# 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 industry uses.

Lime is a basic chemical that ranked fifth in total production in the United States in 1994. 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 600,000 tons (660,000 short tons) to 17.4 million tons (19.2 million short tons) in 1994. Production included the commercial sale or captive consumption of quicklime, hydrated lime, and dead-burned refractory dolomite. These products were valued at more than $1,020 million. Commercial sales increased by 600,000 tons (660,000 short tons) to a record high of 15.5 million tons (17.1 million short tons), while captive consumption was essentially unchanged at 1.88 million tons (2.07 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 ($CaO \cdot MgO$); 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 are also called high-calcium lime. Lime also can be produced from a variety of 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. Bureau of Mines from two separate, voluntary surveys of U.S. operations. The survey used to prepare this report is the annual "Lime" survey. Of the 114 operations to which the annual survey request was sent, 98 responded, representing 86% of the total sold or used by producers shown in table 2. Production for 12 nonrespondents was provided based on the monthly survey. Production for four nonrespondents was estimated using reported prior-year production figures.

In 1994, 64 companies produced lime. Leading producing companies, in descending order, were Chemical Lime Co., with two plants each in Alabama, Arizona, California, Nevada, and Texas and one each in Idaho and Utah; 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; Continental Lime Inc., with one plant each in Montana, Nevada, Utah, and Washington; Martin Marietta Magnesia Specialties in Ohio; APG Lime Co., with one plant each in Texas and Virginia; Wimpey Minerals PA, Inc., with two plants in Pennsylvania, U.S. Lime & Minerals, Inc., with one plant each in Arkansas, Pennsylvania, and Texas; and LTV Steel in Ohio. These 10 companies operated 32 plants and accounted for nearly 64% 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. Specific plant capacity data were unavailable for all commercial lime plants. *(See tables 2 and 3.)*

The year was marked by numerous announcements of closures, restructuring, name changes, acquisitions, planned capacity increases, and new plant construction. Some of the most significant announcements came out of the two largest U.S. lime companies, Chemical Lime Co. and Dravo Lime Co.

The Chemical Lime group of companies was reorganized under a single company name, Chemical Lime Co. The company organized itself into an eastern division consisting of the former Allied Lime plants in Alabama and the Chemical Lime plants in Texas, and a western division consisting of the former Chemstar plants in Arizona, California, Idaho, Nevada, and Utah.[1]

Chemical Lime Co. announced plans to build a new lime plant near Ste. Genevieve, MO, containing two 1,100-ton-per-day (1,200-short-ton) Kennedy Van Saun (KVS) preheater rotary kilns. The construction of this plant was necessitated by the signing of a major long-term contract to supply Monongahela Power Company's Harrison Station near Shinnston, WV. The powerplant will require about 363,000 tons per year (400,000 short tons) of magnesium enhanced lime, which Chemical Lime markets as MAG-ON-DEMAND.[2]

Chemical Lime also announced plans to expand its production of liquid calcium hydroxide slurry. The company anticipates increased demand for neutralization products because of the short supply and volatility of caustic soda prices. Expansions were completed in Florida and in Texas, and the California expansion was scheduled for early 1994.[3]

Dravo Lime Co. reached a renewal agreement to supply about 159,000 tons per year (175,000 short tons) of lime for 10 years to Monongahela Power's Pleasants Station in West Virginia.[4] It also reached a renewal agreement to supply about 408,000 tons per year (450,000 short tons) for 13 years to Pennsylvania Power Company's Bruce Mansfield Station in Pennsylvania.[5] These renewal agreements are in addition to the 15-year contract to supply about 408,000 tons per year (450,000 short tons) to Ohio Power Company's James M. Gavin Station in southeastern Ohio.[6] As a result of these major flue gas desulfurization contracts, Dravo Lime Co. announced plans to expand capacity at its Black River Division at Carntown, KY. The planned expansion called for the installation of two 1000-ton-per-day (1,100-short-ton) KVS preheater rotary kilns;

two lime storage silos; a barge loadout system; three coal storage silos; and a limestone processing, storage, and reclaim system. Computerized process control is also being installed for all surface operations.[7]

Additional industry changes were reported by Global Stone Corp., Marblehead Lime Co., Marine Magnesium Co., and Scottish Heritable, Inc. Global Stone Corp. of Canada purchased Chemstone Corp., Strasburg, VA, a commercial producer of quicklime, hydrate, chemical grade limestone, and construction aggregates.[8] Global Stone also signed an agreement to lease for a period of 10 years the assets of Detroit Lime Co. from Edward C. Levy Co. The agreement includes an option to purchase the assets, which takes effect after Dec. 31, 1999.[9] Calcitherm Nederland N.V. of the Netherlands finalized the purchase of Marblehead Lime Co. from General Dynamics Corp. in early 1994.[10] Marine Magnesium Co. of South San Francisco, CA, a captive producer of dolomitic lime, sold its trademarks, tradenames, rights, and technology for the manufacture of magnesium chemicals to Morton International, Inc. All manufacturing was transferred to Morton's Michigan facilities and the South San Francisco facility was scheduled for demolition.[11] Scottish Heritable, Inc.; parent company of Arkansas Lime, Corson Lime, and Texas Lime; changed its name to United States Lime & Minerals, Inc. The former name was associated with the company's previous majority stockholder.[12]

