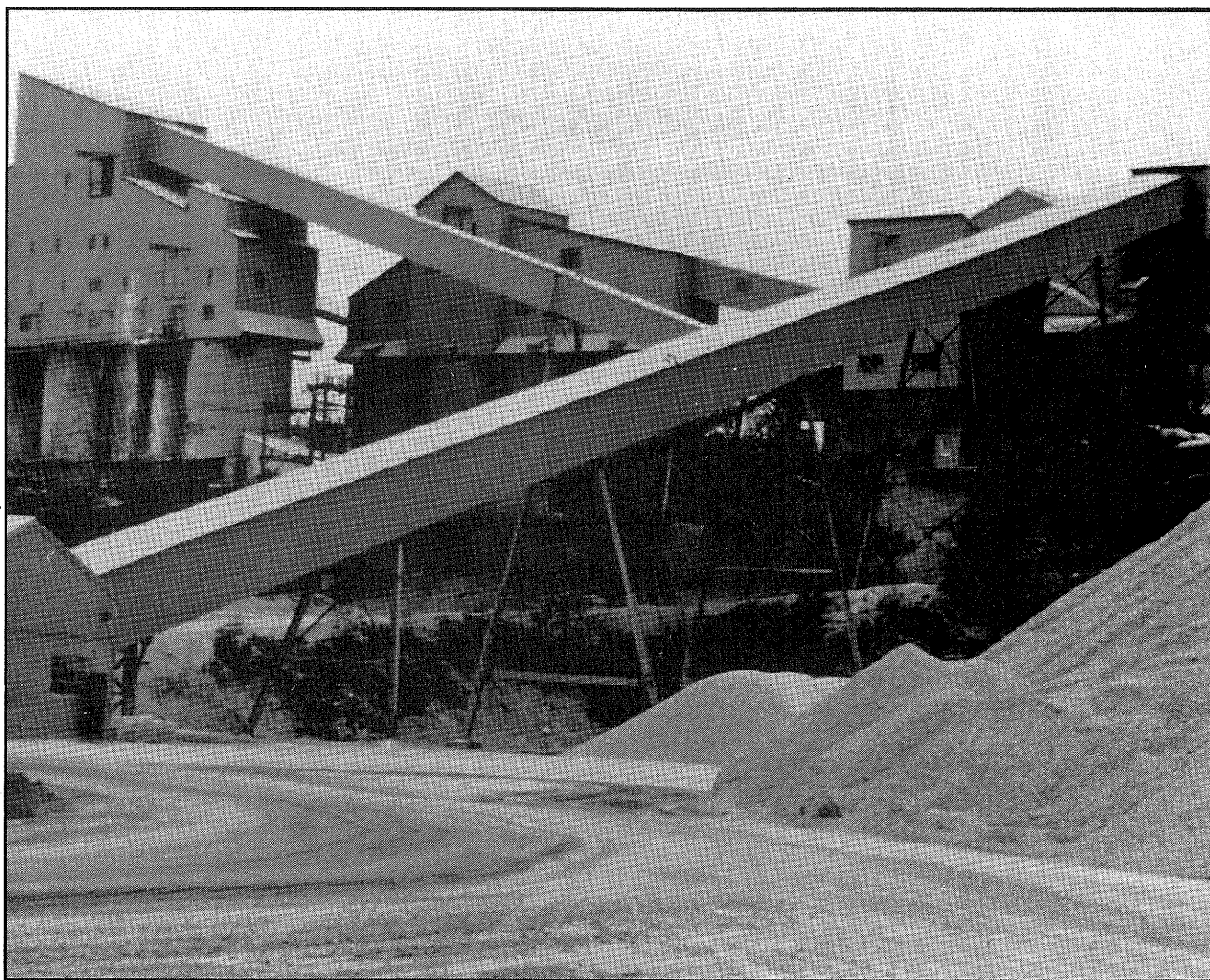


ILLINOIS MINERAL INDUSTRY IN 1990

and Review of Preliminary Mineral Production Data for 1991

Irma E. Samson



Department of Energy and Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY

ILLINOIS MINERALS 110
1992

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ILLINOIS MINERALS 110
1992

Cover photo
*Thornton Quarry, Materials Service Corporation,
Thornton, Illinois: Plant for screening crushed dolomite.*

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EXECUTIVE SUMMARY

This report covers three types of mineral industry operations in Illinois (fig. 1):

- extracting minerals from the ground
- processing crude minerals (mined primarily out of state) into raw industrial materials
- manufacturing mineral products such as coke, lime, and cement from minerals extracted and processed primarily, but not exclusively, in Illinois.

1990 Reported Value

The total reported value of minerals extracted, processed, and manufactured in Illinois during 1990 rose to \$2,915.0 million, 2.5% higher than the 1989 total. The total of the values reported to the U.S. Bureau of Mines (USBM) is not necessarily the actual value because many producers do not report their production figures. Minerals extracted accounted for 90% of the reported value; crude minerals processed and manufactured minerals accounted for the remaining 10%. Coal and oil continued to lead in value, followed by commodities from the industrial and construction materials category (table 1; tables begin on page 22).

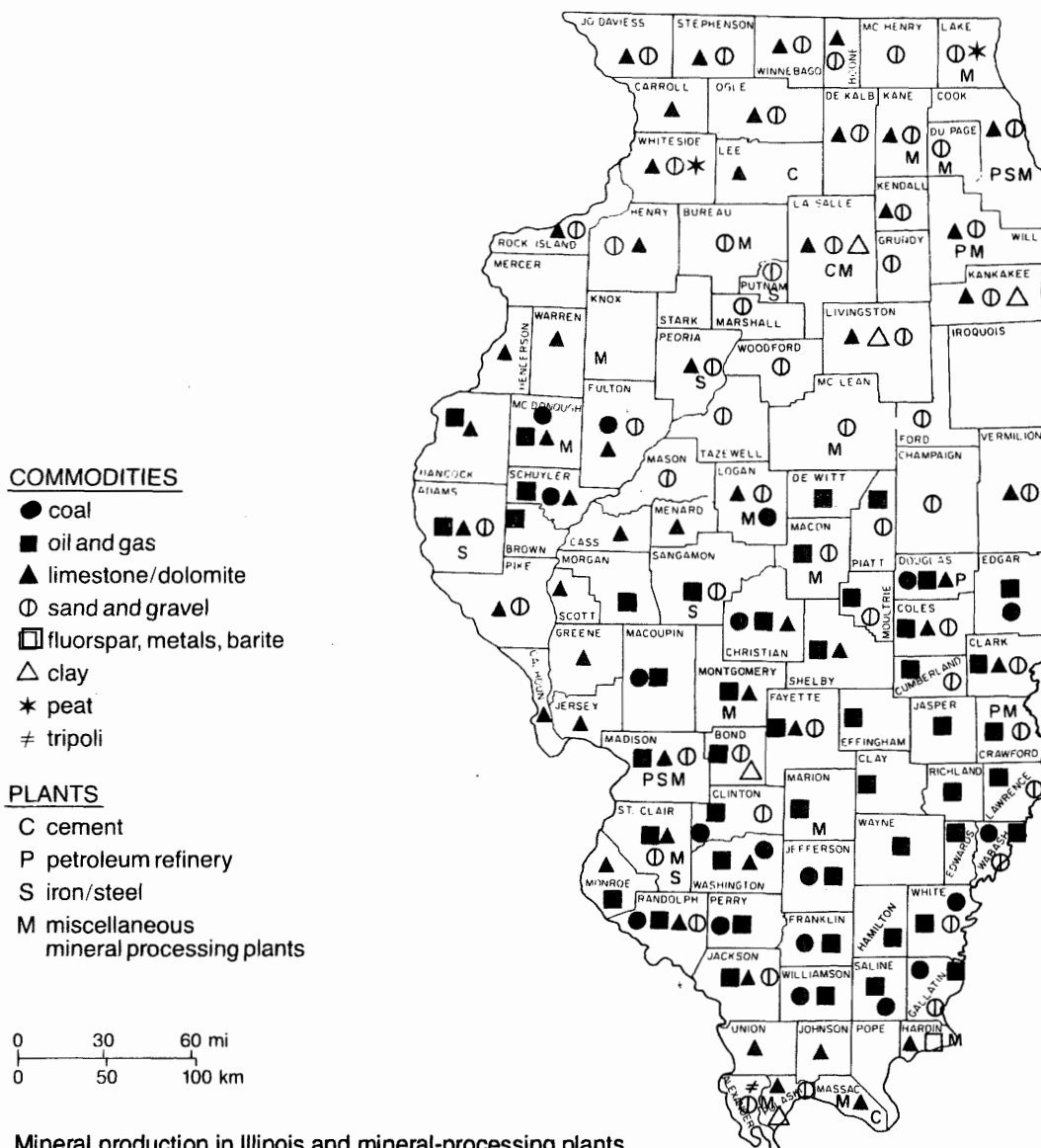


Figure 1 Mineral production in Illinois and mineral-processing plants.

Illinois produced 6% of the tonnage, which amounted to about 7.6% of the value, of coal produced nationally. The state continued to lead the nation in production of fluorspar, industrial sand, and tripoli. Production of stone was 5.1% and sand and gravel was 3.5% of the national total (table 2).

Extracted Minerals

In 1990, the value of commodities mined in Illinois was \$2,624.8 million, an increase of 2.9% over 1989. The mineral fuels of coal, crude oil, and natural gas accounted for 80.7% of the total. Industrial and construction materials such as clay, fluorspar, sand and gravel, stone, and tripoli accounted for 19%. The remaining 0.3% came from metals such as lead, zinc, and silver, and from other minerals such as peat and gemstones.

Mineral extraction in 1990 was reported from 98 of the 102 counties in Illinois (table 3, fig. 1). Only Iroquois, Mercer, Pope, and Stark Counties had no reported mineral extraction. Perry and Franklin Counties, major producers of coal and crude oil, accounted for 11.9 and 8.0% of the state's total value of minerals produced, respectively.

Processed Minerals

Figures for total reported value of processed minerals in 1990 are incomplete. The total includes only the figures for expanded perlite, sulfur, calcined gypsum, and exfoliated vermiculite. Minerals not included on this list but processed in the state, are natural gas liquids, iron-oxide pigments, ground barite, bismuth, columbium, tantalum, and primary and secondary slab zinc.

Manufactured Mineral Products

In Illinois, mineral products manufactured primarily from minerals mined within the state include cement (Portland and masonry), coke, clay products, lime, and glass. The average unit value of sales of Portland cement decreased 2.7%; that of masonry cement declined 12%. Lime production was down about 2% and its value dropped 1%. Clay products increased 1.6% in value. Figures are no longer available for coke or glass.

Employment

The Illinois Department of Labor requires that some of the data published by the Illinois State Geological Survey must henceforth be withheld. Jobs in mining, quarrying, and oil and gas extraction continued a downward trend, decreasing 1.0% from 19,800 in 1989 to 19,600 in 1990. According to the U.S. Department of Energy report, Coal Production, 1990, however, employment in the Illinois coal industry increased slightly from 10,003 in 1989 to 10,018 in 1990. Employment in the primary metal industries decreased from 56,300 in 1989 to 55,400 in 1990, a 1.6% drop (table 4).

Mineral Shipments

Mineral shipments are a large part of the Illinois transportation industry. Stone and sand and gravel are generally shipped by truck, because these products are primarily used near their sources. Coal is generally shipped by rail, barge, or rail/barge combination; only about 4% of the coal was moved to mine-mouth, electricity-generating plants by conveyor belt. Crude oil and natural gas are mainly transported by pipeline. Other materials such as fluorspar and clay products are shipped by rail, truck, and barge. Pig iron and coke are generally used on-site by integrated mills.

Consumption

In 1990, the value of the state's consumption of mineral commodities was about 4.5% to 5% of the nation's total, or about the same proportion as Illinois' share of the total U.S. population. In physical units, the consumption of minerals in Illinois varied from less than 1% of the U.S. total (for residual fuel oil) to almost 16% (for zinc) (table 5). The high consumption of zinc reflects Illinois' status as a major manufacturing state.

