



Mineral Industry Surveys

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LIME IN THE UNITED STATES 1950 TO 2001

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LIME IN THE UNITED STATES 1950 TO 2001

By M. Michael Miller

The term lime as used throughout this discussion and the attached tables and figures refers to chemical lime (sometimes known as burnt lime) produced by the calcination of high-purity calcitic or dolomitic limestone followed by hydration where necessary. Traditionally, data have been collected on three general forms of lime—quicklime (high-calcium and dolomitic), hydrated lime (high-calcium and dolomitic), and refractory dead-burned dolomite.

The last 50 or more years have seen tremendous growth in U.S. lime output despite some significant decreases during poor economic times and some major market shifts (table 1). During this period, the industry has transformed from being primarily a commercial industry to one with several large captive industries (e.g., steel and synthetic soda ash) and then back to a predominantly commercial industry. The following discussion briefly looks at lime in terms of its production growth and attempts to look at lime prices in a bit more detail. Production data include combined quantities of all types of lime, including high-calcium and dolomitic forms of quicklime and hydrated lime and dead-burned dolomite (fig. 1). Value data include all types of lime sold and used by producers, quicklime sold, and hydrated lime sold. Value data for dead-burned dolomite sold are not specifically addressed.

The production data reported in table 1 between 1950 and 1961 do not include production from some captive lime producers; in 1953, 1959, and 1961, increased collection of data from the captive sector was achieved. Lime output was affected by factors unique to the industry and like other commodities fluctuated with the economy (fig. 2). The recessions of 1954, 1958, 1975, and 1980 all saw lime output decrease by 10% to 11% in a single year, but these were minor events compared with the recession of 1982, which saw lime output decrease by 25%.

From 1950 to 1974, lime production grew steadily from a reported figure of 6.8 million metric tons (Mt) in 1950 to a peak of 19.6 Mt in 1974, an increase of 188%. The next 27 years were much more volatile; lime production was fairly stable through the late 1970s, dropped to a 30-year low in the early 1980s, started to recover, slumped again, exhibited a prolonged period of growth from 1987 to 1998, and then decreased for 3 successive years. A snapshot of the development of the U.S. lime industry during the past one-half century is detailed in the "Chronology of Lime from 1950 to 2001" section at the end of the report.

Changing technology, economics, and environmental regulations have played large roles in some lime markets. Steel is the best example of where a change in technology, the replacement of open-hearth furnaces with basic oxygen furnaces, resulted in a dramatic change in the quantity and kinds of lime used. In the 1950s, the steel industry was a large

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

(Thousand metric tons)

Year	Quicklime	Hydrate	Dead-burned dolomite	Total
1950	3,478	1,710	1,596	6,784
1951	3,964	1,742	1,784	7,489
1952	3,867	1,708	1,749	7,324
1953	4,842	1,853	2,082	8,776
1954	4,652	1,796	1,390	7,828
1955	5,546	2,030	1,931	9,507
1956	5,413	1,983	2,199	9,595
1957	5,390	1,888	2,042	9,320
1958	5,024	1,827	1,505	8,356
1959	7,036	2,509	1,802	11,347
1960	7,503	2,463	1,768	11,734
1961	8,163	2,058	1,798	12,019
1962	8,626	2,165	1,686	12,476
1963	9,188	2,221	1,768	13,177
1964	10,315	2,330	1,967	14,612
1965	10,894	2,392	1,974	15,260
1966	11,970	2,448	1,989	16,407
1967	12,201	2,441	1,705	16,347
1968	13,100	2,180	1,663	16,943
1969	14,042	2,634	1,693	18,369
1970	13,833	2,872	1,246	17,951
1971	13,733	3,165	914	17,812
1972	15,069	2,400	975	18,444
1973	15,631	2,406	1,134	19,171
1974	16,143	2,333	1,159	19,635
1975	14,401	2,151	829	17,381
1976	15,353	2,110	914	18,377
1977	14,770	2,482	878	18,130
1978	15,281	2,377	922	18,580
1979	15,924	2,390	719	19,033
1980	14,489	2,331	448	17,268
1981	14,644	2,096	395	17,135
1982	10,615	1,880	306	12,801
1983	11,234	1,906	379	13,519
1984	11,915	2,120	442	14,477
1985	11,791	2,120	343	14,254
1986	10,750	2,017	385	13,152
1987	11,774	2,262	259	14,295
1988	12,760	2,319	413	15,492
1989	13,154	2,064	365	15,583
1990	13,392	2,124	342	15,858
1991	13,191	2,195	308	15,694
1992	13,665	2,259	302	16,226
1993	14,344	2,428	315	17,087
1994 3/	14,800	2,310	300	17,400
1995 3/	15,800	2,410	308	18,500
1996 3/	16,800	2,190	300 4/	19,200
1997 3/	17,300	2,170	300 4/	19,700
1998 3/	17,500	2,330	300 4/	20,100

See footnotes at end of table.

TABLE 1--Continued
LIME SOLD OR USED BY PRODUCERS
IN THE UNITED STATES 1/ 2/

(Thousand metric tons)

Year	Quicklime	Hydrate	Dead-burned dolomite	Total
1998 3/	17,500	2,330	300 4/	20,100
1999 3/	17,100	2,310	300 4/	19,700
2000 3/	17,300	1,970	200 4/	19,600
2001 3/	16,200	2,470	200 4/	18,900

1/ Excludes regenerated lime; includes Puerto Rico.