Several companies announced capacity increases. Germany Valley Limestone Co., Riverton, WV, announced plans to install a 450-ton-per-day (500-short-ton) Kennedy Van Saun (KVS) preheater rotary kiln, due to come on line the last quarter of 1995.[13] Continental Lime Inc. installed hydrators at its plants at Townsend, MT, and Wendhover, NV, and also announced plans to add a 635-ton-per-day (700-short-ton) preheater rotary at Wendhover, NV.[14] Tenn Luttrell Co., Luttrell, TN, which had been purchased by Global Stone Corp. in October 1993, finished permitting and began construction of a 300-ton-per-day (330-short-ton) vertical kiln.[15] *(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, 26% for environmental uses, 8% 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 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 steel industry increased by nearly 4% to 5.3 million tons (5.8 million short tons) and accounted for about 31% 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 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 sludges from sewage and 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.

Specialty Minerals Inc. (SMI) and Continental Lime Inc. entered into an agreement where SMI would distribute and resell precipitated calcium carbonate produced by Continental at its facility in Tacoma, WA. This agreement eliminates the need for SMI to build a new mill in the Pacific Northwest and provides Continental with SMI's greater experience in servicing existing customers and developing new customers. Continental has also agreed to increase precipitated calcium carbonate production capacity, if SMI can generate new sales. SMI also announced plans to expand production capacity at its merchant precipitated calcium carbonate plant in Adams, MA.[16]

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. *(See table 5.)*

**Prices**

The average value of lime sold or used by producers, as reported to the U.S. Bureau of Mines on an f.o.b. plant basis, increased in 1994 to $58.73 per ton ($53.28 per short ton). Average values per ton were $58.20 ($52.81 per short ton) for chemical and industrial lime, $56.64 ($51.39 per short ton) for environmental lime, $64.11 ($58.16 per short ton) for construction lime, $76.79 ($69.66 per short ton) for agricultural lime, and $83.16 ($75.44 per short ton) for refractory dolomite.

The average value of quicklime sold increased to $56.43 per ton ($51.19 per short ton). Average values per ton were $57.02 ($51.73 per short ton) for chemical and industrial lime, $53.91 ($48.91 per short ton) for environmental lime, $56.77 ($51.50 per short ton) for construction lime, and $80.43 ($72.97 per short ton) for refractory dead-burned dolomite. Almost no quicklime was sold as aglime.

The average value of hydrated lime sold decreased to $67.71 per ton ($61.43 per short ton). Average values per ton were $64.13 ($58.18 per short ton) for chemical lime, $69.72 (63.25 per short ton) for environmental lime, $67.81($61.51 per short ton) for construction lime, and $76.18 ($69.11 per short ton) for agricultural lime.

**Foreign Trade**

According to the Bureau of the Census, exports of lime increased by 7% to 74,000 tons (82,000 short tons). Imports of lime were essentially unchanged at 204,000 tons (225,000 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 85% of U.S. exports and shipping 95% of U.S. imports. *(See table 1.)*

**Current Research**

The Zedmark Division of Minteq International Inc. has designed and field tested a new kiln lining for rotary kilns. The new lining, which operates as an internal heat exchanger, converts the internal surface of the kiln from circular to multi-sided. This overcomes the problems caused by the kiln load sliding on the refractory. The polygonal shape allows the lifting and tumbling of the load over itself resulting in more efficient mixing and improved heat transfer. The lining is more mechanically and thermally stable and can be used throughout the kiln, including in the burn zone. Other benefits of the new lining include lower maintenance costs than traditional heat linings, lower weight than trefoil linings, and lower dust generation. The new design is quicker and less expensive to install than tumblers, lifters or trefoils.[17]

Current pyrometallurgical copper production methods result in large amounts of sulfur dioxide, which result in the need for expensive pollution control equipment. Research has been conducted to further the understanding of the lime-concentrate roasting process for recovery of copper-bearing sulfides. Such a process, utilizing hydrated lime, captures sulfur as calcium sulfate. As an extension to the research done by R. W. Bartlett and H. H. Haung in the 1970's, researchers in the United Kingdom and Chile analyzed optimum roasting conditions; the effect of the sulfide:lime ratio, air flow rate, pellet size, and porosity on reaction kinetics; and mechanisms of roasting reactions.[18]

**Outlook**

Lime has dozens of end uses in the chemical, industrial, and construction industries. Steelmaking is still the largest single end use for lime. The steel industry is adding capacity in the form of 10 new minimills, which will add 9 to 18 million tons per year (10 to 20 million short tons) of new flat-rolled steel capacity. Minimills do not consume as much lime per ton of steel as a large integrated steel producer, but the new mills would require an estimated 370,000 to 740,000 tons (410,000 to 820,000 short tons) of lime per year. This demand would be split between high-calcium and dolomitic lime, approximately 65% and 35%, respectively.