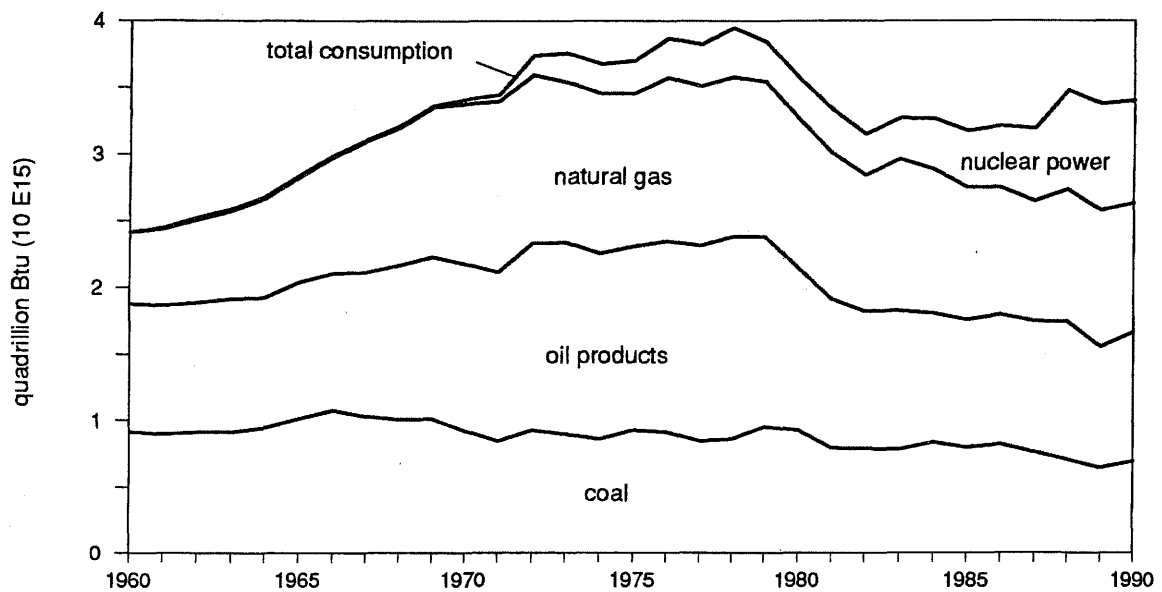


Figure 2 Energy used in Illinois, 1960–90.

The state's energy consumption was estimated at 3.4 quadrillion Btu in 1990 (4.2% of the U.S. total), about the same as in 1989 (table 6). Fossil fuels provided about 77% of the state's energy needs: oil and oil products supplied 28.5%, natural gas also supplied 28.5%, and coal contributed 20% (fig. 2). The consumption of nuclear power in Illinois dropped more than 4% from 802 trillion Btu in 1989 to 768 trillion Btu in 1990. Nevertheless, this is the second year that consumption of electricity generated by nuclear power exceeded the amount produced by coal in Illinois.

MINERALS EXTRACTED

Fuels

Coal

Production Production of coal in Illinois increased from 60.1 to 61.7 million tons in 1990, a 2.5% increase over tonnage reported in 1989. Total value was fixed at \$1,709.7 million. Unit value was \$27.73 per ton, a 1.6% decrease in per ton value from 1989 (table 7). Illinois continued to rank fifth in production, trailing Wyoming, Kentucky, West Virginia, and Pennsylvania.

Nineteen counties produced coal in 1990 (fig. 3), as compared with 21 counties in 1989. Perry, Saline, Franklin, and Randolph Counties together accounted for 51.8% of the state's total production. Perry County was again the top producer, contributing about 18.3% of all coal produced in the state. Approximately 91% of Perry County's output was surface-mined coal, representing more than 55% of the state's total output of surface-mined coal. In Saline County, 84% of its coal was produced from underground mines, contributing 14% to the state's total from underground mines. Franklin County, with all its tonnage coming from underground mines, contributed about 16% and

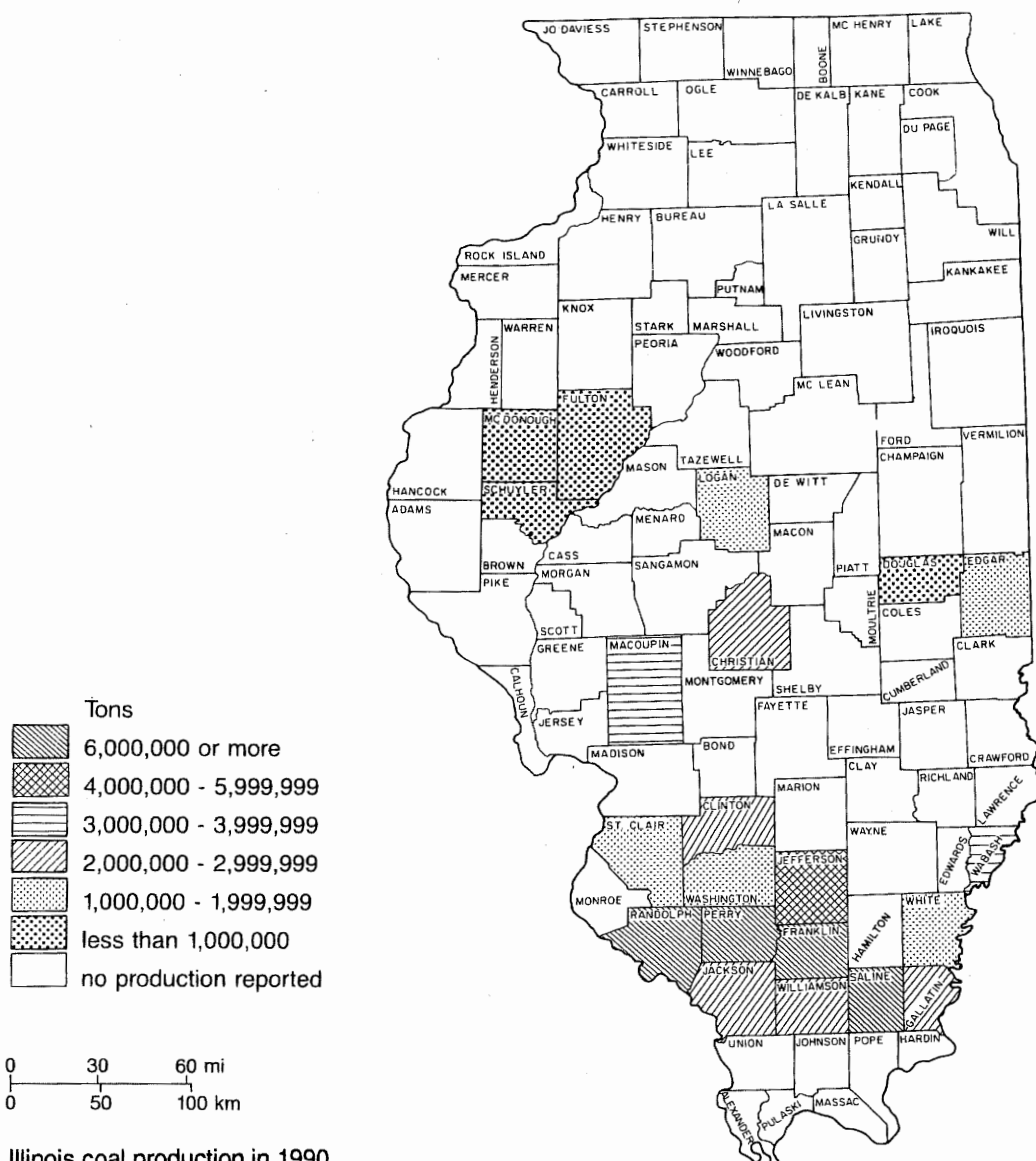


Figure 3 Illinois coal production in 1990.

Randolph County about 12% to the state's total production from underground mines. Other counties contributed substantially to underground coal mine production: Jefferson added about 10%, Wabash added 7.5%, and Macoupin, 7.3%. Approximately 70% of the state's total production came from underground mines and about 30% came from surface operations (fig. 4).

The number of coal mines operating in Illinois has steadily declined since the early 1900s. There were 920 mines in 1900. By the 1950s, approximately 200 mines were in operation. A rapid decline to about 60 mines had occurred by 1970. In the last half of the 1970s, the number of mines increased to about 70 as new mines opened after the first oil-price shock of 1974. Demand for coal did not increase, however, and the number of mines again fell. By 1990, only 42 mines remained in operation: 26 underground and 16 surface mines (fig. 5).

Since 1833, Illinois mines have produced more than 5.44 billion tons of coal (table 8). Surface mines operating since 1911 have accounted for 1.29 billion tons or 23.7% of the total. The average output per underground mine reached a peak of 1.52 million tons in 1975. Since then, the average output has fluctuated between 0.9 and 1.5 million tons per year. In 1990, the average output reached a new high of 1.72 million tons, 13.3% above the 1975 peak. The average surface-mine output has increased each year since 1977, except for a 10% decline in 1985, and reached a high of 1.31 million tons in 1989. In 1990, output decreased 11% to 1.2 million tons (table 9).

The trend in Illinois is toward fewer but larger coal companies. Of the 21 coal mining companies in Illinois in 1990, the top five—Zeigler, Peabody, Arch of Illinois, Consolidation, and AMAX—contributed about 64% of the state's total output (table 10). The share of the top five companies changed slightly as Zeigler purchased all the Old Ben Coal mines and became the largest coal company in Illinois. By comparison, the U.S. coal mining industry is much less concentrated. In

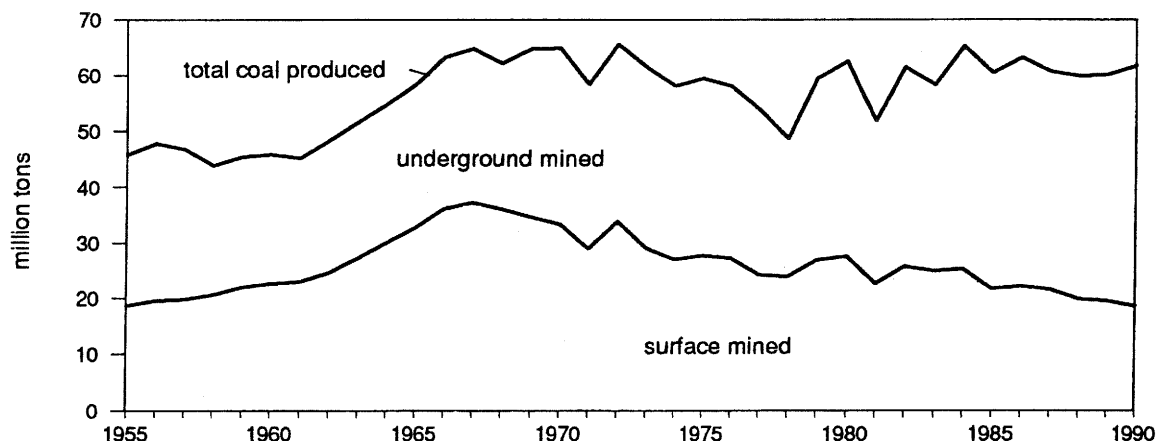


Figure 4 Trends in coal production in Illinois.

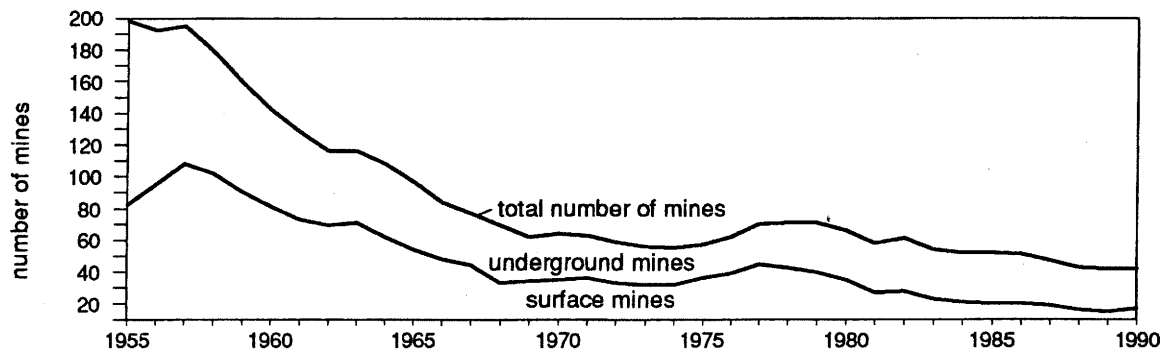


Figure 5 Trends in the number of mines in Illinois.

