	95	[r] [3]179	200
Japan (quicklime only)	8,486	8,983	[r]9,045	[r]8,049	8,000
Jordan	3	5	5	[r]7	7
Kenya	32	14	[r]12	[r] [e]12	12
Korea, Republic of [e]	230	230	240	240	250
Kuwait	65	50	5	[r] [e]5	35
Lebanon[e]	10	10	10	15	15
Libya[e]	260	260	260	260	260
Macedonia[e]	—	—	—	[r]20	20

See footnotes at end of table.

TABLE 8—Continued

QUICKLIME AND HYDRATED LIME, INCLUDING DEAD-BURNED DOLOMITE: WORLD PRODUCTION, BY COUNTRY[1]

(Thousand metric tons)

Country[2]	1989	1990	1991	1992	1993[e]
Malawi	3	4	[e]4	[e]4	4
Martinique[e]	5	5	5	5	5
Mauritius[e]	7	7	7	7	7
Mexico[e]	6,000	6,000	6,500	6,500	6,500
Mongolia[e]	95	103	[r]76	[r]50	55
New Zealand[e]	100	100	90	100	100
Nicaragua	[e]4	[r]1	2	[r]2	2
Norway[e]	100	100	100	100	100
Panama[e]	[3]2	3	[3]1	2	2
Paraguay[e]	[3]103	100	100	100	100
Peru[e]	13	13	14	14	14
Philippines	[e]4	12	7	[e]10	10
Poland	4,421	[r]3,200	[r]2,413	[r]2,526	2,500
Portugal[e]	200	200	200	200	200
Romania	[r]3,983	[r]3,028	[e]3,000	[r][e]3,000	3,000
Saudi Arabia[e]	12	12	12	12	12
Serbia and Montenegro	—	—	—	[r]565	500
Slovakia[5]	—	—	—	—	1,070
Slovenia[e]	—	—	—	[r]250	250
South Africa, Republic of (sales)	1,939	1,830	1,765	[r]1,738	[3]1,599
Spain[e]	[r]1,200	1,200	1,200	1,200	1,200
Sweden	[r]656	[r]603	[r]506	[r][e]500	500
Switzerland	30	26	[e]40	[r][e]30	40
Taiwan	615	554	614	[r]670	650
Tanzania (calcined and hydrated)	3	1	[e]1	[r]2	1
Tunisia[e]	650	650	650	600	600
Turkey[e] [8]	[r]1,432	[r]1,407	[r]1,581	[r]1,582	1,700
Uganda[e]	1	2	2	[r][3]2	[3]2
U.S.S.R.[9]	30,378	[e]28,000	[e]26,000	[e][10]23,000	[10]20,000
United Arab Emirates[e]	45	45	45	45	45
United Kingdom[e]	2,800	[r]2,800	[r]2,800	2,500	2,500
United States, including Puerto Rico (sold or used by producers)	15,584	15,859	15,694	16,227	[3]16,959
Uruguay[e]	[3]12	12	12	12	12
Venezuela[e]	2	2	2	2	3
Yugoslavia[11]	2,407	2,123	1,600	—	—
Zaire	100	92	83	65	50
Zambia	[r]230	[r]214	184	[r]212	200
Total metric tons[12]	[r]139,946	[r]135,592	[r]131,598	[r]125,955	124,395
Total short tons	[r]154,264	[r]149,464	[r]145,062	[r]138,841	137,122

[e]Estimated. [r]Revised.

[1]Table includes data available through July 12, 1994.

[2]Lime is produced in many other countries besides those listed. Argentina, Iraq, Pakistan, and Syria are among the more important countries for which official data are not available.

[3]Reported figure.

[4]Less than 1/2 unit.

[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.

[10]Total production of the former U.S.S.R. Production data for the 15 new countries are not yet reported separately.

[11]Dissolved in Apr. 1992.

[12]Data may not add to totals shown because of independent rounding.

FIGURE 1

TIME-VALUE RELATIONSHIPS FOR QUICKLIME SOLD

(Metric tons)

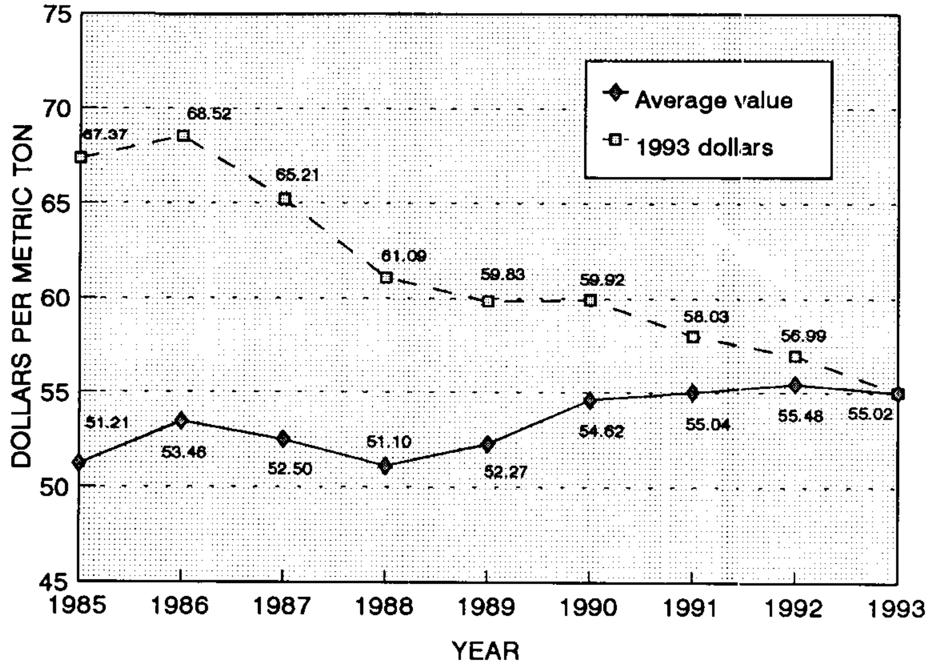

FIGURE 2

TIME-VALUE RELATIONSHIPS FOR HYDRATED LIME SOLD

(Metric tons)