2/ Prior to 1961 some captive production data were unavailable.

3/ Data are rounded to three significant digits.

4/ Data are rounded to one significant digit to protect company proprietary data.

market for dead-burned dolomite as refractory lime for use in open-hearth furnaces, but the basic oxygen furnace did not require dead-burned dolomite but did require large quantities of high-calcium and dolomitic quicklime. The soda ash market is an example of how simple economics caused the shift from synthetic soda ash production, which at its peak consumed more than 3 million tons per year of lime, to less expensive mined production that consumed no lime. Flue gas desulfurization (FGD) is an example of a market that essentially did not exist prior to enactment of the Clean Air Act Amendments in 1970, but passage of this legislation and successive amendments have made the FGD market the second largest market for lime.

An analysis of lime prices during this same period reveals a much simpler pattern of growth. Prices are represented as the average value per metric ton of lime on a free on board basis as

prepared for shipment at the plant and in constant 2001 dollars based on the implicit price deflator¹ for gross domestic product (table 2). In simple terms, there was a long period where values gradually increased, followed by a shorter period when values increased rapidly, and then finally another long period exhibiting gradual increases (fig. 3). Although the trend in nominal values is simple, the way these values relate to the rate of inflation is not. The following is more of a macroeconomic look and does not take into account some of the industry specific factors that may have affected lime values during certain time periods. These factors may have included excess capacity, intense competition among lime companies and with other alkali producers, costs of environmental regulation, and other factors. In addition, the average value of all lime sold and used may be affected by the ratio of quicklime to hydrate produced in a given year (hydrate being a higher value product) and possibly by values assigned by the captive sector.

Figure 3 shows the very slow gradual increase in average nominal values from 1950 until the first oil crisis in 1973. During this period, the nominal value increased from \$12.30 per ton to \$19.20 per ton or by only 56%, which in constant 2001 dollars actually represented a decrease of nearly 19%. From 1973 to 1979, the nominal value increased from \$19.20 per ton to \$45.50 per ton—an increase of 137%—and while the constant dollar value also increased, it only increased by 53% during the same period. The large jump in prices during the 1970s

¹Implicit price deflator equals current dollar gross domestic product divided by constant dollar gross domestic product. This ratio is used to account for the effects of inflation, by reflecting the change in the price of the bundle of goods that makes up the gross domestic product.