1990, the top five U.S. companies produced 24.5% of the national total. Peabody, Consolidation, and AMAX are also among the top five companies in the United States. The presence of large companies in Illinois gives financial strength to its coal mining industry. The downside is that during critical times—for example, following passage of the 1990 amendments to the Clean Air Act—production may shift away from Illinois mines to operations owned by the same companies in other states.

Employment and wages In 1990, employment in Illinois coal mines decreased by 8.8% to 10,129; the figure was 11,105 in 1989 (table 9). Employment in the mines has declined about 45% from the 1979 high of 18,499. Underground mines showed a 11.3% decrease, but surface mines showed an approximate 0.5% increase. The average hourly wage was estimated to be slightly higher in 1990 than in 1989 (table 4).

Mine productivity Productivity is calculated by multiplying average production per miner per hour by the average length of a miner's shift. Unrounded data are used in calculating percentages of changes. The labor productivity of underground mining operations increased by 11% from 20.35 tons in 1989 to 22.63 tons in 1990. The peak level was 22.9 tons in 1969, only 1.2% above the 1990 level. In surface mines, labor productivity decreased by 7.3% from 31.6 tons in 1989 to 29.3 tons in 1990. The peak year was 1967 with 41.6 tons (fig. 6). Although the average levels of productivity in U.S. underground and surface mines have surpassed the peaks reached in 1969 and 1974, the levels of productivity in Illinois mines have yet to return to their past peaks. In 1989, as figure 6 indicates, the productivity of the state's underground mines was surpassed by the U.S. average for the first time. The gap between the productivity of U.S. and Illinois surface mines has been widening since about 1975. This difference in productivity at the national versus state level indicates that the economic competitiveness of Illinois coal has declined during the 1980s.

Prices The average price (f.o.b. mine) of Illinois coal dropped 1.6% from \$28.17 in 1989 to \$27.73 per ton in 1990 (table 7). The average price of coal mined underground in Illinois was \$28.30 per ton, a 1.3% decrease from 1989; and the price of surface-mined coal was \$26.45 per ton, a 2.8% decrease.

Shipments Illinois coal was used in 20 states to generate electricity, manufacture coke, and supply energy for other industries. In 1990, about 90% of Illinois coal was sold to electric utility plants, about 2% to plants manufacturing metallurgical coke, and 7% to industrial plants and retail dealers (table 11). Shipments to electric utilities increased about 3% from 53.4 million tons in 1989 to 54.8 million tons in 1990. Only 29% was sold within the state. Out-of-state shipments to utilities increased less than 1%; 31% of the out-of-state shipments went to Missouri, 24% to Indiana, and 23% to Georgia and Florida.

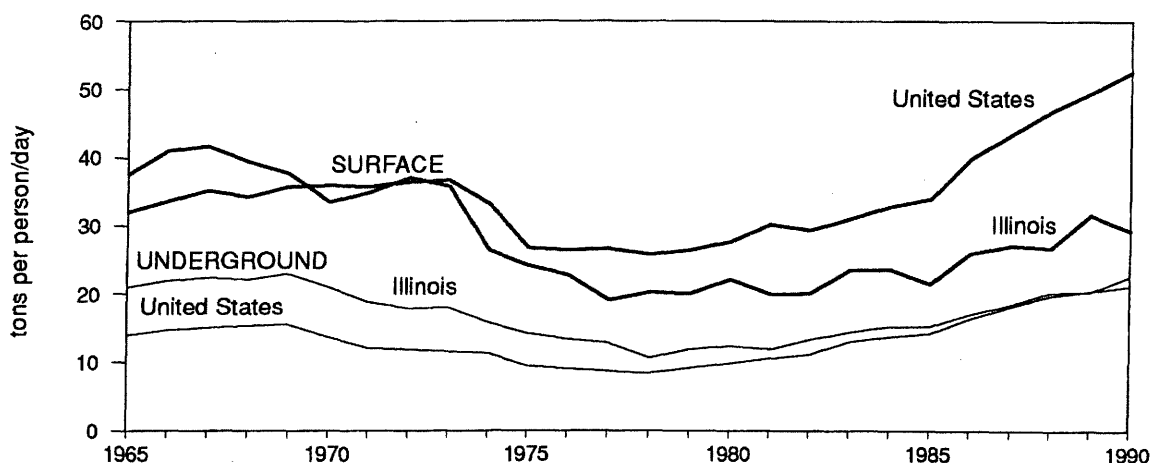


Figure 6 Trends in the productivity of coal mining in Illinois, 1965-90.

About 83% of Illinois coal used in making coke was shipped to coking plants in northwestern Indiana, and the remainder was consumed within the state. Of the Illinois coal used for other industrial activities, about 59% was consumed within the state, and about 20% was shipped to Missouri, 8% to Wisconsin, 6% to Iowa, and 4% to Indiana.

Transportation Coal was shipped from mines to the consumer by rail, barge, and truck. Barge or rail/barge combination has been gaining importance in Illinois as transportation costs become an important aspect of price competition. Illinois coal depends primarily on out-of-state markets and transportation costs must be kept low to compete with other coals.

	<i>Tonnage</i> ¹		
	1988	1989	1990
Rail	35,010,520	34,668,177	35,893,529
Barge or rail/barge ²	17,110,495	17,514,528	17,020,572
Local trade and truck ³	7,755,903	7,846,818	6,438,849
<hr/>			
Rail Lines			
Illinois Central	18,428,442	22,657,159	17,108,784
Union Pacific	15,026,302	10,795,330	14,346,093
Norfolk Southern	5,968,193	5,500,783	6,084,152
Chicago & North Western	1,748,509	1,953,006	1,850,480
Burlington Northern	2,574,678	1,827,505	2,200,114
Others	6,066,900	7,030,897	3,112,844
Total rail	49,813,024	49,764,680	44,702,467

¹ Tonnages do not total because part of the rail tonnage is shown in the combined rail/barge category, and some was shipped from inventory.

² Revised.

² Part of this coal sent from mine to barge-loading facility by conveyor belt.

³ Part of this coal was sent by truck to barge.

Source: Illinois Department of Mines and Minerals.

Consumption Illinois coal consumption increased 8% to 32.5 million tons after declining for three consecutive years. (table 12). Coal shipments from Illinois mines to Illinois markets have been declining steadily since the late 1960s. As can be seen in figure 7, coal imports from other states are increasing, probably because of the high sulfur content of Illinois coal and the impact of the Clean Air Act. In 1968, more than 82% of all the coal consumed in Illinois was also produced within the state; in 1990, in-state mines supplied only 58%. Total coal consumption in the state has been going down, although an increase of about 8% occurred in 1990. From 1986 to 1990, total coal consumed by electric utilities in Illinois declined about 16%—the result of the increasing use of nuclear energy. In 1990, however, the use of coal by these electric utilities increased about 7%. Coking-coal consumption increased 3% in 1990. Industrial consumption increased about 20% in 1990, after falling 32% in 1989.

Crude Oil

Production Crude oil experienced a decline (2.1%) in production for the fifth straight year. From 1985 to 1990, production decreased 34% (10.2 million barrels of oil). The 1990 production of 20.0 million barrels of oil was valued at \$406.5 million, with an average unit value of \$20.37 per barrel. This represents a 9% increase in per-barrel value since 1989 (table 1). The secondary production method of waterflooding accounted for approximately 9.1 million barrels of oil, or about 46% of the state's total. Pressure maintenance operations produced an estimated 41,000 barrels, or 0.2% of the state's total (fig. 8). About 3.4 billion barrels of oil have been produced in Illinois during the past 102 years (table 13).

Illinois ranked 13th of 31 oil-producing states in 1990. Forty-seven counties produced crude oil (table 13). The following six counties produced more than 1 million barrels each, contributing about 52.4% of the state's total oil production.

<i>County</i>	<i>1989</i>	<i>1990</i>	<i>County</i>	<i>1989</i>	<i>1990</i>
Lawrence	13.8%	12.9%	Wayne	7.6%	8.3%
Crawford	10.0	10.4	Marion	5.5	6.0
White	9.0	9.5	Wabash	5.0	5.4

An oil field producing more than 200,000 barrels per year is considered a major field. There were 12 major fields in 1990, a 20% decrease from the 15 major fields in 1989. The combined production of these 12 fields in 1990 amounted to 57.6% of the state's total output (table 14). The three largest fields—Lawrence, Clay City Consolidated, and Main Consolidated—each produced more than 2 million barrels during 1990 or 34.5% of the state's total. In 1990, there were 33 new wells with reported initial production of at least 100 or more barrels of oil per day. The highest initial production reported during the year was 315 barrels of oil per day from a field in Crawford County. The average daily per-well production in Illinois remains well below three barrels; thus the state remains highly sensitive to oil price changes.

Crude-oil production reached a peak of 147.6 million barrels in 1940 (fig. 8). From that level, oil production by primary recovery methods declined steadily until 1973, although some years showed small gains. The introduction of the hydraulic rock fracturing method in 1954 and the increased use of waterflooding stabilized oil production at about 78 million barrels per year from 1955 to 1962. Production fell steadily after 1962 as reserves were depleted. In 1989 and 1990, production was the lowest since 1937, when production was just 7.4 million barrels.

By December 1990, proved reserves were 131 million barrels, a 6.5% increase since December 1989. Current reserves are 81.3% below the 700 million barrels of reserves recorded in January 1956, the post-World War II peak.

Refineries At the beginning of 1991, Illinois had seven operating refineries, one more than the year before. The Indian Refining Company refinery (formerly owned by Texaco Refining and Mar-

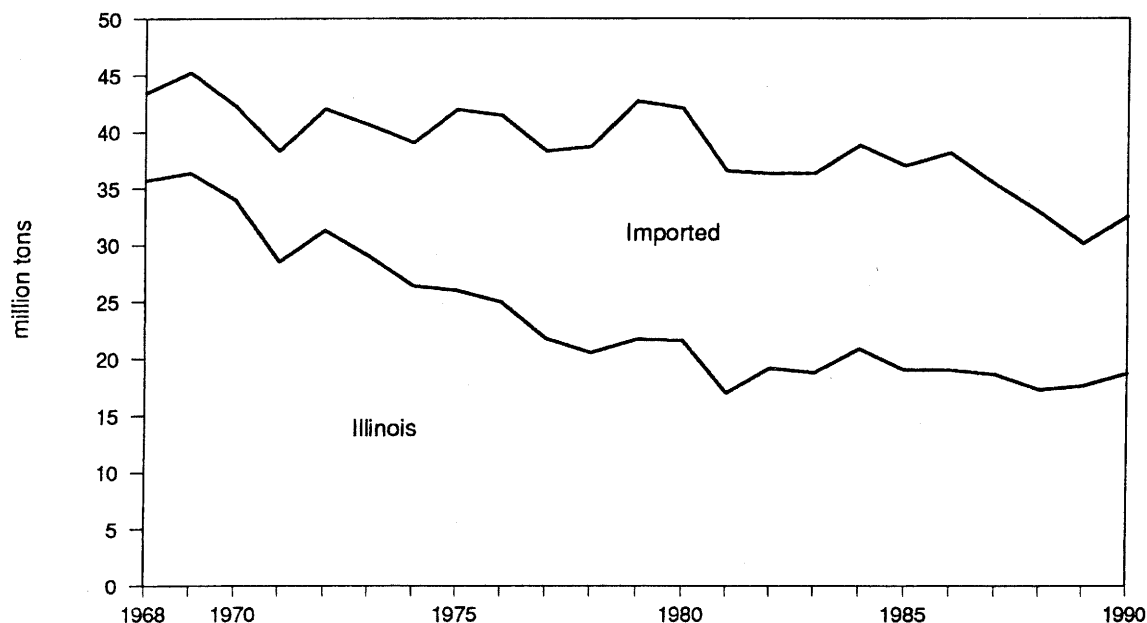


Figure 7 Coal consumption in Illinois, 1968-90.