The FGD market is showing the growth expected due to the requirements of Phase I compliance with the Clean Air Act Amendments. The lime industry announced plans to install about 1.8 million tons (2 million short tons) of new capacity in 1995, most of which is intended to supply increased demand for FGD lime. Three midwestern powerplants have begun consuming lime in recently installed scrubbers. Over the course of a year, these plants alone will consume about 725,000 to 815,000 tons (800,000 to 900,000 short tons) per year. Longer-term increases could materialize from the use of lime in dry scrubbers used with small utility boilers (less than 25 Mw), which will be regulated in Phase II of the Clean Air Act Amendments.

Additionally, as a result of the increasing regulation of sulfur dioxide, nitrogen oxides, heavy metals, and fly ash from combustion units, an integrated process to treat flue gases has been developed as an alternative to traditional systems that operate a separate system for each pollutant. A three-stage lime system designed to capture sulfur dioxide and fly ash simultaneously and incorporating a selective catalytic reduction unit to recover nitrogen oxides shows cost and operational advantages over traditional systems. These operational and cost advantages may result in switch from limestone systems to lime systems as utility and industrial operators become more familiar with the potential advantages of the integrated lime system.[19]

The Environmental Protection Agency has proposed new rules regulating emissions of dioxins, heavy metals, and air-borne toxins from smaller municipal incinerators. If the new rules are passed, they would affect about 180 existing incinerators that would probably have to install new pollution control equipment. Current control equipment involves dry-lime scrubbing coupled with bag houses or electrostatic precipitators. Passage of these rules would provide a boost to the incinerator gas scrubbing market in the late 1990's.

Consumption of lime for FGD will likely top 3 million tons (3.3 million short tons) in the next 2 to 3 years, and increase even more when Phase II of the Clean Air Act Amendments goes into effect January 1, 2000.

Other environmental markets as a whole were relatively stable, with a slight increase in the sewage treatment market, which probably reflects the continued growth in the sewage sludge stabilization market. Despite occasional variations in yearly consumption patterns, the individual environmental markets should remain strong, with the greatest potential for growth in sewage sludge stabilization.

Despite downward revisions to the 1993 soil stabilization numbers and the apparent decrease in 1994, soil stabilization will remain a major market, particularly in Texas. The use of lime in asphalt paving should continue to grow.

Lime's traditional pulp and paper market increased in 1994 and paper industry analysts forecast that pulp, paper, and paperboard production will grow faster in 1995 than the overall economy.

The PCC market also increased in 1994 and should continue to show growth as PCC, especially as industry leader Specialty Minerals, Inc., attempts to expand the market share of PCC in the paper coating pigment market.

The three chemical caustic soda plants

constructed in recent years all reopened in 1994, as a result of tight caustic soda supplies and higher prices. When operating, one plant purchases 100% of required lime and the other two regenerate lime needing only to purchase make-up lime. Caustic soda prices increased dramatically in 1994, which made reopening the chemical caustic plants economically feasible. Prices stabilized in the first half of 1995 with contract prices for the remainder of 1995 reported at $235 per ton. Caustic supplies are expected to become tight in 1996, which would put upward pressure on prices. As long as caustic supplies are tight and prices remain at their current level or go higher, chemical caustic will be economically competitive. The chemical caustic industry remains a regional market for lime, albeit a cyclic market that depends entirely on the price of caustic soda.

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[6]———. News From Dravo Corporation (news release). June 21, 1993, Dravo Corp., Pittsburgh, PA.

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[13]Pit and Quarry. Economic Index. V. 87, No. 3, Sept. 1994, p. 16.

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[15]Global Stone Corporation. Global Stone Announces Unaudited Results for the Quarter to December 31, 1994 (news release). Jan. 26, 1995, Global Stone Corp., Oakville, Ontario, Canada.

[16]Work cited in footnote 14.

[17]Industrial Minerals (London). Revolutionary Kiln Lining Concept. Processing/Equipment. No. 330, Mar. 1995, p. 79.

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[9]Rinaldi, N. U. Wet Scrubbers: Choose the Best Chemical Reagent. Environmental Engineering World, March-April 1995, pp. 18-24.

## OTHER SOURCES OF INFORMATION

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Lime. Ch. in Mineral Commodity Summaries, annual.
Lime. Mineral Industry Surveys, monthly.

**Other Sources**

Chemical Economics Handbook, Lime.
Chemical Marketing Reporter.
Industrial Minerals (London).
Industrial Minerals and Rocks.
Industrial Specialty News.
Lime Lites (quarterly newsletter of National Lime Association).
Pit and Quarry.
Rock Products.