FIGURE 1
LIME SOLD OR USED BY PRODUCERS IN THE UNITED STATES

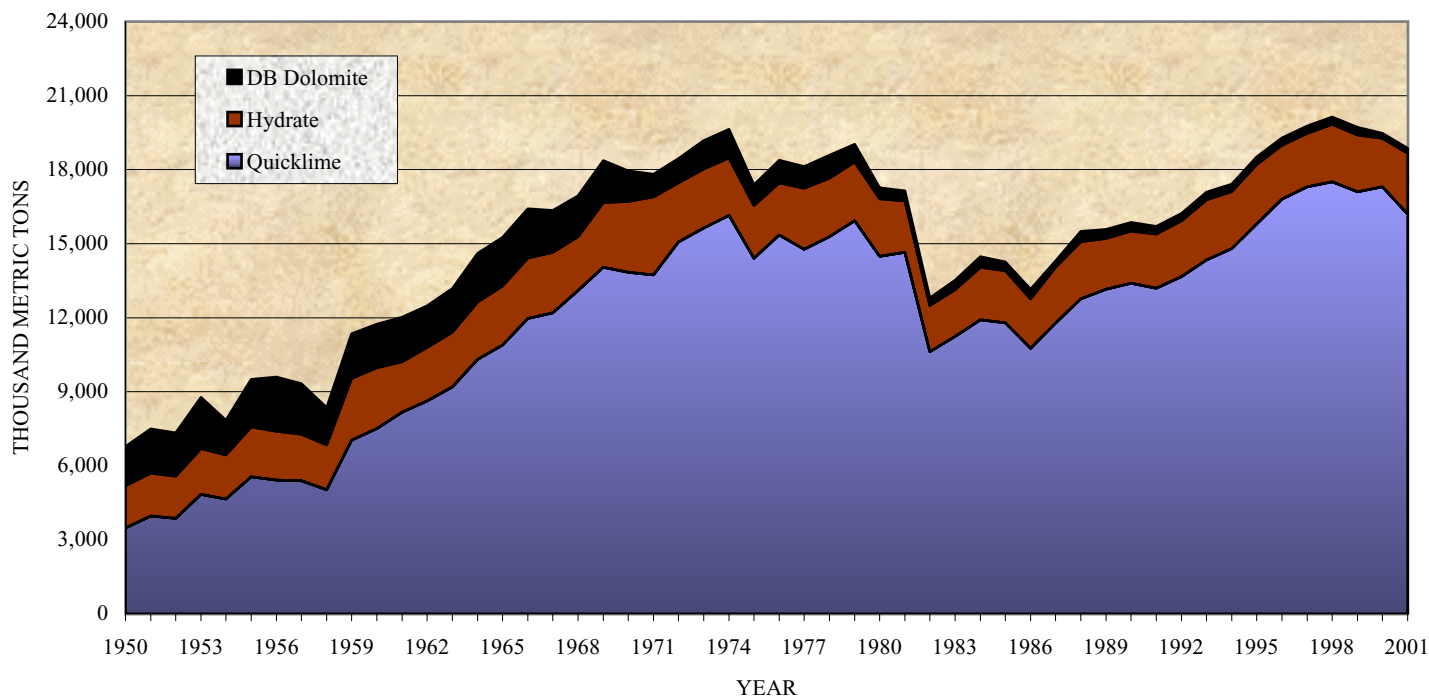
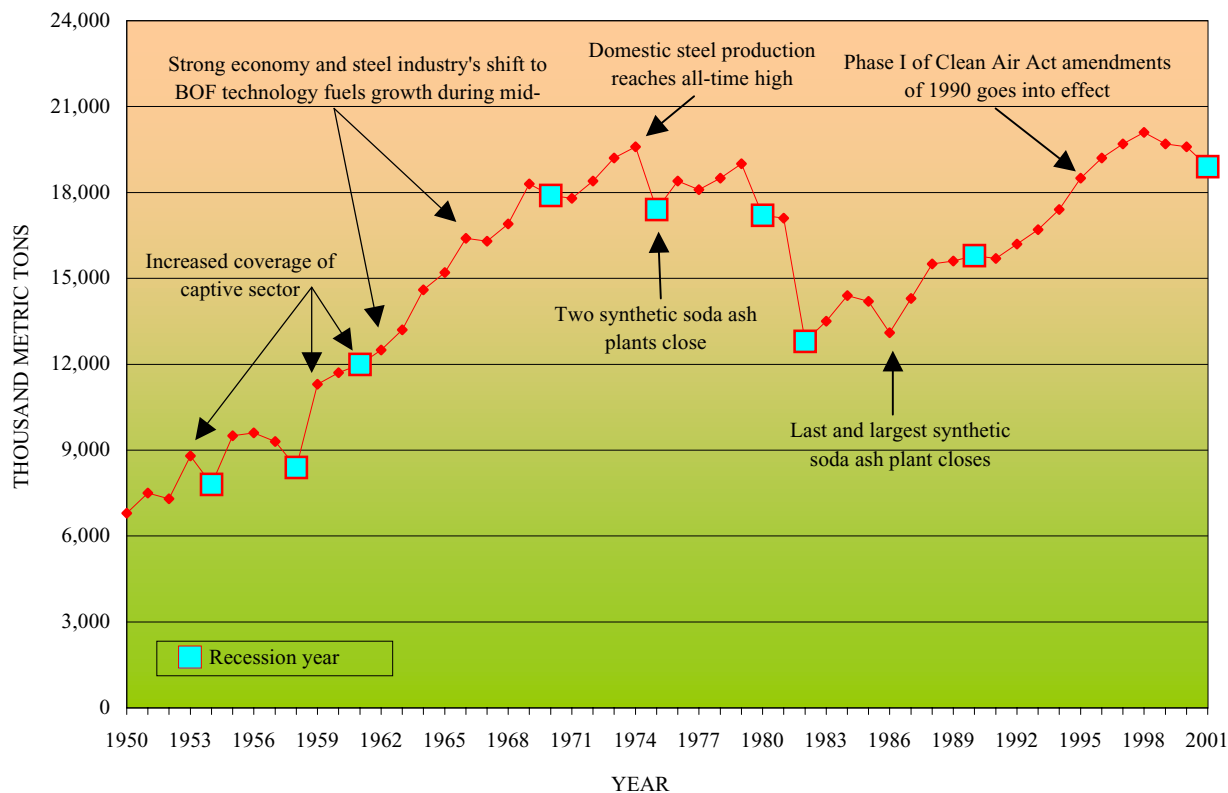


FIGURE 2
SOCIOECONOMIC FACTORS AFFECTING LIME PRODUCTION IN THE UNITED STATES FROM 1950 TO 2001



was caused by a period of high inflation and, more directly, as a result of rising fuel costs. Prior to 1973, many lime kilns in the United States were oil fired, and because fuel is frequently the single largest cost of operation in a lime plant utilizing rotary kilns, the jump in oil prices dramatically increased lime production costs. According to data compiled by the U.S. Department of Energy's Energy Information Administration, the crude oil refiner acquisition cost increased by 327% during this period (U.S. Energy Information Administration, [undated]b§²). As a result, many lime plants shifted to coal, but even coal prices were pushed upward during this period; coal prices increased by 176% during the same time period (U.S. Energy Information Administration, [undated]a§). The second oil crisis, in 1979, continued the upward push during which the crude oil price increased by another 100% between 1979 and 1981. Crude oil prices soon decreased but would always remain significantly higher than in the early 1970s. Coal prices followed a similar pattern, but they peaked a year later, in 1982, after which they entered a long period of decline, and in 2001 they were roughly in the same range as in 1974. This decline was likely the result of the increased supply of lower cost coal from the large open pit operations in the West (e.g., Powder River Basin in Wyoming).

From 1979 to 1986, the nominal value increased by 27%, but the constant dollar value decreased by 12%. Between 1986 and 1988, nominal lime values experienced an uncharacteristically sharp decrease to \$53.00 per ton from \$57.90 per ton. From

1988 to 2001, nominal lime values entered a period of fairly consistent, albeit modest, growth represented by an increase of nearly 13%. Meanwhile, the constant dollar value decreased by 15%.