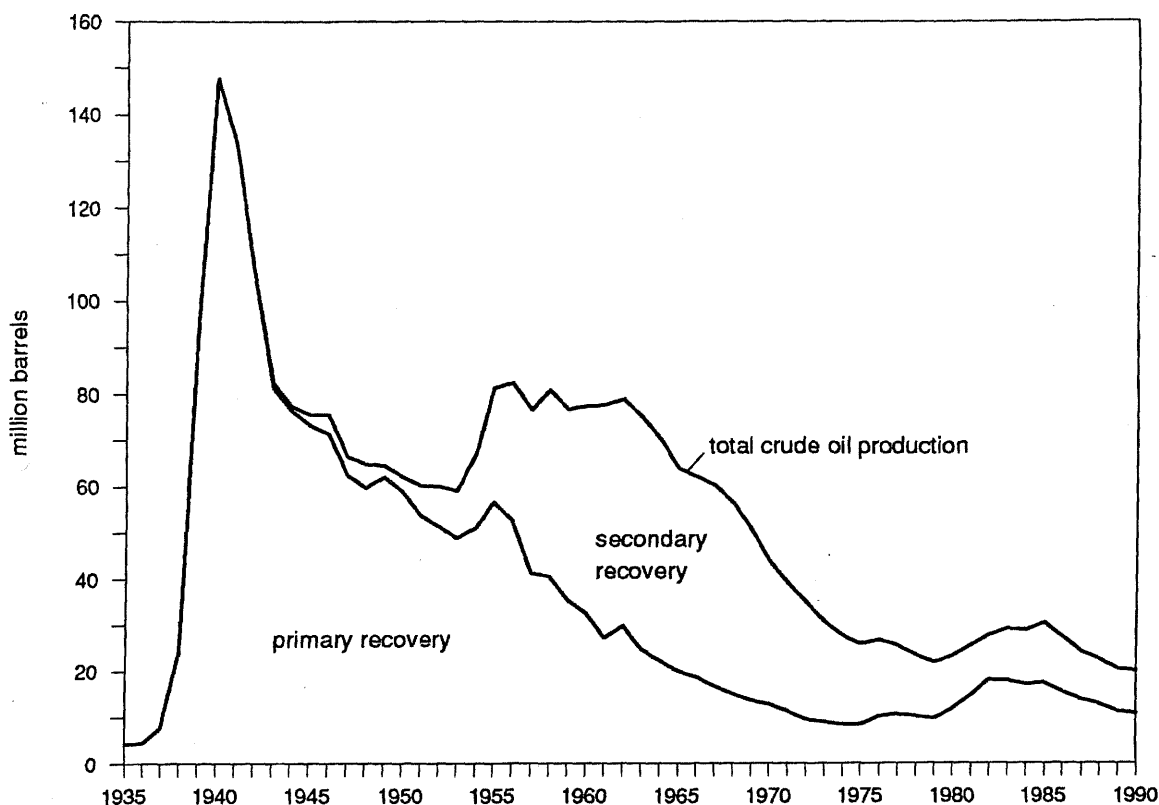


Figure 8 Annual crude oil production in Illinois.

keting) was reactivated in Lawrence County and became operable in August 1990. The other six refineries are located in Cook, Crawford, Madison, and Will Counties. Total refining capacity was 937,600 barrels of oil per day, or nearly 17 times the daily oil production in Illinois. Refining capacity was up 6.2% since January 1, 1990.

Consumption In 1990, reported consumption of major petroleum products in Illinois increased about 7% because of gains in motor gasoline and distillate fuel oil. Liquefied petroleum gases (LPG) slipped another 1%, after dropping about 66% in 1989. LPG is used as feedstock by the petrochemical industry and for manufacture of synthetic rubber. The use of kerosene, residual fuel oil, and liquefied gases declined; all other products increased (table 15).

Natural Gas

Production Natural gas is not produced in large quantities in Illinois. In 1990, the state's reported production of natural gas decreased 54%. Gas wells yielded 48.5% less than the previous year, and gas from oil wells dropped 88.5% (table 16). Three of the state's largest fields shut down: Prentice Pool in Morgan County and Keenville in Wayne County were closed temporarily. Fishhook in Pike County closed permanently; it had no production in 1990. Adams County was the top producer with about 27% of the state's total output. Williamson County came in second with 20%, and St. Clair County took third place with 15% (table 17). The average wellhead value of Illinois gas decreased 2% from \$2.15 per thousand cubic feet (Mcf) in 1989 to \$2.11 per Mcf in 1990 (table 1).

Consumption Reported consumption of natural gas in Illinois decreased 5.6% in 1990 (table 18), continuing a slow trend downward since 1971 (fig. 9). Residential consumption showed the largest decrease (11.6%); industrial use decreased slightly (1.1%). Although the largest

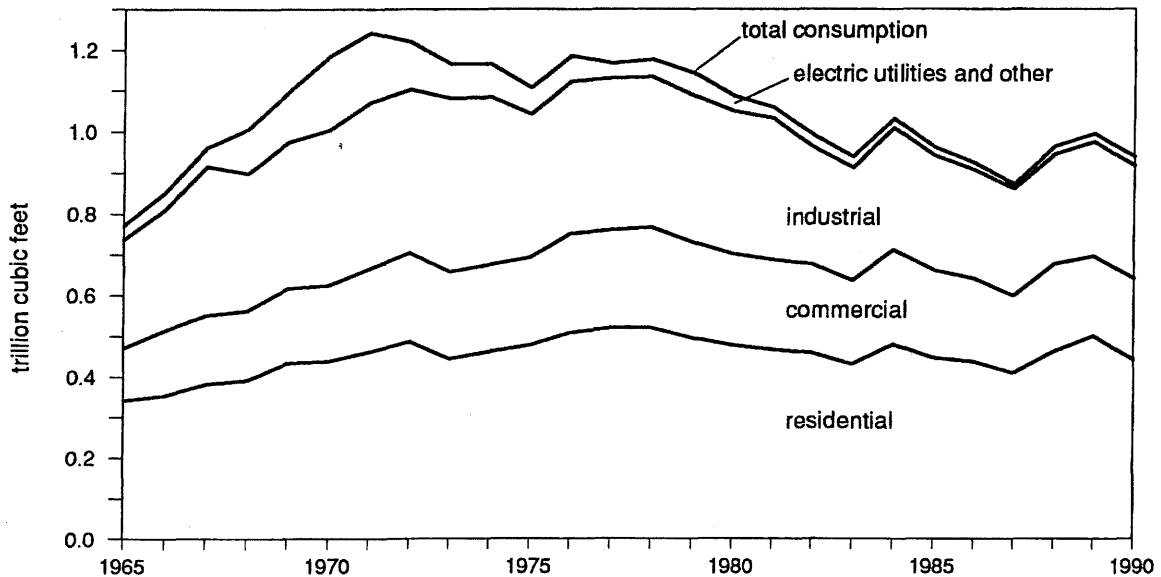


Figure 9 Consumption of natural gas in Illinois, 1965-90.

percentage of increased consumption (32%) was by electric utilities, it represented only a small volume of gas.

Industrial and Construction Materials

Primary Barite

As an accessory mineral in fluorspar ore, barite was recovered as a byproduct by the fluorspar industry of Hardin County from 1974 to 1985. But in 1985, Ozark-Mahoning, the only producer, shut down the barite circuit at its Rosiclare mill. In 1989, they reopened the circuit and produced barite. Production continued in 1990. Barite is used primarily as a weighting agent in mud systems for oil and gas drilling. Other uses include manufacture of paints, glass, rubber, and barium chemicals.

Clays

Production Both common clay and absorbent clay (fuller's earth) are mined in Illinois. Common clay is defined as a clay or claylike material that is sufficiently plastic to permit ready molding. Fuller's earth is a clay or claylike material that has absorbing, decolorizing, and purifying properties.

The USBM reported that Illinois' clay production (excluding fuller's earth) made a large jump from 156,756 tons in 1989 to 659,710 tons in 1990 (fig. 10). The U.S. clay industry fell by 5% in 1989, although it had been growing steadily for several years. In 1990, growth resumed and total U.S. production of common clay increased by 1.5%. In Illinois, a downturn in the clay industry began 20 years ago as competition from cheaper southern clays became keen. The large increase in production reported for 1990 could not be verified; but the USBM stated the increase was due to quarry tile. Without it, Illinois clay production would have remained about the same as in 1989. The clay experts at ISGS believe that no significant increase in quarry tile production actually occurred in Illinois and that the reported increase is an error.

The average value per ton of common clay in 1990 decreased to \$3.81, although the total value, as reported by USBM, jumped to \$2,516,000. Production of common clay was reported from six companies in four counties. Livingston County was the leading producer of common clay, with Bond County running second. La Salle and Kankakee counties also produced common clay. Two companies produce absorbent clay (fuller's earth) from Pulaski County. Their combined production decreased 2.3%, although the value increased 3.2% in 1990.

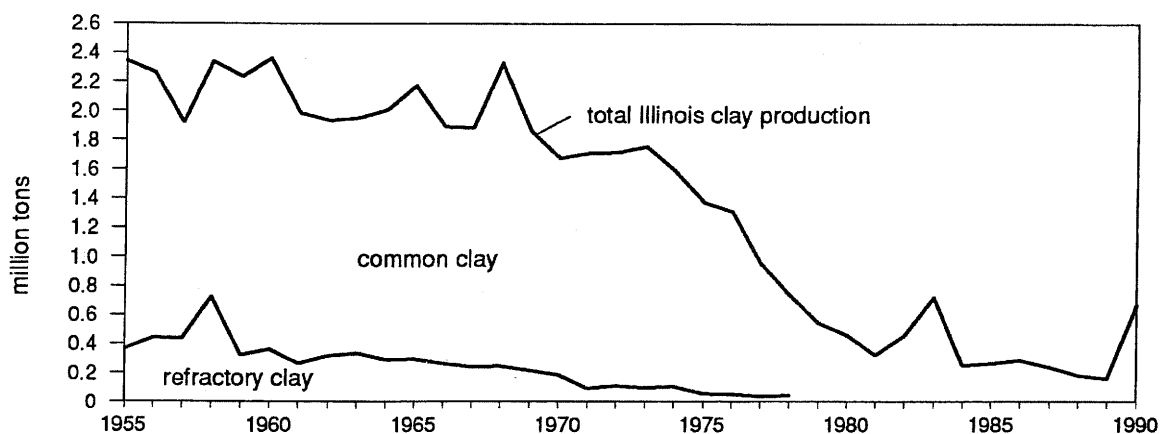


Figure 10 Trends in clay production in Illinois, 1955–90.

Uses Common clays and shales mined in Illinois are used to manufacture bricks, sewer pipes, drain tiles, wall tiles, dinnerware, lightweight aggregates, and cement. About 4.2% of the state's common clay production in 1990 was used for Portland cement, structural concrete, and concrete blocks. Sales of Illinois clay to manufacturers of sewer pipe and drain tile accounted for the remaining production.

Fluorspar

Production and shipments U.S. production of finished fluorspar dropped 3.8% from 66,000 tons in 1989 to 63,500 tons in 1990. (For comparison, the lowest production since 1938 was recorded in 1983 at 61,000 tons.) One major producer and two small producers supplied the 1990 production, which was 11% of the nation's fluorspar requirements. The United States depends on foreign sources for most of its fluorspar.