TABLE 1
SALIENT LIME STATISTICS 1/

(Thousand metric tons unless otherwise specified) 2/

| | | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|
| United States: 3/ | | | | | | |
| Number of plants | | 113 | 112 | 112 | 112 | 108 |
| Sold or used by producers: | | | | | | |
| Quicklime | | 13,400 | 13,200 | 13,700 | 14,200 r/ | 14,800 |
| Hydrated lime | | 2,100 | 2,170 | 2,230 | 2,250 r/ | 2,290 |
| Dead-burned dolomite | | 342 | 308 | 302 | 315 | 300 |
| Total | | 15,800 | 15,700 | 16,200 | 16,800 r/ | 17,400 |
| Value 4/ | thousands | $902,000 | $890,000 | $950,000 | $965,000 r/ | $1,020,000 |
| Average value per ton | | $57.09 r/ | $56.69 r/ | $58.64 r/ | $57.44 r/ | $58.62 |
| Lime sold | | 14,000 | 13,800 | 14,300 | 14,900 r/ | 15,500 |
| Lime used | | 1,820 | 1,820 | 1,890 | 1,870 r/ | 1,880 |
| Exports 5/ | | 49 | 47 | 59 | 69 | 74 |
| Value | thousands | $6,150 | $6,060 | $7,540 | $7,830 | $7,800 |
| Imports for consumption 5/ | | 157 | 158 | 193 | 201 | 204 |
| Value | thousands | $10,400 | $11,100 | $15,000 | $13,300 | $13,100 |
| Consumption, apparent 6/ | | 15,900 | 15,800 | 16,300 | 16,900 r/ | 17,530 |
| World: Production | | 136,000 | 132,000 | 127,000 r/ | 125,000 r/ | 118,000 e/ |

e/ Estimated. r/ Revised.
1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines 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/ Calculated by sold or used plus imports minus exports.

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

| | 1993 | | | | | 1994 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| State | Plants | Hydrated (thousand metric tons) | Quicklime (thousand metric tons) | Total (thousand metric tons) | Value (thousands) | Plants | Hydrated (thousand metric tons) | Quicklime (thousand metric tons) | Total (thousand metric tons) | Value (thousands) |
| Alabama | 4 | 178 | 1,450 | 1,630 | $89,500 | 4 | 184 | 1,470 | 1,660 | $88,300 |
| Arizona, Nevada, Utah | 8 | 199 | 1,410 | 1,610 | 72,400 | 8 | 243 | 1,570 | 1,810 | 114,000 |
| California | 9 | 22 | 171 | 193 | 14,800 | 7 | 26 | 178 | 203 | 16,900 |
| Colorado, Montana, Wyoming | 10 | -- | 369 | 369 | 24,200 | 10 | -- | 335 | 335 | 20,900 |
| Idaho, Oregon, Washington | 8 | 17 | 547 | 565 | 40,900 | 8 | 25 | 597 | 622 | 44,600 |
| Illinois, Indiana, Missouri | 8 | 455 | 2,730 | 3,190 | 175,000 | 8 | 464 | 2,910 | 3,380 | 184,000 |
| Iowa, Nebraska, South Dakota | 5 | W | W | 235 | 14,400 | 5 | W | W | 242 | 13,700 |
| Kentucky, Tennessee, West Virginia | 5 | 129 | 1,730 | 1,850 | 105,000 | 5 | 132 | 1,800 | 1,930 | 106,000 |
| Michigan | 8 | 25 | 592 r/ | 617 r/ | 32,100 r/ | 9 | 26 | 611 | 637 | 33,000 |
| North Dakota | 3 | -- | 112 r/ | 112 r/ | 4,800 r/ | 3 | -- | 108 | 108 | 6,590 |
| Ohio | 9 | W | W | 1,700 | 101,000 | 9 | W | W | 1,850 | 113,000 |
| Pennsylvania | 9 | 286 | 1,250 | 1,540 | 95,400 | 8 | 263 | 1,330 | 1,590 | 95,500 |
| Puerto Rico | 1 | 27 | -- | 27 | 3,650 | 1 | 23 | (3/) | 23 | 2,970 |
| Texas | 7 | 522 r/ | 850 r/ | 1,370 r/ | 86,400 r/ | 6 | 471 | 740 | 1,210 | 76,200 |
| Virginia | 5 | 117 | 639 | 756 | 40,000 | 5 | 121 | 621 | 742 | 40,200 |
| Wisconsin | 4 | 116 | 395 | 511 | 30,900 | 4 | 124 | 383 | 507 | 30,300 |
| Other 4/ | 9 | 181 | 2,260 r/ | 507 r/ | 35,200 r/ | 9 | 213 | 2,430 | 548 | 35,300 |
| Total | 112 | 2,270 r/ | 14,500 r/ | 16,800 r/ | 965,000 r/ | 109 | 2,310 | 15,100 | 17,400 | 1,020,000 |

r/ Revised. W Withheld to avoid disclosing company proprietary data; included with "Other."
1/ Excludes regenerated lime. Includes Puerto Rico.
2/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three siginificant digits; may not add to totals shown.
3/ Less than 1/2 unit.
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 2/