Value data for quicklime and hydrated lime sold have only been available since 1971 (tables 3-4). The majority of lime sold is in the form of quicklime, and as a result, the graph displaying the average value of quicklime sold (fig. 4) tracks that of figure 3 fairly closely. Some of the major factors that affected quicklime prices are highlighted in figure 5. In contrast, the average value of hydrated lime sold (fig. 6) increased more rapidly and for a longer period of time; values increased by 333% between 1971 and 1986. In 1987, the average value decreased by nearly 16%, which began a period of 9 years (1987 to 1995) when the values stabilized in the \$67 to \$72 per ton range. In 1996, hydrate nominal values jumped by nearly 10%, while from 1997 through 2001 they were usually in the range of \$80 per ton, although jumping to as high as \$85.10 per ton in 2000.

When comparing the graphs showing all lime sold and used, quicklime sold, and hydrated lime sold, only the hydrated lime values increased (and decreased) proportionally to the rate of inflation. In other words, the nominal value of hydrated lime sold and the corresponding constant dollar values went up and down more or less concurrently. The other two graphs show that the constant dollar values were frequently moving downward even when the nominal values were increasing, indicating that product price increases were losing ground to the rate of inflation.

²References that include a section twist (§) are found in the Internet References Cited section.

TABLE 2
PRICES FOR LIME SOLD AND USED IN THE UNITED STATES

(Dollars per metric ton)

Year	Nominal value 1/	2001 dollars 2/
1950	12.30	77.13
1951	12.90	75.42
1952	13.00	74.83
1953	12.80	72.74
1954	13.00	73.14
1955	13.40	74.11
1956	14.10	75.40
1957	14.50	75.05
1958	14.50	73.30
1959	14.50	72.48
1960	14.70	72.45
1961	14.80	72.15
1962	15.00	72.13
1963	15.10	71.81
1964	15.30	71.69
1965	15.30	70.38
1966	14.60	65.29
1967	14.80	64.20
1968	14.80	61.56
1969	15.40	61.04
1970	16.30	61.35
1971	17.50	62.71
1972	18.60	63.94
1973	19.20	62.49
1974	24.30	72.56
1975	30.30	82.80
1976	33.30	86.10

See footnotes at end of table.

TABLE 2--Continued
PRICES FOR LIME SOLD AND USED IN THE UNITED STATES

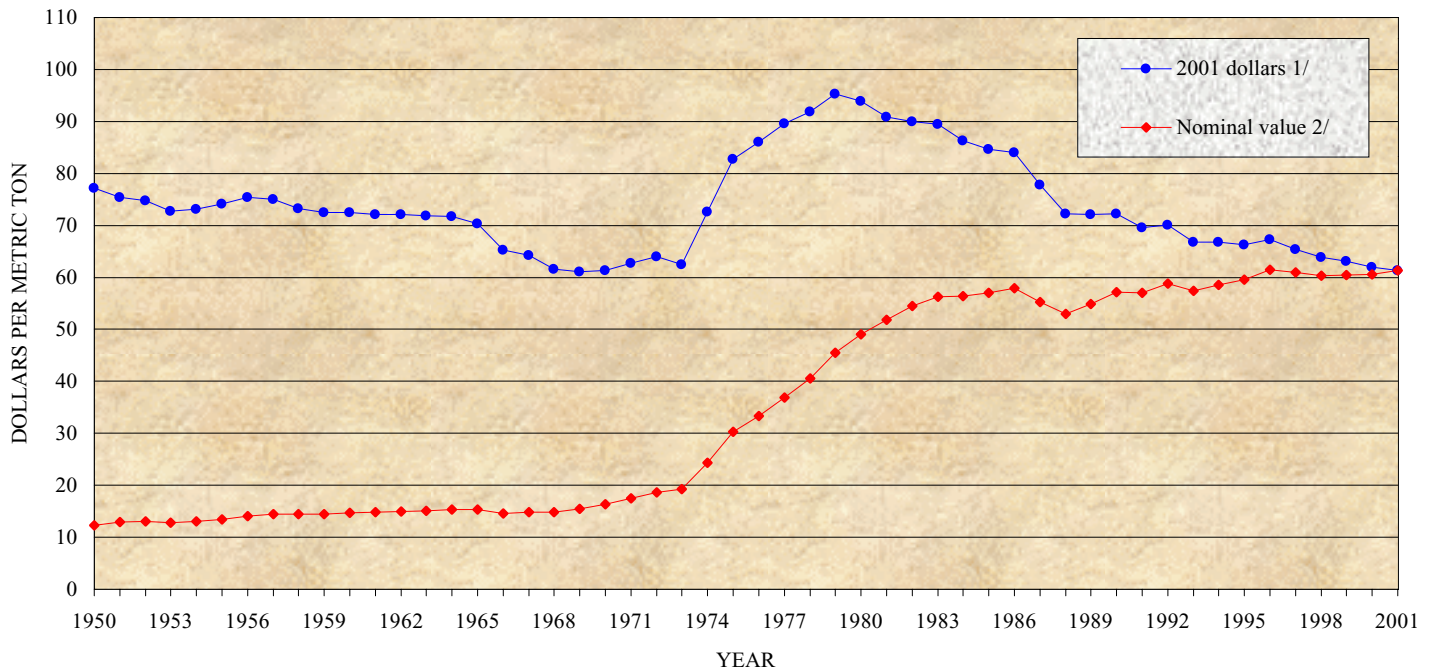
(Dollars per metric ton)