Illinois continued to be the nation's leading producer of fluorspar, although small amounts were also produced by Nevada and Utah. Barite, zinc (sphalerite), and lead (galena) concentrates were recovered as coproducts of fluorspar processing in Illinois. In addition to the fluorspar mined in the United States, about 46,754 tons of byproduct fluosilicic acid (FSA), equivalent to 82,287 tons of fluorspar, was recovered from seven phosphoric acid plants processing phosphate rock. FSA is used primarily in water fluoridation, either directly or after being converted to sodium silicofluoride. It is also used by the aluminum industry.

Ozark-Mahoning Company, the nation's largest fluorspar producer, operated a flotation plant near Rosiclare in Hardin County and three mines—the Annabell Lee, the Denton mines, and the re-opened Minerva No.1 Mine formerly owned by the Inverness Mining Company. Ozark-Mahoning dried imported fluorspar to supplement production. At facilities in Cave In Rock, the Seaforth Mineral and Ore Company also dried imported fluorspar, primarily for consumption in the ceramic industry.

Consumption Reported consumption of fluorspar (acid spar and metallurgical spar only) in the United States dropped for the second year. The 1988 revised figure is 651,055 tons. In 1989, there was a 1.4% decrease to 641,882 tons, and in 1990, a 12% drop to 564,545 tons. More than 57% of the reported output went into the production of hydrofluoric acid, the primary ingredient in most organic and inorganic fluorine-bearing chemicals. Hydrofluoric acid is also used in processing aluminum and uranium. About 20% of the fluorspar produced was used by the steel industry as a flux and in iron and steel foundries. The remainder was used to manufacture glass, welding-rod coatings, and enamels, and to fluoridate water (fluosilicic acid).

The apparent U.S. consumption (production + imports - exports ± change in stocks) decreased from 693,121 tons in 1989 to 586,856 tons in 1990, a 15% loss. The discrepancy between

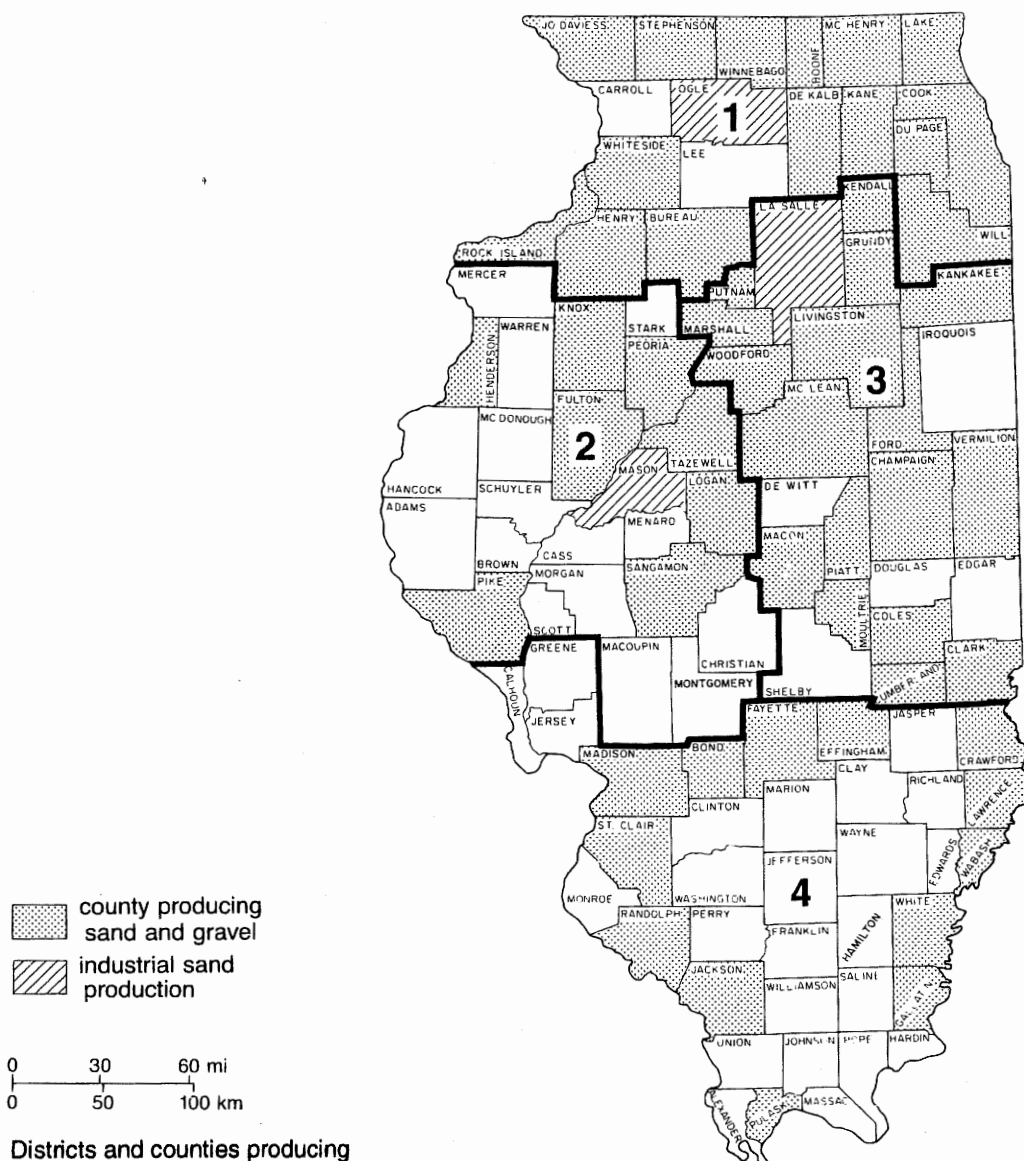


Figure 11 Districts and counties producing sand and gravel in 1990.

apparent and reported consumption is often large for many minerals, including fluorspar, because not all users report consumption to the USBM.

Sand and Gravel

Since 1981, the USBM has been surveying sand and gravel producers only in even-numbered years. Estimates are published in odd-numbered years. In 1985, the USBM began compiling sand and gravel production by district rather than by county so that the confidentiality of individual producers would be preserved (fig. 11). Data for individual counties are no longer available.

Production Sand and gravel deposits are widely distributed in Illinois. Glacial deposits, chiefly valley trains and outwash plains, are the principal sources of construction sand and gravel. Production in 1990 was 32.4 million tons, about 2% less than the 1989 estimate of production. The combined value of sand and gravel was \$104.7 million (table 19), with an average estimated unit value at the pit of \$3.23 per ton, about 2% less than the 1989 estimate (table 1). Illinois ranked seventh of 50 states in production of sand and gravel in 1990. The Meyer Material Corporation at McHenry

ranked sixth among the U.S. sand and gravel plants, but the company ranked first in Illinois. The Vulcan Materials Corporation Crystal Lake plant ranked 12th in the nation and second in Illinois.

Seven counties (McHenry, Kane, Lake, Cook, Grundy, Woodford, and Peoria), all producing more than 1 million tons, accounted for about 70% of the sand and gravel production in Illinois. District 1 accounted for 63%, District 2 for 10%, District 3 for 19%, and District 4 for 8%. In 1990, 105 companies operated 144 pits at 143 operations in 55 counties of Illinois (fig. 11). About 49% of the state's production came from operations of 1 million tons per year and more, as compared to 35% in 1988 (table 20).

Transportation Because of its low unit price, most construction sand and gravel is not shipped farther than about 50 miles from the pit, although operations on navigable rivers may ship material much farther by barge. About three-quarters of the material was shipped by truck in 1990, with the remainder shipped by barge or rail, or used at the pit, for example, in asphalt production.

Consumption and uses The production reported is actually the material sold or used; stockpiled production is not reported until it is sold or consumed. Illinois sand and gravel is primarily used as various types of construction aggregate for building and roads (table 21).

Industrial Sand

Production The area best known for production of industrial sand (silica sand) from the St. Peter Sandstone of Middle Ordovician age is the Ottawa district of La Salle County. Within the district, the St. Peter is referred to as the Ottawa Sand. Illinois maintained its ranking as first among 38 states in industrial sand production for 1990, accounting for 4.5 million tons (16% of the U.S. total). This was a 2% increase over the tonnage reported for 1989. The total value increased 18% to \$62.5 million. The average unit value was estimated at \$13.94 per ton, an increase from \$11.55 per ton in 1989. Five companies operated seven pits in La Salle, Mason, and Ogle Counties.

Transportation Industrial sand was shipped mainly by rail in 1990, although a significant amount is still shipped by truck and a small amount by barge.

Consumption and uses Industrial silica sand was produced in two forms, ground and unground. Unground sand was used primarily in glass manufacturing, but other products included molding sand, blasting sand, grinding and polishing sand, railroad traction sand, filtration sand, and propping sand for hydrofracturing reservoir rock (frac sand) in oil wells. Ground sand was used in chemicals, abrasives, enamels, pottery, porcelain, tile, and various fillers.

The Unimin Corporation's plants in La Salle and Ogle Counties were among the leaders in production for the glass, foundry, and frac sand markets. Fairmont Minerals, operating in La Salle County, was a major producer for the blasting, foundry, and glass sand markets. U.S. Silica's plant, also in La Salle County, was a large producer of glass, frac, and foundry sand.

Stone

Since 1981, the USBM has been surveying stone production only in odd-numbered years. Actual data are given for 1989 and estimated data for 1990. In 1985, the USBM began compiling stone production in Illinois by district (fig. 12). Data for individual counties are no longer available.

Production Of the 48 states producing crushed stone, Illinois ranked fourth behind Pennsylvania, Texas, and Florida. Total Illinois stone production in 1990 was estimated to be 62.7 million tons, an increase of 3% from the 1989 total. The estimated total value was \$283.1 million, a 10% gain.

In 1989, the latest year for which actual figures are available, 54 of the state's 102 counties reported stone production (fig. 12). Crushed stone was produced by 103 companies in 178 quarries.

Vulcan Materials Company in 1989 had 118 plants in the United States; the combined production made Vulcan the largest U.S. producer. In Illinois, they ranked second, however, with only

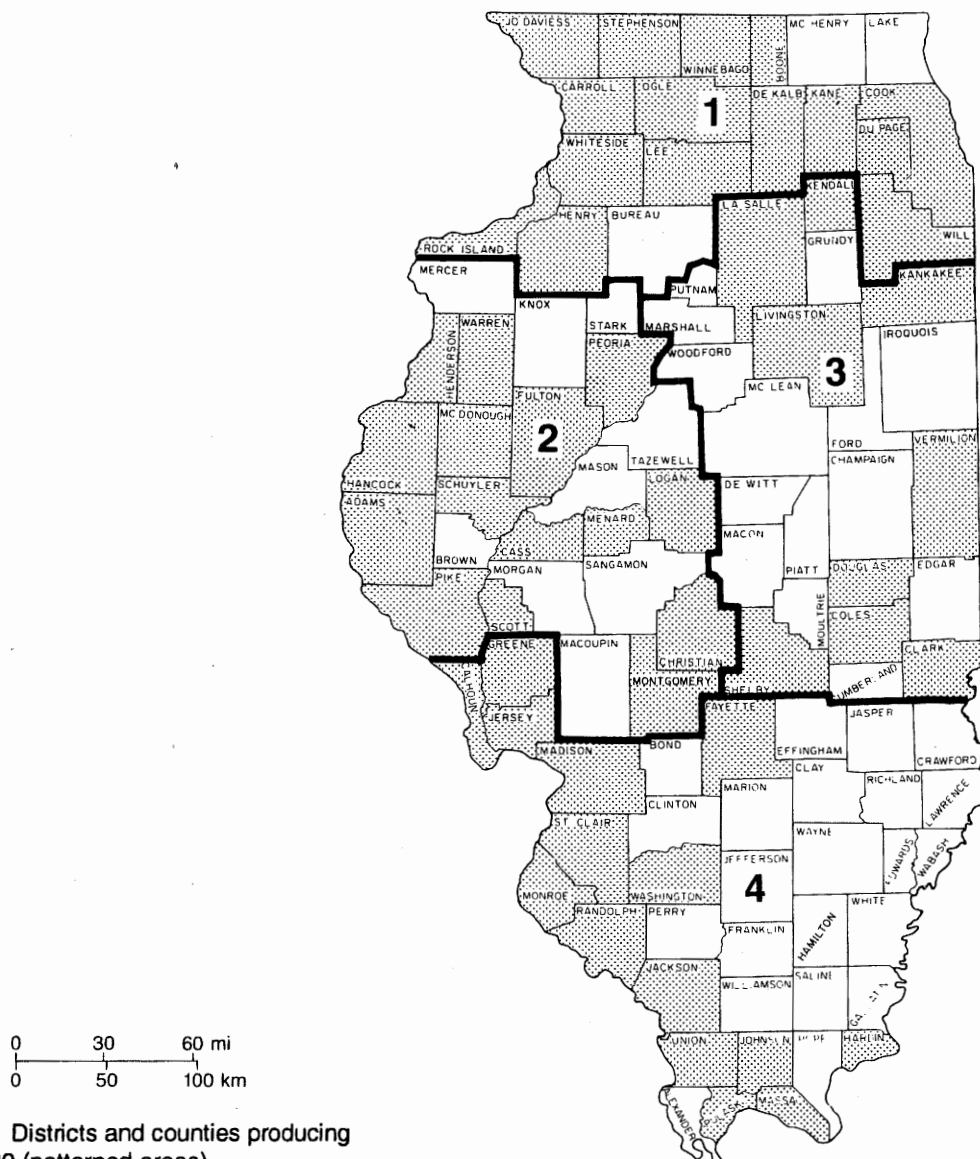


Figure 12 Districts and counties producing stone in 1989 (patterned areas).

nine operations. Material Service Corporation ranked eighth among producers in the nation, but ranked first in Illinois.