| Range of production | 1993 | | | 1994 | | |
|---|---|---|---|---|---|---|
| | Plants | Quantity 3/ (thousand metric tons) | Percent of total | Plants | Quantity 3/ (thousand metric tons) | Percent of total |
| Less than 10,000 tons | 8 | 57 r/ | (4/) | 9 | 52 | (4/) |
| 10,000 to 25,000 tons | 19 | 288 r/ | 2 | 16 | 238 | 1 |
| 25,000 to 50,000 tons | 13 | 385 r/ | 2 | 13 | 370 | 2 |
| 50,000 to 100,000 tons | 23 | 1,670 r/ | 10 | 15 | 1,000 | 6 |
| 100,000 to 200,000 tons | 17 | 2,140 | 13 | 24 | 3,070 | 18 |
| 200,000 to 400,000 tons | 20 | 4,980 r/ | 32 | 21 | 5,220 | 31 |
| More than 400,000 tons | 12 | 7,260 r/ | 41 | 11 | 7,450 | 42 |
| Total | 112 | 16,800 r/ | 100 | 109 | 17,400 | 100 |

r/ Revised.
1/ Excludes regenerated lime. Includes Puerto Rico.
2/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines 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/ 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/

| State | 1993 | | | 1994 | | |
|---|---|---|---|---|---|---|
| | Quicklime | Hydrated lime | Total | Quicklime | Hydrated lime | Total |
| Alabama | 661 | 47 | 708 | 619 | 53 | 673 |
| Alaska | 5 | 1 | 6 | 7 | 1 | 8 |
| Arizona | 321 | 47 | 368 | 488 | 59 | 547 |
| Arkansas | 124 | 25 | 149 | 180 | 25 | 205 |
| California | 343 | 67 | 410 | 402 | 83 | 485 |
| Colorado | 156 | 32 | 189 | 73 | 38 | 111 |
| Connecticut | 22 | 2 | 24 | 21 | 6 | 27 |
| Delaware | 17 | 2 | 19 | 54 | 4 | 58 |
| District of Columbia | 8 | 8 | 16 | 13 | 13 | 26 |
| Florida | 400 | 22 | 422 | 390 | 24 | 414 |
| Georgia | 216 | 86 | 302 | 233 | 79 | 312 |
| Hawaii | -- | (4/) | (4/) | (4/) | (4/) | (4/) |
| Idaho | 162 | 2 | 163 | 210 | 2 | 213 |
| Illinois | 504 | 161 | 664 | 448 | 162 | 610 |
| Indiana | 1,400 r/ | 31 | 1,430 r/ | 1,550 | 34 | 1,590 |
| Iowa | 56 | 25 | 81 | 65 | 25 | 90 |
| Kansas | 83 r/ | 21 | 104 r/ | 81 | 25 | 106 |
| Kentucky | 371 r/ | 36 r/ | 407 r/ | 373 | 37 | 411 |
| Louisiana | 221 r/ | 86 | 306 r/ | 252 | 91 | 343 |
| Maine | 4 | (4/) | 4 | 3 | (4/) | 3 |
| Maryland | 124 | 17 | 141 | 104 | 17 | 121 |
| Massachusetts | 143 | 12 | 155 | 147 | 13 | 159 |
| Michigan | 918 r/ | 32 | 950 r/ | 940 | 30 | 969 |
| Minnesota | 302 r/ | 17 | 319 r/ | 271 | 18 | 289 |
| Mississippi | 187 | 16 | 204 | 194 | 22 | 216 |
| Missouri | 166 | 58 | 223 | 164 | 62 | 226 |
| Montana | 122 | 9 | 131 | 141 | 11 | 152 |
| Nebraska | 54 | 10 | 65 | 58 | 9 | 67 |
| Nevada | 415 | 36 | 451 | 468 | 46 | 515 |
| New Hampshire | 2 | (4/) | 2 | 2 | (4/) | 2 |
| New Jersey | 115 | 20 | 135 | 146 | 22 | 168 |
| New Mexico | 130 | 42 r/ | 172 r/ | 43 | 31 | 74 |
| New York | 87 | 26 | 113 | 83 | 31 | 114 |
| North Carolina | 202 | 43 | 245 | 197 | 44 | 241 |
| North Dakota | 261 r/ | 3 | 264 r/ | 225 | 3 | 228 |
| Ohio | 1,700 r/ | 137 r/ | 1,840 r/ | 1,830 | 161 | 1,990 |
| Oklahoma | 120 | 9 | 129 | 138 | 13 | 151 |
| Oregon | 130 | 18 | 148 | 106 | 27 | 133 |
| Pennsylvania | 1,540 | 203 | 1,740 | 1,630 | 173 | 1,800 |
| Rhode Island | 8 | 1 | 9 | 2 | 1 | 3 |
| South Carolina | 191 | 48 | 239 | 223 | 45 | 268 |
| South Dakota | 19 | 1 | 20 | 20 | 3 | 22 |
| Tennessee | 193 | 48 | 241 | 203 | 52 | 256 |
| Texas | 836 r/ | 526 r/ | 1,360 r/ | 716 | 468 | 1,180 |
| Utah | 263 | 21 | 284 | 288 | 26 | 314 |
| Virginia | 205 | 56 | 261 | 209 | 43 | 252 |
| Washington | 231 | 12 | 243 | 272 | 17 | 289 |
| West Virginia | 421 | 52 | 473 | 484 | 62 | 546 |
| Wisconsin | 136 | 43 | 179 | 136 | 40 | 176 |
| Wyoming | 124 | 15 | 140 | 97 | 20 | 117 |
| Total | 14,400 r/ | 2,230 r/ | 16,700 r/ | 14,900 | 2,270 | 17,300 |
| Puerto Rico | -- | 21 | 21 | 8 | 18 | 18 |
| Canada | 55 | 16 | 71 | 62 | 17 | 79 |
| Other 5/ | 25 | 8 | 32 | 12 | 6 | 26 |
| Total | 80 | 45 | 124 | 82 | 41 | 123 |
| Grand total | 14,500 r/ | 2,280 r/ | 16,800 r/ | 15,000 | 2,310 | 17,400 |

r/ Revised.