Year	Nominal value 1/	2001 dollars 2/
1977	36.90	89.66
1978	40.50	91.88
1979	45.50	95.25
1980	49.00	93.94
1981	51.80	90.83
1982	54.50	89.96
1983	56.30	89.42
1984	56.40	86.35
1985	57.00	84.60
1986	57.90	84.08
1987	55.20	77.83
1988	53.00	72.27
1989	54.90	72.11
1990	57.10	72.18
1991	57.00	69.53
1992	58.80	70.02
1993	57.40	66.75
1994	58.60	66.76
1995	59.50	66.33
1996	61.50	67.26
1997	61.00	65.44
1998	60.30	63.90
1999	60.40	63.12
2000	60.60	61.92
2001	61.30	61.30

1/ Value of all lime sold and used as prepared for shipment, free on board plant.

2/ Based on implicit price deflator for gross domestic product; base year is 2001.

FIGURE 3
AVERAGE VALUE FOR ALL LIME SOLD AND USED



1/ Based on implicit price deflator for gross domestic product; base year is 2001.

2/ Value of all lime sold and used as prepared for shipment, free on board plant.

During the past 50 years, the lime industry has adapted to major market changes that required product shifts and has seen some markets disappear and new ones appear. The industry weathered recessions, coped with new environmental regulations that resulted in the permanent closure of some plants, experienced periods of rising energy costs, and responded to threatened or shrinking margins. This has resulted in the construction of larger lime plants and the installation of larger and more energy-efficient lime kilns, such as modern vertical shaft kilns and preheater rotary kilns. In addition, the

industry has consolidated into a handful of major companies with the five largest accounting for more than 70% of production in 2001.

Internet References Cited

U.S. Energy Information Administration, [undated]a, Coal prices—1949-1999, accessed August 29, 2002, at URL <http://www.eia.doe.gov/emeu/aer/txt/tab0708.htm>.

U.S. Energy Information Administration, [undated]b, Crude oil refiner acquisition costs—1968-2000, accessed August 29, 2002, at URL <http://www.eia.doe.gov/emeu/aer/txt/tab0519.htm>.

TABLE 3
PRICE OF QUICKLIME SOLD IN THE UNITED STATES

(Dollars per metric ton)

Year	Nominal value 1/	2001 dollars 2/
1971	16.85	60.40
1972	18.02	61.95
1973	17.87	58.16
1974	23.39	69.84
1975	31.09	84.94
1976	32.87	84.99
1977	36.06	87.61
1978	40.12	91.03
1979	43.83	91.75
1980	48.83	93.62
1981	51.46	90.23
1982	52.81	87.18
1983	51.86	82.37
1984	51.50	78.85
1985	51.21	76.01
1986	53.46	77.63
1987	52.50	74.02
1988	51.10	69.68
1989	52.27	68.65
1990	54.62	69.04
1991	55.04	67.14
1992	55.48	66.07
1993	55.02	63.98
1994	56.43	64.28
1995	56.77	63.29
1996	57.26	62.63
1997	56.62	60.74
1998	57.00	60.41
1999	56.60	59.15
2000	57.60	58.86
2001	58.00	58.00

1/ Value of quicklime sold as prepared for shipment, free on board plant.

2/ Based on implicit price deflator for gross domestic product; base year is 2001.

TABLE 4
PRICE OF HYDRATED LIME SOLD IN THE UNITED STATES

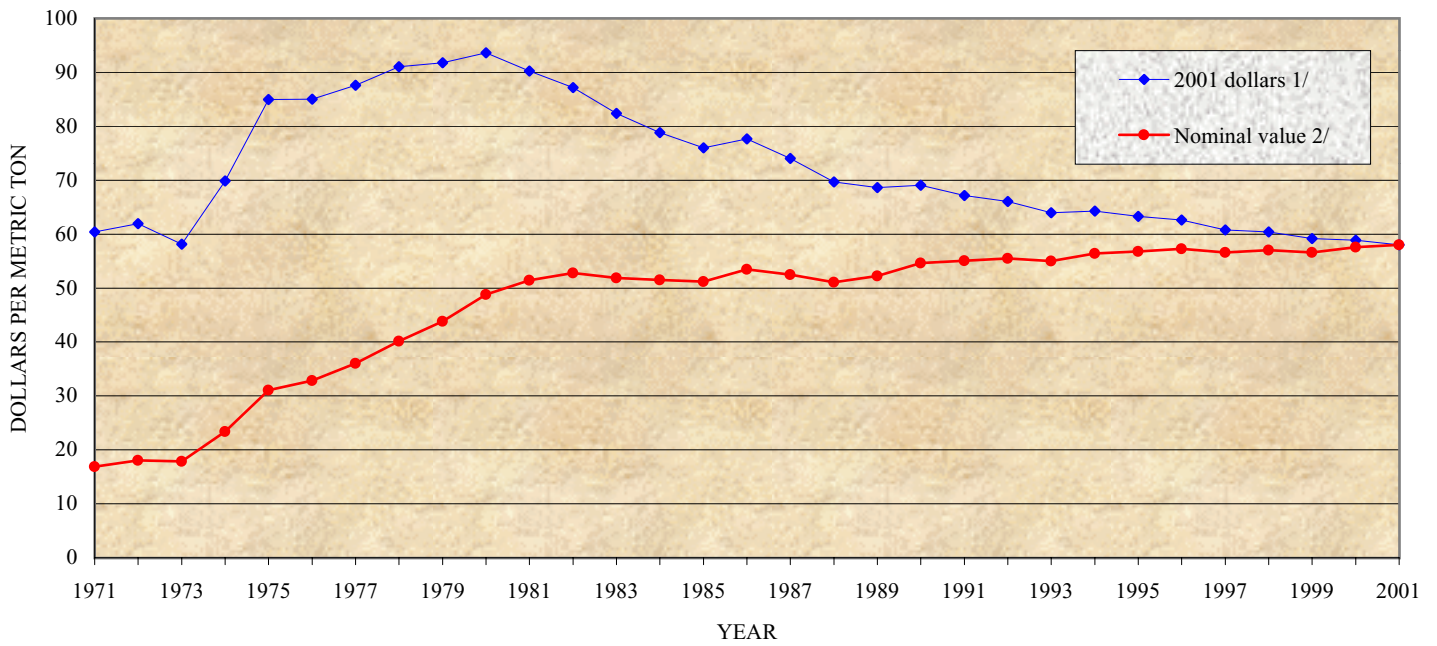
(Dollars per metric ton)