Shipments Stone, a bulk commodity, is used primarily near the quarry, and 58% of it was transported by truck. Another 33% was moved by rail or barge, but much of the remainder was used at the site. Waterways were put to use by some producers along the Illinois, Ohio, and Mississippi Rivers. Crushed stone was barged to in-state destinations as well as to Pennsylvania and Gulf Coast markets in Alabama, Texas, and Louisiana. The Illinois Central Railroad uses stone produced in Illinois for ballast throughout the entire system.

Consumption and uses Construction aggregate, Portland cement, road-base stone, and materials for bituminous highway construction are the main uses for stone. It is also used for chemical, agricultural, and other purposes. The small amount of dimension stone mined in Illinois is used as veneer in house construction, small retaining walls, rubble, and flagging.

Tripoli

Production The term tripoli refers to microcrystalline silica. The Unimin Corporation combined two operations, the former Illinois Minerals Company (a division of Georgia Kaolin Company) and Tammsco (a division of Unimin) to become the nation's leading tripoli producer, Unimin Specialty Minerals Inc. The company is located in Alexander County in southern Illinois.

Illinois has remained the nation's largest producer of tripoli, accounting for more than half the total U.S. production in 1990. Although actual production figures are confidential, crude tripoli production in Illinois declined about 10% from 1989 to 1990. Value increased about 22%.

Consumption and uses Tripoli processed in Illinois was used as filler in paints, plastics, and rubber products, and as abrasives in buffing and polishing compounds, soap, and toothpaste. Some iron-stained tripoli is now being used in the manufacture of Portland cement. Processed material sales dropped 9%, but value rose about 20%.

Metals

Zinc, Lead, Silver, and Copper

Production Minerals bearing zinc, lead, silver, and copper were recovered from fluorspar ore mined in Hardin County by Ozark-Mahoning Company. In 1990, zinc production increased 7%, but value dropped 3%. Lead decreased 54% in production and 47% in value. Copper produced from sulfide concentrate rose 42%; its value increased 31%. Silver dropped 57% in production and 60% in value. Because these metals are byproducts of the fluorspar industry, they are produced in relatively small quantities and add only a small amount to the total value of minerals produced in the state.

Other Minerals

Peat

The USBM formerly classified peat as a fuel. Because all commercial sales of peat in the United States (excluding imports) are for agricultural and horticultural purposes, peat has been placed in the nonfuel category. Three major kinds of peat—reed sedge, moss, and peat humus—were produced by four companies in Lake and Whiteside Counties. More than 99% of the peat produced in Illinois was sold in packaged form, almost entirely for general soil improvement. Peat production and value remained approximately the same in 1990 as in 1989.

Approximately 80 peat operations are active in 22 peat-producing states. Florida and Michigan led all states. Production in Illinois, Indiana, Minnesota, New Jersey, and Wisconsin was about equally balanced, accounting collectively for about 20% of the U.S. total. The market for domestic peat stabilized in 1990 after a downturn in market conditions during 1988 and 1989. The overall downturn in the U.S. peat industry since 1987 has been attributed mainly to the general decline in economic growth, new emphasis placed on commercial composting, recycling of yard wastes by the public and private sectors, and competition from Canada.

Gemstones

Because production is limited to specimen-grade fluorite and accessory minerals collected in the fluorspar mines in Illinois, gemstones contributed little to the total value of mineral production. The value of gemstones rose substantially in 1989, followed by a small drop in 1990. The estimated value of gemstones must be withheld.

MINERALS PROCESSED

This category refers to minerals extracted mainly in other states or foreign countries but processed in Illinois. These minerals include ground barite, columbium and tantalum, calcined gypsum, crude iodine, iron-oxide pigments, natural gas liquids, expanded perlite, pig iron, sulfur, exfoliated vermiculite, primary slab zinc, and secondary slab zinc. Because the two largest producers of pig iron

did not respond to the USBM annual survey, no figures are available for pig-iron production in the state. The values of several minerals processed in Illinois cannot be disclosed, thus the "total value of mineral materials processed" (as indicated in table 1) is not the true value.

Ground Barite

Three Illinois companies—American Minerals at Rosiclare in Hardin County, Harcros Pigments (formerly Mineral Pigments and Metals) at East St. Louis in St. Clair County, and J. M. Huber at Quincy in Adams County—continued to process ground barite. The Illinois product is used almost exclusively as a filler or an extender in paints.

Columbium and Tantalum

Fansteel in Cook County is no longer processing columbium-tantalum concentrate imported from foreign countries, but retains its corporate office in North Chicago. Columbium and tantalum are used primarily to produce various steel alloys.

Calcined Gypsum

Calcined gypsum, used primarily for prefabricated housing materials such as wallboard, is processed by the National Gypsum Company in Lake County. Use of gypsum wallboard in elevator shaft walls, manufactured (mobile) homes, and home and office remodeling has increased steadily every year. Repair and remodeling remained a strong market for the gypsum industry. Production of calcined gypsum stayed about the same in 1989 as in 1988, but it declined 3.4% in 1990. The decline is expected to carry through 1991 because of the sluggish economy, then production should slowly climb with an improving economy. Value also declined 3.4%.

Gypsum from flue-gas desulfurization (sulfo-gypsum) has not entered Illinois markets because the state has no plants generating large quantities of usable gypsum. Also, there are marketing problems associated with the color and purity of sulfo-gypsum.

Crude Iodine

Crude iodine was processed into inorganic compounds for commercial use at three Illinois plants: Allied Signal Company at Metropolis in Massac County, West Agro Inc. at Des Plaines in Cook County, and ECHOLAB Inc. at Joliet in Will County. Although crude iodine is used primarily as a catalyst or stabilizer, it is also added to animal feed, salt, inks, colorants, pharmaceuticals, and sanitary and industrial disinfectants.

Iron-Oxide Pigments

Finished pigments were produced from iron ore imported from other states by three companies: the Prince Manufacturing Company in Adams County, Pfizer in St. Clair County, and Solomon Grinding Service in Sangamon County.

Natural Gas Liquids

Natural gas liquids include ethane, propane, isobutane, unsplit butane, and a combination of gasoline and liquefied petroleum gas. Natural gas liquids were processed in Douglas County by the U.S. Industrial Chemical Company, a division of Quantum Chemical Corporation. The U.S. Department of Energy reports that Illinois processed 1,011 Mcf of gas in 1990, 607 Mcf from Illinois and 404 Mcf from out of state. Total liquids extracted from gas in Illinois amounted to 90,000 barrels.

Expanded Perlite

Crude perlite mined outside the state was processed by three corporations: Silbrico in Cook County, Strong-Lite Products in La Salle County, and Manville Products in Will County. Production and value of expanded perlite increased 6.3% and 4%, respectively, but the average price per ton dropped 2.2% in 1990. Expanded perlite is used primarily in roof insulation and for horticulture. Other uses include aggregate for concrete and plaster, insulation, and filters.

Pig Iron and Raw Steel

Data on pig-iron output for Illinois are not available for 1990. In the United States, pig iron was produced by 15 companies in approximately 60 blast furnaces. Five blast furnaces are in Illinois. Steel-making furnaces located at the same site used most of the pig iron in liquid form for refining raw steel.

The American Iron and Steel Institute in Washington, D.C., ranked Illinois fifth in raw steel production with 7.61 million tons, or 7.8% of the U.S. output in 1990. Production was up 1% from the 7.52 million tons in 1989. The year 1990 was not an eventful one for the iron and steel industry.

Slag (Iron and Steel)

In 1990, Illinois ranked eighth of 14 states in iron slag output and tenth of 25 states in steel slag production. Four companies operating eight plants in Alton, Bourbonnais, Chicago, Granite City, and Sterling processed slag from iron and steel furnaces. Five of the plants processed steel slag; one produced both air-cooled and expanded slag; and three produced only air-cooled slag. The slag was used mostly for construction aggregate, road-base materials, asphaltic concrete, mineral wool, railroad ballast, and fill.

Recovered Elemental Sulfur

Four companies in three counties, Crawford, Madison, and Will, recovered elemental sulfur as a byproduct of their oil refinery operations. Sales of sulfur increased 3.2% from 251,874 tons in 1989 to 259,846 tons in 1990. Total value decreased 4.4% from \$21.9 million in 1989 to \$20.9 million in 1990. Sulfur differs from most other major mineral commodities in that it is primarily used as a chemical reagent rather than as a component of a finished product. The largest use is for agriculture, as phosphatic fertilizers.

Exfoliated Vermiculite

Exfoliated vermiculite processed from crude vermiculite mined outside the state was produced by two companies in Du Page and La Salle Counties. The state's sales decreased 10.5% in 1990, but their value increased about 1% because of a 12.8% rise in the average value per ton. In Illinois, exfoliated vermiculite has the following uses:

	1989 (%)	1990 (%)
Loose-fill insulation	15.7	16.1
Block insulation	12.8	24.3
Concrete and plastic aggregate	13.5	15.8
Horticulture and agriculture	14.8	17.6
Fireproofing and other uses	43.2	26.2

Primary and Secondary Slab Zinc

During 1990, secondary slab zinc was processed at Illinois Smelting and Refining Company in Cook County. Production data are not available for individual states. About 74% of U.S. slab zinc was consumed in Illinois, Indiana, Michigan, New York, Ohio, and Pennsylvania. U.S. smelter production in 1990 was near capacity and the highest since 1981. Zinc recovery from waste and scrap was the main source of the increase. To recover zinc, Horsehead Resources at Calumet City uses the Waelz process to recycle electric arc furnace dust, a byproduct of steel making. The recovery of zinc has increased from virtually nothing a decade ago to about 75,000 tons in 1991.

Primary zinc recovery was up slightly in the United States. Only three U.S. companies operated four primary zinc refineries, including the Big River Zinc Company in Illinois.

Eagle Zinc Company in Hillsboro, Illinois, is the only domestic producer of oxide by the American process. The product is sold directly for agricultural purposes, including its use in animal feed. ASARCO Inc., also located in Hillsboro, used the French process to produce 12,000 tons of zinc oxide. Their output was down about 43% from last year's total.

PRODUCTS MANUFACTURED FROM MINERALS

Cement, clay products, coke, glass, and lime were manufactured in 1990 from crude mineral materials mined in and out of state.