1/ Excludes regenerated lime.

2/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines 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/ Less than 1/2 unit.

5/ 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 | 1993 | | | | 1994 | | | |
|---|---|---|---|---|---|---|---|---|
| | Sold | Used | Total | Value | Sold | Used | Total | Value |
| Agriculture | 19 | -- | 19 | 1,430 | 19 | -- | 19 | 1,440 |
| Chemical and industrial: | | | | | | | | |
| Alkalies | W | W | 129 | 6,200 | W | W | 115 | 5,790 |
| Aluminum and bauxite | 155 r/ | -- | 155 r/ | 8,980 r/ | 142 | -- | 142 | 8,060 |
| Copper ore concentration | W | W | W | 18,400 r/ | W | W | W | 25,200 |
| Food products, animal or human | 23 r/ | -- | 23 r/ | 1,790 r/ | 17 | -- | 17 | 1,190 |
| Glass | 109 | -- | 109 | 6,650 | 114 | -- | 114 | 7,250 |
| Oil well drilling | 12 r/ | -- | 12 r/ | 751 r/ | 12 | -- | 12 | 819 |
| Oil and grease | 46 | -- | 46 | 4,620 | 36 | -- | 36 | 4,420 |
| Ore concentration, other | 366 r/ | -- | 366 r/ | 21,100 r/ | 611 | -- | 611 | 36,000 |
| Paper and pulp | W | W | 1,030 r/ | 60,300 r/ | W | W | 1,160 | 69,300 |
| Petrochemicals | 39 r/ | -- | 39 r/ | 2,840 r/ | 67 | -- | 67 | 5,350 |
| Precipitated calcium carbonate | 473 | 99 r/ | 572 r/ | 30,300 r/ | 540 | 114 | 654 | 35,200 |
| Steel: | | | | | | | | |
| Basic oxygen furnaces | W | W | 3,560 r/ | 193,000 r/ | W | W | 3,850 | 207,000 |
| Electric arc furnaces | 1,140 r/ | -- | 1,140 r/ | 58,200 r/ | 1,050 | -- | 1,050 | 60,600 |
| Argon oxygen decarburization | 96 | -- | 96 | 5,240 | 106 | -- | 106 | 5,960 |
| Ladle desulfurization, iron or steel | 116 | -- | 116 | 6,380 | 83 | -- | 83 | 4,640 |
| Other chemical and industrial 4/ | 191 r/ | -- | 191 r/ | 10,900 r/ | 227 | -- | 227 | 12,800 |
| Total steel: | 1,540 r/ | W | 5,110 r/ | 274,000 r/ | 1,470 | W | 5,310 | 291,000 |
| Sugar refining | 32 r/ | 707 r/ | 738 r/ | 50,000 r/ | 32 | 691 | 723 | 45,800 |
| Tanning | 21 | -- | 21 | 1,480 | 15 | -- | 15 | 1,050 |
| Other 4/ | 6,230 r/ | 883 r/ | 2,390 r/ | 115,000 r/ | 6,410 | 921 | 2,210 | 114,000 |
| Total | 9,050 r/ | 1,690 r/ | 10,700 r/ | 603,000 r/ | 9,470 | 1,730 | 11,200 | 651,000 |
| Construction: | | | | | | | | |
| Asphalt paving | 126 r/ | -- | 126 r/ | 7,370 r/ | 238 | -- | 238 | 13,000 |
| Finishing lime | 41 r/ | -- | 41 r/ | 3,080 r/ | 38 | -- | 38 | 2,970 |
| Mason's lime | (5/) | (5/) | 164 | 11,200 | (5/) | (5/) | 168 | 11,100 |
| Soil stabilization | 973 r/ | -- | 973 r/ | 60,300 r/ | 784 | -- | 784 | 44,700 |
| Other | 184 r/ | -- | 184 r/ | 12,300 r/ | 188 | -- | 188 | 19,100 |
| Total | (5/) | (5/) | 1,490 r/ | 94,300 r/ | (5/) | (5/) | 1,420 | 90,800 |
| Environmental: | | | | | | | | |
| Acid water, mine or plant | 364 r/ | 2 | 365 r/ | 22,500 r/ | 409 | 3 | 412 | 24,800 |
| Flue gas sulfur removal | 1,780 r/ | -- | 1,780 r/ | 99,700 r/ | 1,960 | -- | 1,960 | 104,000 |
| Industrial solid waste treatment | 34 | -- | 34 | 1,960 | 53 | -- | 53 | 2,910 |
| Industrial wastewater treatment | 39 | -- | 39 | 2,320 | 40 | -- | 40 | 2,440 |
| Scrubber sludge solidification | 53 | -- | 53 | 2,990 | 53 | -- | 53 | 2,980 |
| Sewage treatment | 462 r/ | 2 | 464 r/ | 28,800 r/ | 427 | -- | 427 | 27,100 |
| Water purification | 1,060 r/ | -- | 1,060 r/ | 63,300 r/ | 1,160 | -- | 1,160 | 67,600 |
| Other | 418 r/ | (6/) | 418 r/ | 23,600 r/ | 373 | -- | 373 | 21,600 |
| Total | 4,210 r/ | 2 | 4,210 r/ | 245,000 r/ | 4,470 | 3 | 4,480 | 254,000 |
| Refractory lime (dead-burned dolomite) | (5/) | (5/) | 315 | 26,200 | (5/) | (5/) | 300 | 25,000 |
| Grand total | 14,900 r/ | 1,870 r/ | 16,800 r/ | 970,000 r/ | 15,500 | 1,880 | 17,400 | 1,020,000 |