Year	Nominal value 1/	2001 dollars 2/
1971	19.06	68.30
1972	21.61	74.29
1973	22.70	73.89
1974	28.29	84.47
1975	32.54	88.92
1976	37.50	96.96
1977	40.21	97.70
1978	45.89	104.11
1979	52.73	110.39
1980	54.44	104.37
1981	59.03	103.51
1982	58.32	96.27
1983	66.28	105.27
1984	72.41	110.87
1985	74.47	110.53
1986	82.62	119.98
1987	69.67	98.23
1988	68.28	93.11
1989	68.52	89.99
1990	67.11	84.83
1991	69.78	85.12
1992	72.15	85.92
1993	67.84	78.89
1994	67.71	77.13
1995	72.09	80.37
1996	79.21	86.63
1997	80.43	86.29
1998	78.40	83.08
1999	80.30	83.92
2000	85.10	86.96
2001	80.80	80.80

1/ Value of hydrated lime sold as prepared for shipment, free on board plant.

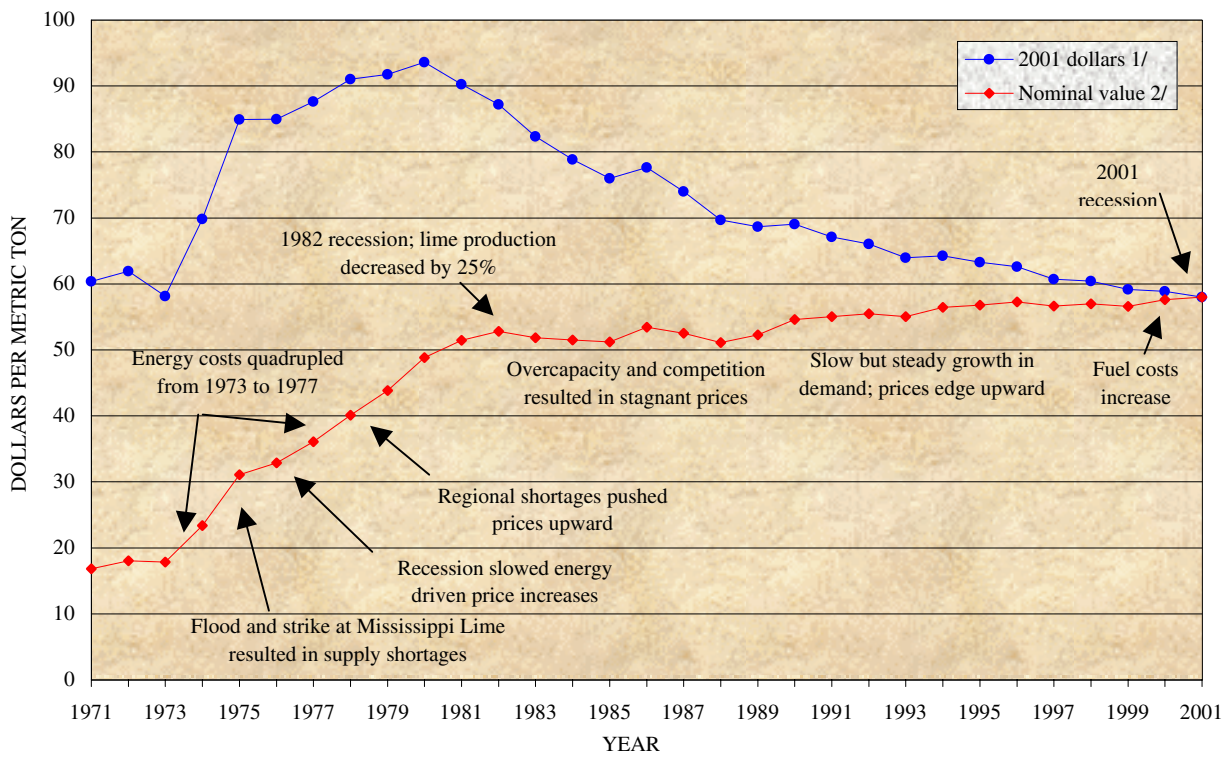
2/ Based on implicit price deflator for gross domestic product; base year is 2001.