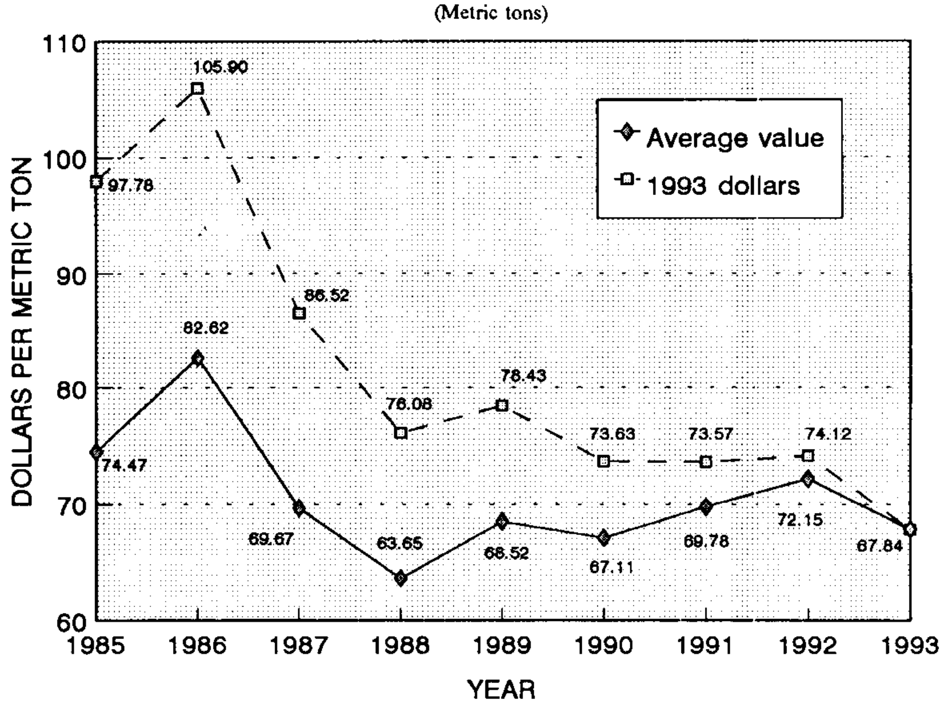

FIGURE 3
TIME-VALUE RELATIONSHIPS FOR QUICKLIME SOLD

(Short tons)

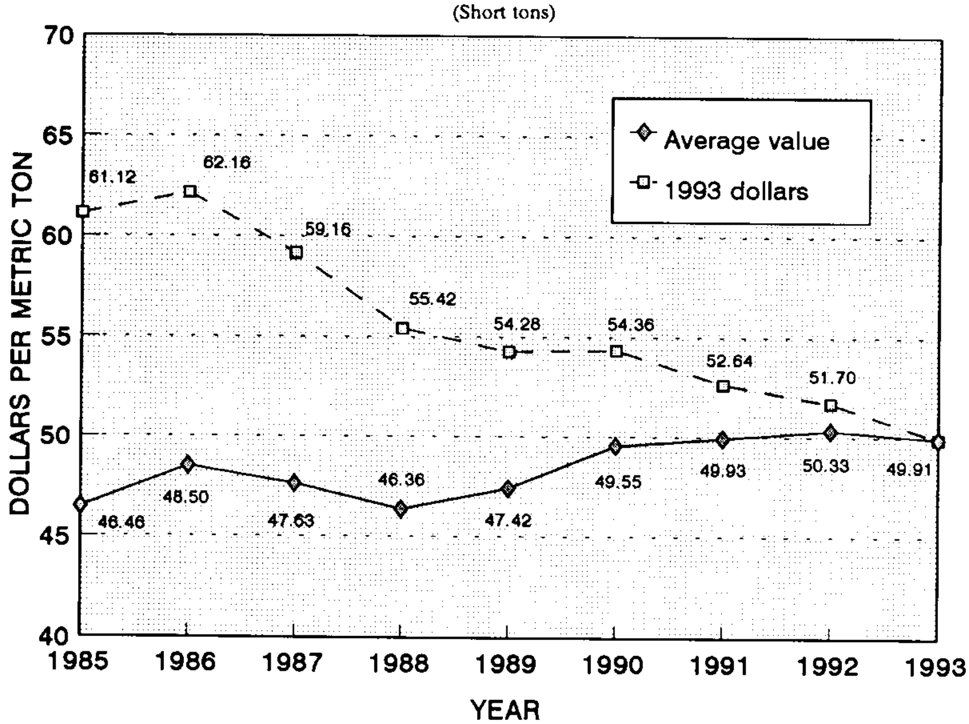

FIGURE 4
TIME-VALUE RELATIONSHIPS FOR HYDRATED LIME SOLD

(Short tons)