r/ Revised. W Withheld to avoid disclosing company proprietary data; included in "Other Chemical and Industrial."

1/ Excludes regenerated lime. Includes Puerto Rico.

2/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines 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/ Includes briquetting, brokers, calcium carbide, chrome, citric acid, commerical hydrators, desiccants, ferroalloys, fiberglass, glue, insecticides, magnesia from seawater or brine, magnesium metal, metallurgy, pelletizing, pharmaceuticals, rubber, silica brick, soap.

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

6/ Revised to zero.

TABLE 6
QUICKLIME AND HYDRATED LIME, INCLUDING DEAD-BURNED DOLOMITE: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Thousand metric tons)

| Country 3/ | 1990 | 1991 | 1992 | 1993 | 1994 e/ |
|---|---|---|---|---|---|
| Algeria (hydraulic) | 32 | 61 | 62 e/ | 62 e/ | 62 |
| Australia e/ | 1,500 | 1,500 | 1,500 | 1,500 | 1,500 |
| Austria | 1,640 | 1,600 e/ | 1,720 | 1,810 r/ | 1,850 4/ |
| Belgium | 2,080 | 2,020 | 1,870 | 1,750 e/ | 1,750 |
| Belize e/ | 1 | 1 | 1 | 1 | 1 |
| Bosnia Herzegovina e/ | XX | XX | 50 | 50 | 50 |
| Botswana | (5/) | (5/) | -- r/ | -- r/ | -- |
| Brazil e/ | 5,700 | 5,700 | 5,700 | 5,700 | 5,700 |
| Bulgaria | 1,560 | 1,030 | 1,000 e/ | 1,000 e/ | 1,000 |
| Burundi | (5/) | (5/) | (5/) | (5/) e/ | 150 |
| Canada | 2,340 | 2,380 | 2,380 r/ | 2,380 r/ | 2,390 |
| Chile (hydraulic) e/ | 1,300 | 1,200 | 1,300 | 1,300 | 1,250 |
| China e/ | 17,000 | 18,500 | 19,000 | 19,500 | 19,500 |
| Colombia e/ | 1,300 | 1,300 | 671 | 439 r/ | 450 |
| Congo e/ | (5/) | (5/) | (5/) | (5/) | (5/) |
| Costa Rica e/ | 13 | 9 4/ | 9 | 10 | 10 |
| Croatia e/ | XX | XX | 200 | 200 | 180 |
| Cuba e/ | 180 | 180 | 160 | 180 | 170 |
| Cyprus (hydrated) | 7 | 7 | 6 | 6 e/ | 6 |
| Czech Republic | XX | XX | XX | 2,500 e/ | 2,500 |
| Czechoslovakia 6/ | 3,120 | 3,230 | 3,000 e/ | XX | XX |
| Denmark (sales) | 156 r/ | 114 r/ | 128 r/ | 124 r/ | 125 |
| Dominican Republic e/ | 4 | -- | -- | -- | -- |
| Egypt e/ | 68 | 749 4/ | 749 | 749 | 749 |
| Ethiopia | (5/) | (5/) | (5/) e/ | (5/) e/ | (5/) |
| Finland e/ | 225 | 225 | 241 4/ | 250 | 315 4/ |
| France e/ | 3,000 | 3,000 | 3,000 | 3,000 | 2,500 |
| Germany: | | | | | |
| Eastern states | 3,000 e/ | XX | XX | XX | XX |
| Western states | 6,890 | XX | XX | XX | XX |
| Total | 9,890 e/ | 7,530 | 7,540 | 7,480 r/ | 7,500 |
| Guadeloupe e/ | 5 | 5 | 5 | 5 | 5 |
| Guatemala e/ | 75 | 72 | 70 | 70 | 70 |
| Hungary | 831 | 571 | 446 | 300 e/ | 340 |
| India e/ | 800 | 820 | 850 | 860 | 860 |
| Iran e/ | 650 | 650 | 650 | 650 | 650 |
| Ireland | 112 | 110 | 110 | 100 e/ | 100 |
| Israel | 230 | 208 | 208 e/ | 208 e/ | 210 |
| Italy e/ 7/ | 3,850 | 3,800 | 3,600 | 3,600 e/ | 3,500 |
| Jamaica e/ | 90 | 95 | 179 4/ | 151 r/ | 170 4/ |
| Japan (quicklime only) | 8,980 | 9,040 | 8,050 | 7,960 r/ | 7,710 4/ |
| Jordan | 5 | 5 | 7 | 7 e/ | 7 |
| Kenya | 14 | 12 | 12 e/ | 12 e/ | 12 |
| Korea, Republic of e/ | 230 | 240 | 240 | 250 | 250 |
| Kuwait | 50 | 5 | 5 e/ | 35 e/ | 40 |
| Lebanon e/ | 10 | 10 | 15 | 15 | 15 |
| Libya e/ | 260 | 260 | 260 | 260 | 260 |
| Macedonia e/ | XX | XX | 20 | 20 | 20 |
| Malawi e/ | 4 4/ | 4 | 4 | 4 | 4 |
| Martinique e/ | 5 | 5 | 5 | 5 | 5 |
| Mauritius e/ | 7 | 7 | 7 | 7 | 7 |
| Mexico e/ | 6,000 | 6,500 | 6,500 | 6,500 | 6,500 |
| Mongolia e/ | 103 | 76 | 50 | 55 | 55 |
| New Zealand e/ | 100 | 90 | 100 | 100 | 100 |