FIGURE 4
AVERAGE VALUE FOR QUICKLIME SOLD



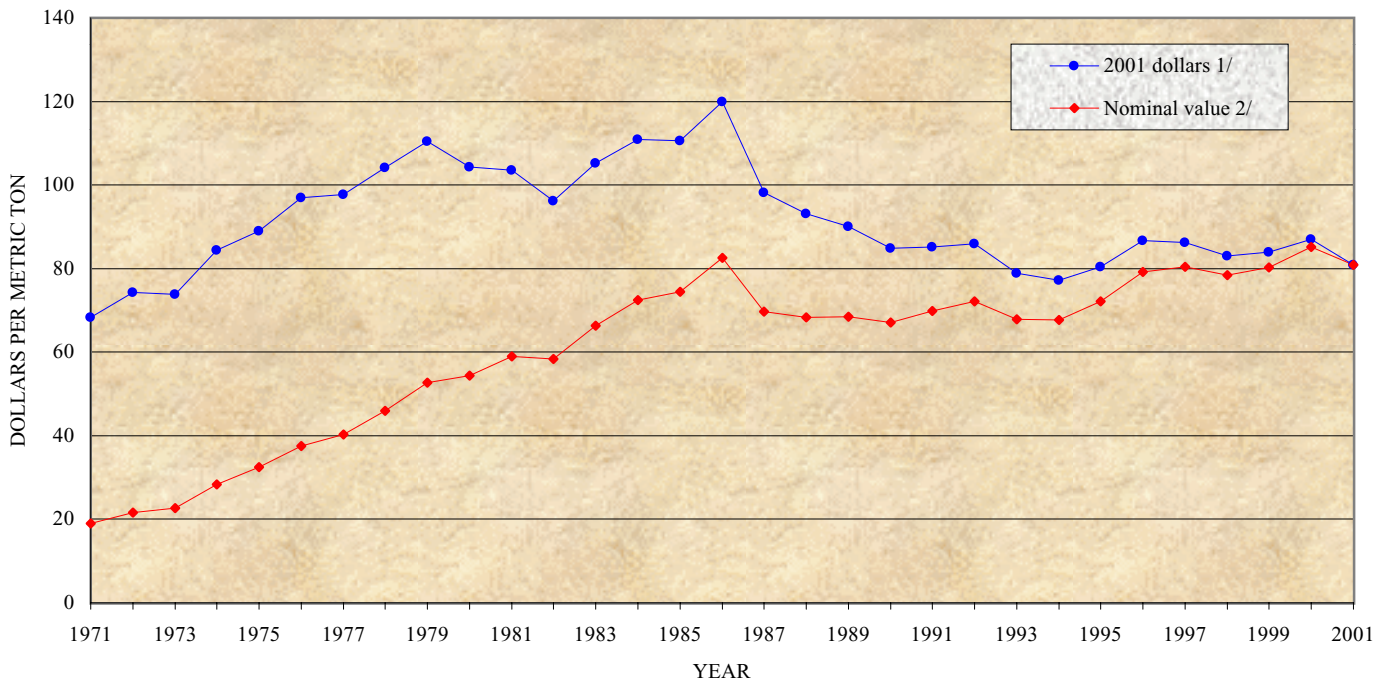
1/ Based on implicit price deflator for gross domestic product; base year is 2001.
2/ Value of quicklime sold as prepared for shipment, free on board plant.

FIGURE 5
SOCIOECONOMIC FACTORS AFFECTING AVERAGE ANNUAL QUICKLIME VALUES FROM 1971 TO 2001



1/ Based on implicit price deflator for gross domestic product; base year is 2001.
2/ Value of quicklime sold as prepared for shipment, free on board plant.

FIGURE 6
AVERAGE VALUE FOR HYDRATED LIME SOLD



1/ Based on implicit price deflator for gross domestic product; base year is 2001.

2/ Value of hydrated lime sold as prepared for shipment, free on board plant.

CHRONOLOGY OF LIME 1950 TO 2001

- 1950:** High level of industrial activity stimulated by the program of national preparedness and by the Korean conflict during the latter half of the year was reflected in a substantial increase in production in 1950. Sales were up 18% from the previous year.
- 1951:** Conditions that prevailed in 1950 resulted in a production increase of 10% above record output of 1950; chemical and industrial uses increased by 14% and dead-burned dolomite refractories by 12%.
- 1952:** Production continued at high levels, but decreased slightly because of a steel strike.
- 1953:** Steps were taken to include all captive lime in U.S. Bureau of Mines statistics, but coverage still was incomplete; additional discussion under "1959." Substantial gains were recorded for chemical, industrial, and dead-burned refractory uses.
- 1954:** Lime output declined considerably as the Korean conflict ended.
- 1955:** Production reached an all-time high. Consumption of lime for chemical, industrial, and refractory uses have tended to follow the trend of industrial production.
- 1956:** Another all-time high, but output increased only slightly compared with 1955. Dead-burned dolomite production increased but other general categories decreased. Building-lime sales have failed to keep pace with the strong upward movement of construction during the years since 1950. Building lime has lost market share to gypsum wallboard and portland cement mortars.
- 1957:** Production decreased as a result of declining business conditions, but road stabilization markets grew.
- 1958:** Output decreased by 10%, but substantial growth was recorded in road stabilization.
- 1959:** New production record reached owing to increased coverage of captive market. Output would have been higher but for a steel strike.
- 1960:** Industry made significant increases in capacity.
- 1961:** U.S. Bureau of Mines attained additional coverage of captive operations.
- 1964:** Record production was reported. Use for steelmaking in basic oxygen furnaces (BOF) is the fastest growing market. BOF technology is replacing the open hearth furnace, which is the major market for dead-burned dolomite.
- 1965-1966:** Record production reported for both years. Consumption for BOF continues to be fastest growing market.