Cement

Production In 1990, cement manufacturing in Illinois took approximately 4.0 million tons of raw materials, including cement rock (an argillaceous limestone containing calcium, silica, alumina, and magnesia), limestone, clay, shale, sand, fly ash, slag, gypsum, and tripoli. Four companies produced cement in the state: Illinois Cement Company (a subsidiary of Centex Corporation) and Lone Star Industries, both in La Salle County; Dixon-Marquette Cement (a subsidiary of Prairie Materials Sales) in Lee County; and Missouri Portland Cement Company (a division of Cementia Oldings AG) in Massac County. All produced Portland cement, and all except Illinois Cement Company produced masonry cement.

Portland cement sales increased 2.4% in 1990, but the value per ton decreased 2.7% from \$42.23 in 1989 to \$41.10 in 1990 (table 22). Prepared masonry cement sales declined about 25% and the price per ton decreased 12%. Nearly all of the cement was delivered by truck in bulk form, although small amounts were shipped by rail and barge.

Consumption Among the cement-consuming states, Illinois ranked fourth behind California, Texas, and Florida. Consumers in Illinois used about 3.6 million tons of Portland cement (fig. 13) and 92,000 tons of masonry cement in 1990. These figures represent a 1% decrease in the use of Portland cement and a 5.2% decrease in masonry cement. About 87% of the Portland cement was consumed by producers of ready-mix concrete, 7% by manufacturers of concrete products and dealers in building materials, and 6% by government agencies and others for highway construction and related purposes.

For the first time in several years, sales declined (5.5%) in the Chicago area, which covers Cook, Du Page, Kane, Kendall, Lake, McHenry, and Will Counties. The recession is expected to carry through 1991, and result in further slowing of residential and nonresidential construction. Consumption in the remaining counties of Illinois increased 7.5% after declining for several years in a row.

Clay Products

The Illinois State Geological Survey sends questionnaires every year to all manufacturers of clay products in the state (table 1). Clay products were valued at \$87.6 million in 1990. Whiteware and

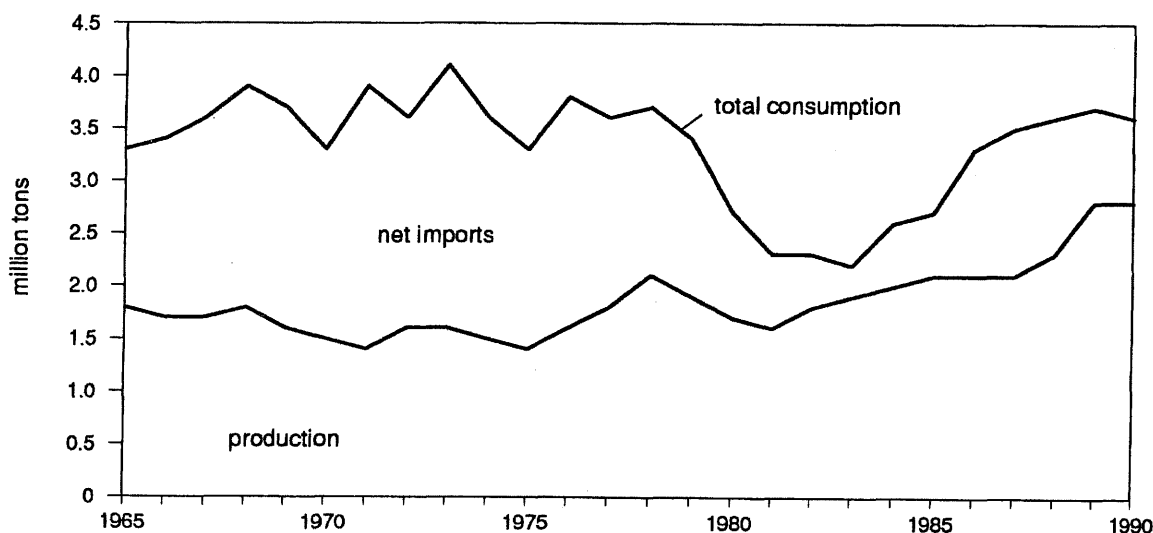


Figure 13 Production and consumption of finished Portland cement in Illinois, 1965-90.

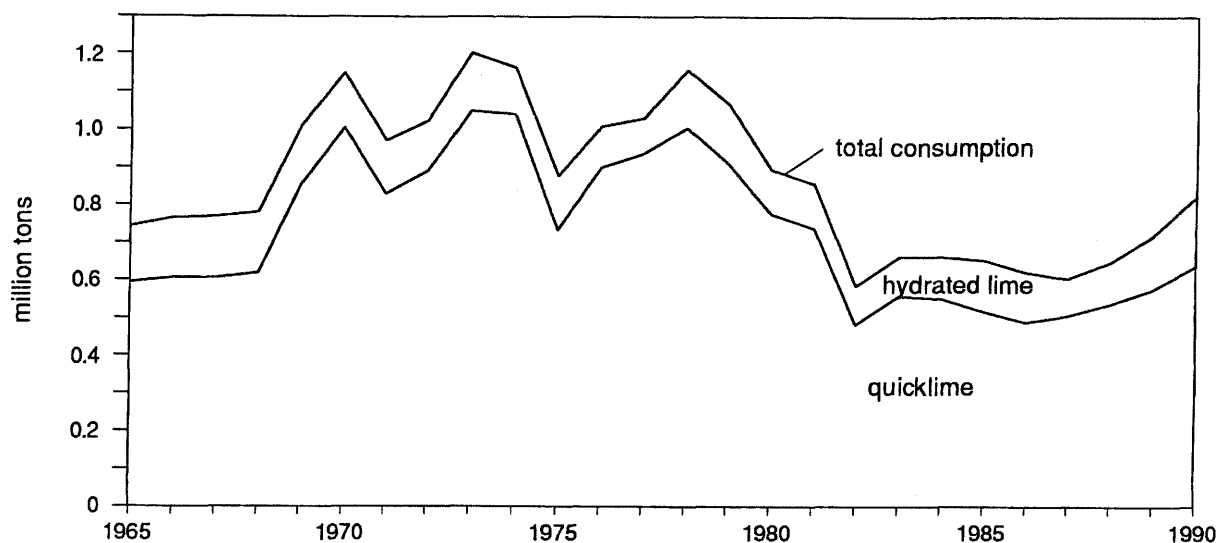


Figure 14 Trends in consumption of quicklime and hydrated lime in Illinois, 1965-90.

pottery decreased from \$57.0 million in 1989 to \$56.0 million in 1990. All other clay products increased from \$28.9 million in 1989 to \$31.6 million in 1990.

Coke

Production All data on coke production in Illinois are unavailable. U.S. production decreased 12.3% in 1990. The U.S. Department of Energy no longer provides data on byproducts on a state-by-state basis. The average U.S. price of coal receipts at coke plants was \$47.79 per ton in 1990, as compared with \$47.50 per ton in 1989.

Consumption and uses Coke is used for pig-iron production, foundry and other industrial purposes, and residential heating. U.S. consumption decreased 14% from 33.9 million tons in 1989 to 29.1 million tons in 1990. Coke breeze was used as fuel in steam and agglomerating plants. State-by-state data on coke breeze are no longer available.

Glass

Glass and/or fiberglass are manufactured in Du Page, Lake, La Salle, Logan, McLean, Macon, Madison, Marion, Montgomery, St. Clair, and Will Counties. Production data are not available.

Lime

Production Illinois ranked seventh of 32 states in production of lime in 1990. Although data for lime cannot be disclosed, production decreased 2% and value slipped 1%, after increasing for the past 3 years. Three plants in Cook County supplied the state's entire output. Two plants owned by Marblehead Lime Company, a division of General Dynamics, produced quicklime and hydrated lime. The plant owned by Vulcan Materials Company produced quicklime. Marblehead Lime Company, with two plants in Illinois and one each in Indiana and Michigan, was the third largest of 70 companies producing lime in the United States.

Consumption and uses In 1990, Illinoisians consumed 639,000 tons of quicklime, an 11% increase from 1989, and 183,000 tons of hydrated lime, a 27% increase (fig. 14, table 5). The principal consumer of lime is the steel industry. Lime is used in steel refining to remove impurities. Power plants, municipal water plants, and chemical firms also increased their use of lime.

PRELIMINARY PRODUCTION DATA: 1991

Minerals Extracted

The total value of minerals mined in 1991 is placed at \$2.4 billion, down 8.2% from the 1990 figure, according to preliminary data (table 23). The decline, which affects nonfuel commodities as well as fuels, can largely be related to the state of the economy. Coal continues to lead in value, contributing more than 67% of the total value of mineral commodities in Illinois. Oil ranks second, contributing 14%, and is followed by stone, sand and gravel, and industrial sand.

Fuels

The value of fossil fuel production is about \$1.9 billion for 1991, 8% less than for 1990.

Coal The estimated, per ton value of coal for 1991 is \$27.00, down 2.6% from that for 1990. Coal production is estimated to have decreased 2.6% to 60.0 million tons in 1991. In production nationally, Illinois is again fifth behind Wyoming, Kentucky, West Virginia, and Pennsylvania. Consumption by electric utilities decreased during the first 9 months of 1991 (table 24). Increases were shown in coal shipments to Mississippi, Florida, and Iowa as well as in exports. Decreases were recorded in shipments to Alabama, Wisconsin, Tennessee, Georgia, Indiana, Missouri, and some other states as well as within Illinois (table 25).

It is feared that many coal mines in Illinois will be forced to close by 1995 as utilities try to comply with the amended Clean Air Act by switching away from high sulfur coal. The amendment signed by President Bush in 1991 states that the nation's power plants must reduce their emission of nitrogen oxide into the atmosphere by 2 million tons and that of sulfur dioxide by 10 million tons by year 2000. The state of Illinois, through the Department of Energy and Natural Resources, has invested more than \$110 million in clean coal projects.

Crude oil and natural gas Crude oil production in 1991 is estimated at 19.1 million barrels, a 4% decrease from the 1990 total (table 23). Production is estimated to have a value of \$17.14 per barrel, making the total value \$326.8 million. Oil price per barrel is estimated to have decreased about 16% from its level in 1990.

Natural gas production is estimated to have decreased about 31%, and its value to have decreased 30%. The estimated unit value is \$2.17 per Mcf in 1991.

Industrial and Construction Materials

In 1991, the value of nonfuel minerals produced in Illinois—2% of the U.S. total—puts the state in 16th place nationally. Preliminary data for 1991 show a decrease of 9% in total value for industrial and construction materials. (Data for 1991 do not include estimates for copper, lead, silver, or tripoli.) Gains are expected in fluorspar, fuller's earth, zinc, barite, and peat. Losses are expected in clay, stone, sand and gravel (table 23). Crushed stone continues to be the leading nonfuel commodity in terms of value, followed by sand and gravel, and industrial sand. Illinois ranks first nationally in production of fluorspar and industrial sand, fourth in crushed stone (by contributing 5% of the nation's total output), and seventh in sand and gravel.

Two new industrial mineral companies were announced in 1991: Quincy Carbonate Company in Adams County began producing high-purity calcium carbonate for the filler, extender, and pigments market; Crystal Products Company plans to develop high-purity limestone and silica sand in Hardin County.

Metals and Other Minerals

Lead, zinc, copper, silver, and barite continued to be recovered as byproducts of Illinois fluorspar production in 1991. Zinc production is estimated to have increased by 65%, and its value by 14%. Barite production shows an increase of 50%, and its value, a rise of 71%. No estimate is available for silver, copper, and lead for 1991.

A gain in peat production is estimated at 67%, with its value up about 39%; the data place Illinois seventh nationally among 22 peat-producing states.

The output of gemstones is expected to increase less than 1% over that of 1990.

Minerals Processed

Preliminary data for 1991 are not yet available for most of the minerals processed in Illinois. The American Iron and Steel Institute reported that Illinois raw steel production decreased to 7,195,457 net tons, a 5.4% drop from the 1990 output.

Products Manufactured from Minerals

Preliminary figures for 1991 show a decrease of about 10% in both production and value of Portland cement. Illinois remains the fourth largest consumer of Portland cement in the nation, behind California, Texas, and Florida. Masonry cement production and value are down substantially. The declines are blamed on the decrease in housing construction starts (a 13% drop in 1991), high interest rates, growing concerns over a slow economy, and greater foreign competition. Gradual increases in demand are anticipated when the economy improves.