See footnotes at end of table.

TABLE 6--Continued
QUICKLIME AND HYDRATED LIME, INCLUDING DEADBURNED DOLOMITE: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Thousand metric tons)

| Country 3/ | 1990 | 1991 | 1992 | 1993 | 1994 e/ |
|---|---|---|---|---|---|
| Nicaragua | 1 | 2 | 2 | 2 e/ | 2 |
| Norway e/ | 100 | 100 | 100 | 100 | 100 |
| Panama e/ | 3 | 1 3/ | 2 | 2 | 2 |
| Paraguay e/ | 100 | 100 | 100 | 100 | 100 |
| Peru e/ | 13 | 14 | 14 | 14 | 14 |
| Philippines | 12 | 7 | 10 e/ | 10 e/ | 10 |
| Poland | 3,200 | 2,410 | 2,530 | 2,500 e/ | 2,500 |
| Portugal e/ | 200 | 200 | 200 | 200 | 200 |
| Romania e/ | 3,030 4/ | 3,000 | 3,000 | 3,000 | 3,000 |
| Saudi Arabia e/ | 12 | 12 | 12 | 12 | 12 |
| Serbia and Montenegro | XX | XX | 565 | 500 e/ | 500 |
| Slovakia 6/ | XX | XX | XX | 1,070 e/ | 1,000 |
| Slovenia e/ | XX | XX | 250 | 250 | 250 |
| South Africa, Republic of (sales) | 1,830 | 1,770 | 1,740 | 1,600 | 1,600 |
| Spain e/ | 1,200 | 1,200 | 1,200 | 1,200 | 1,000 |
| Sweden | 603 | 506 | 460 r/ | 500 e/ | 500 |
| Switzerland e/ | 26 4/ | 40 | 30 | 40 | 40 |
| Taiwan | 554 | 614 | 670 | 650 e/ | 650 |
| Tanzania (calcined and hydrated) | 1 | 1 e/ | 2 | 1 e/ | 1 |
| Tunisia e/ | 650 | 650 | 600 | 600 | 600 |
| Turkey 8/ | 1,410 | 1,580 | 1,580 | 1,700 e/ | 1,800 |
| Uganda | 2 e/ | 2 e/ | 2 | 2 | 2 |
| U.S.S.R. e/ 9/ | 28,000 | 26,000 | 23,000 10/ | 20,000 10/ | 16,000 10/ |
| United Arab Emirates e/ | 45 | 45 | 45 | 45 | 45 |
| United Kingdom e/ | 2,800 | 2,800 | 2,500 | 2,500 | 2,500 |
| United States, including Puerto Rico (sold or used by producers) | 15,900 | 15,700 | 16,200 | 16,800 r/ | 17,400 4/ |
| Uruguay e/ | 12 | 12 | 12 | 12 | 12 |
| Yugoslavia 11/ | 2,120 | 1,600 | XX | XX | XX |
| Zaire | 92 | 83 | 65 | 50 e/ | 40 |
| Zambia | 214 | 184 | 212 | 200 e/ | 200 |
| Total | 136,000 | 132,000 | 127,000 r/ | 125,000 r/ | 118,000 |

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

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ Table includes data available through June 27, 1995.

3/ 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. Venezuela does not report production of lime, which is thought to be produced in very small amounts on individual farms. Previous estimates of lime production in Venezuela have lacked any basis, and will not be reported in the future.

4/ Reported figure.

5/ Less than 1/2 unit.

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 cement 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.