1967: BOF market continued to increase and dead-burned dolomite decrease as a result of the continuing switch from open-hearth furnaces to BOF. Growth in capacity continued, mostly in captive steel sector.

1968: Quicklime sales increased 8%, pushed by BOF consumption. Capacity continued to expand, mainly in captive steel sector.

1969: Lime production reached a new high. Large consumption increases recorded for BOF and soil stabilization. New plant construction plans announced by steel companies and commercial lime companies.

1970: Clean Air Act Amendments enacted which, among other things, regulated emissions of sulfur dioxide and particulate matter. The first will create the flue gas desulfurization (FGD) market for lime while the latter will lead to the closure of numerous lime plants unable to absorb the cost of dust control technology. Dead-burned dolomite production continues to decline.

1970–1980: Some unprecedented peacetime shortages occurred resulting in a “sellers market.” A number of smaller, older lime kilns closed because they were unable to meet new particulate emissions standards promulgated by the U.S. Environmental Protection Agency. Production was lost because of strikes and shut downs caused by plants exceeding particulate emissions limits, natural gas curtailments, and time spent refitting kilns to burn coal instead of gas or oil.

1973–1974: Arab oil embargo occurred, which resulted in raised fuel prices. Lime prices responded by increasing by 74% between 1973 and 1975, although other industry-specific factors played a part, as noted in the “1974” discussion.

1974: A flood and 3-month strike at Mississippi Lime Co. caused industry shortage that extended into early 1975. Shortages added to upward pressures on lime prices.

1975: A recession resulted in decreased demand and slowed the rise in lime prices.

Late 1977 and 1978: Pronounced regional shortage developed, first in Texas and then spreading to the entire Southeast. By late 1978, supply was tight nationwide. At each instance of insufficient supply, consuming industries tended to look at alternative alkalis. Timely expansion of industry capacity to meet increased demand levels was hampered by increasingly complicated environmental and other regulations.

Late 1970s: During this period of high inflation, lime prices showed corresponding increases.

1982: Major recession occurred, very large decrease in raw steel production fueled an overall decrease in lime production of 25% compared with the previous year. Lime plants or individual lime kilns were idled or permanently shut down across the country.

1983: Lime output began to recover, but lime plant closures continued and others remained idle.

1984: Most markets showed growth, and overall output increased by 7%.

1986: Production declined by 8%; major causes were weak demand for steel and the closure of the last synthetic soda ash plant. First precipitated calcium carbonate satellite mill was built at a paper mill.

1987–1988: Production increased by more than 8% per year driven by increased consumption for chemical and industrial uses.

1990: Clean Air Act Amendments of 1990 were enacted into law. Title IV was amended to include a market-based system for reduction of sulfur dioxide and nitrogen oxide emissions. This will have a dramatic affect on lime sales for FGD, especially in 1995, the year that phase I of the law goes into effect. More information on phase I can be found under the heading “1995.”

1990s: Significant trends in the 1990s were industry consolidation and growth in sales for FGD, gold mining, precipitated calcium carbonate, and soil stabilization.

1990–1991: The lime industry weathered the recession; lime sales decreased only by about 1%.

1993: Lime output increased by 3.7% compared with previous year driven by solid gains in construction and FGD.

1995: Phase I regulations of the Clean Air Act Amendments of 1990 went into effect. Two large coal-fired power plants in Midwest began using lime scrubbers, and in a single year, FGD sales increased by nearly 37%. This made FGD the second largest market accounting for 14% of lime consumption.

1997: Severe spring flooding along the Mississippi and Ohio Rivers disrupted barge shipments, especially to powerplant customers in the upper Ohio River Valley.

1998: Carmeuse Lime Inc., which had acquired Marblehead Lime Co. in 1994 and the Pennsylvania lime operations of Tarmac America Inc. in 1996, acquired Dravo Lime Co. making it the largest lime producer in North America.

1999: The lime industry recorded its first decrease in production since 1991; decreases in the FGD, steel, and mining markets were the main causes. The two largest lime companies in North America got even bigger as Carmeuse merged its North American lime operations with those of Lafarge S.A. and Chemical Lime acquired APG Lime Corp.

2000: Natural gas prices began rising in the summer, and by December had spiked at nearly five times their previous price causing the temporary shutdown of gas-fired kilns across the country.

2001: The recession and a battered domestic steel industry resulted in a 700,000 t decrease in total production despite a 16% increase in construction sales.