In 1991, lime sales and value show a decrease of 11%. For the second year, lime is down, reversing the upward trend that began in 1986.

Table 1 Illinois minerals extracted, processed, and manufactured into products, 1988-90: production and value^a

		1988			1989			1990		
Minerals	Unit	Quantity	Value	Average	Quantity	Value	Average	Quantity	Value	Average
			(\$1000)	unit ^b value (\$)		(\$1000)	unit ^b value (\$)		(\$1000)	unit ^b value (\$)
EXTRACTED										
FUELS										
Coal	thousand tons	59,852	1,708,786	28.55	60,131	1,693,892	28.17	61,657	1,709,750	27.73
Crude oil	thousand bbl	22,476	332,422	14.79	20,380	380,693	18.68	19,954	406,462	20.37
Natural gas	million cu ft	1,471	3,221	2.19	1,477	3,175	2.15	677	1,428	2.11
TOTAL ^d			2,044,429			2,077,760			2,117,640	
INDUSTRIAL AND CONSTRUCTION MATERIALS										
Clay - common	thousand tons	180	704	3.90	157	641	4.09	660	2,516	3.81
Sand and gravel										
Common	thousand	30,098	93,504	3.11	33,000 ^e	108,900 ^e	3.30	32,380	104,728	3.23
Industrial	thousand tons	4,328	56,142	12.96	4,582	52,935	11.55	4,486	62,531	13.94
Stone (limestone & dolomite)										
Crushed & broken	thousand tons	57,900 ^e	251,200 ^e	4.34 ^e	60,829	256,832	4.22	62,700 ^e	283,100 ^e	4.52
Dimension	thousand tons	1 ^e	129 ^e	109.75 ^e	W	W	W	W	W	W
TOTAL ^d			401,679			419,308			452,875	
Metals, Gemstones and other undisclosed ^c			46,058			53,822			54,352	
Total value of mineral materials extracted ^d			2,492,166			2,550,890			2,624,867	
PROCESSED										
Sulfur	thousand tons	258	22,367	86.78	252	21,852	86.84	260	20,894	80.47
TOTAL ^d			22,367			21,852			20,894	
Values that cannot be disclosed ^c			48,151			g			g	
Total value of mineral materials processed ^d			70,518			21,852			20,894	

Table 1 *continued*

		1988			1989			1990		
Minerals	Unit	Quantity	Value (\$1000)	Average unit ^b value (\$)	Quantity	Value (\$1000)	Average unit ^b value (\$)	Quantity	Value (\$1000)	Average unit ^b value (\$)
MANUFACTURED INTO PRODUCTS										
Cement (shipments)										
Portland	thousand tons	2,307	101,760	44.10	2,776	117,224	42.23	2,842	116,781	41.10
Clay products, estimated			96,248			86,207			87,594	
TOTAL ^d			198,008			203,431			204,375	
Values that cannot be disclosed ^c			47,217			66,686 ^g			64,866 ^g	
Total value of mineral products manufactured ^d			245,225			270,117			269,241	
STATE TOTAL ^d			\$2,807,909 ^f			\$2,842,859 ^f			2,915,002 ^f	

^a Sources: U.S. Bureau of Mines (USBM), Illinois Department of Mines and Minerals, Illinois State Geological Survey.

^b Units used for reporting value are 1 barrel for oil, 1000 cubic feet for gas, 1 troy ounce for silver, and 1 ton for all other minerals and materials. Metals are reported in metric tons and other materials in short tons.

^c Products that cannot be disclosed or are not available:

EXTRACTED, Fuels - natural gas liquids

Industrial and construction materials - absorbent clay, fluorspar, dimension stone, tripoli

Metals - lead, zinc, silver, copper

Other - peat

PROCESSED - Natural gas liquids, expanded perlite, ground barite, calcined gypsum, exfoliated vermiculite, iron-oxide pigments, primary slab zinc, secondary slab zinc, columbium and tantalum, crude iodine, slag (iron and steel), pig iron

MANUFACTURED INTO PRODUCTS - Masonry cement, lime, coke, glass

^d Data may not add up to totals shown because of independent rounding.

^e Estimate by USBM, no survey.

^f Does not include pig iron. ISGS estimated value approximately \$375 million.

^g The values of mineral products PROCESSED that cannot be disclosed are included in MANUFACTURED INTO PRODUCTS.

W = Withheld to avoid disclosing individual company data.

Table 2 Illinois mineral production compared with U.S. mineral production, 1989-90^a

Table 2. Illinois mineral production compared with U.S. mineral production, 1989-90

Commodity	Unit	Illinois		United States		Illinois % of U.S. production	
		Quantity	Value (\$1,000)	Quantity	Value (\$1,000)	Quantity	Value (\$1,000)
1989							
Coal	thousand tons	60,131	1,693,892	1,035,855	22,602,356	5.80	7.49
Crude oil	thousand bbls	20,380	380,693	2,983,172	47,283,276	0.68	0.81
Natural gas liquids	million cu ft	509	NA	12,080,751	NA	0.004	NA
Natural gas	million cu ft	1,477	3,175	18,044,499	30,575,912	0.01	0.01
Clays ^b	thousand tons	157	641	42,254	1,515,300	0.33	0.04
Sand and gravel ^c	thousand tons	37,582	161,835	926,505	3,659,300	4.06	4.42
Stone (includes dimension stone)	thousand tons	60,829	256,832	1,213,400	5,325,800	5.01	4.82
Cement shipments (portland)	thousand tons	2,776	117,224	84,229	4,121,558	3.30	2.84
1990							
Coal	thousand tons	61,657	1,709,750	1,029,076	22,392,694	5.99	7.64
Crude oil	thousand bbls	19,954	406,463	2,684,687	53,774,281	0.74	0.76
Natural gas liquids	million cu ft	607	NA	13,846,932	NA	0.004	NA
Natural gas	million cu ft	677	1,428	21,490,470	36,748,704	0.003	0.004
Clays ^b	thousand tons	660	2,516	42,904	1,619,824	1.54	0.16
Sand and gravel ^c	thousand tons	32,380	104,728	939,006	3,685,716	3.45	2.84
Stone (excludes dimension stone)	thousand tons	62,700	283,100	1,222,000	5,591,300	5.13	5.06
Cement shipments (portland)	thousand tons	2,842	116,781	84,370	4,173,762	3.37	2.80

^aSources: U.S. Bureau of Mines, Illinois State Geological Survey, Illinois Department of Mines and Minerals, and American Petroleum Institute.

^bExcluding fuller's earth.

^cIncludes industrial sand.

NA = not available.

Table 3 Minerals extracted, processed, and manufactured by county in Illinois, 1990^a

County	Approximate rank based on total value ^b	Minerals extracted in order of value ^c	Minerals processed, in order of value	Mineral products, in order of value
Adams	29	Stone, sand/gravel, natural gas, crude oil	Iron oxide pigments ^d	—
Alexander	45	Tripoli, sand/gravel	—	—
Bond	62	Crude oil, sand/gravel, clay	—	—
Boone	74	stone, sand/gravel	—	—
Brown	84	Crude oil	—	—
Bureau	80	Sand/gravel	—	Clay products
Calhoun	94	Stone	—	—
Carroll	90	Stone	—	—
Cass	98	Stone	—	—
Champaign	78	Sand/gravel	—	—
Christian	13	Coal, crude oil, stone	—	—
Clark	48	Crude oil, stone, sand/gravel	—	—
Clay	33	Crude oil	—	—
Clinton	10	Coal, crude oil, natural gas, sand/gravel	—	—
Coles	49	Crude oil, sand/gravel, stone, natural gas	—	—
Cook	5	Stone, sand/gravel	Expanded perlite, slag ^d , pig iron ^d , secondary slab zinc ^d , crude iodine	Lime, coke ^d
Crawford	15	Crude oil, sand/gravel	Sulfur	Clay products
Cumberland	81	Sand/gravel, crude oil	—	—
De Kalb	58	Stone, sand/gravel	—	—
De Witt	77	Crude oil	—	—
Douglas	28	Coal, stone, crude oil	Natural gas liquids ^d	—
Du Page	46	Stone, sand/gravel	Exfoliated vermiculite	Glass ^d
Edgar	21	Coal, crude oil, natural gas	—	—
Edwards	43	Crude oil	—	—
Effingham	53	Crude oil, natural gas,	—	—
Fayette	32	Crude oil, stone, sand/gravel, natural gas	—	—
Ford	89	Sand/gravel	—	—
Franklin	2	Coal, crude oil	—	—
Fulton	40	Coal, stone, sand/gravel	—	—
Gallatin	12	Coal, crude oil, sand/gravel, natural gas	—	—
Greene	85	Stone	—	—
Grundy	66	Sand/gravel	—	—
Hamilton	50	Crude oil	—	—
Hancock	86	Stone, crude oil	—	—
Hardin		Fluorspar, stone, zinc, gemstones, sandstone, lead, copper, barite, silver, germanium ^d	Ground/crushed barite ^d	—
Henderson	79	Stone	—	—
Henry	92	Stone, sand/gravel	—	—
Iroquois	99	—	—	—
Jackson	69	Stone, sand/gravel, crude oil	—	—
Jasper	39	Crude oil	—	—
Jefferson	6	Coal, crude oil	—	—
Jersey	92	Stone	—	—
Jo Daviess	82	Stone, sand/gravel	—	—
Johnson	60	Stone	—	—
Kane	23	Sand/gravel, stone, dimension stone	—	Clay products
Kankakee	47	Stone, clay, sand/gravel	—	—
Kendall	65	Stone, sand/gravel	—	—
Knox	30	—	—	Clay products
Lake	42	Sand/gravel, peat	Calcined gypsum, crude iodine ^d , columbium ^d	Clay products
La Salle	8	Industrial sand, stone, sand/gravel, clay	Exfoliated vermiculite, expanded perlite	Portland cement, clay products, masonry cement, glass ^d

Table 3 *continued*

County	Approximate rank based on total value ^b	Minerals extracted in order of value ^c	Minerals processed, in order of value	Mineral products, in order of value
Lawrence	18	Crude oil, sand/gravel	—	—
Lee	27	Stone	—	Portland/masonry cement
Livingston	44	Stone, clay, sand/gravel	—	—
Logan	22	Coal, stone, sand/gravel	—	Glass ^d
Macon	61	Crude oil, sand/gravel	—	Glass ^d
Macoupin	9	Coal, crude oil	—	—
Madison	36	Crude oil, stone sand/gravel	Sulfur, slag ^d , pig iron ^d	Clay products, coke ^d , glass ^d
Marion	31	Crude oil	Secondary slab zinc ^d	Glass ^d
Marshall	76	Sand/gravel	—	—
Mason	51	Industrial sand	—	—
Massac	17	Stone	Crude iodine	Portland & masonry cement
McDonough	35	Coal, stone, crude oil	—	Clay products
McHenry	25	Sand/gravel	—	—
McLean	73	Sand/gravel	—	Fiberglass ^d
Menard	70	Stone	—	—
Mercer	100	—	—	—
Monroe	71	Stone, crude oil	—	—
Montgomery	56	Stone, crude oil	—	Glass ^d
Morgan	97	Crude oil	—	—
Moultrie	96	Crude oil, sand/gravel	—	—
Ogle	38	Industrial sand, stone, sand/gravel	—	—
Peoria	54	Sand/gravel, stone	Slag ^d	—
Perry	1	Coal, crude oil	—	—
Piatt	95	Sand/gravel, crude oil	—	—
Pike	64	Sand/gravel, stone	—	—
Pope	101	—	—	—
Pulaski	19	Clay, stone, sand/gravel	—	Clay products
Putnam	87	Sand/gravel	—	—
Randolph	4	Coal, stone, crude oil, sand/gravel, natural gas	—	—
Richland	41	Crude oil	—	—
Rock Island	63	Stone, sand/gravel	—	—
St. Clair	37	Stone, crude oil, sand/gravel, natural gas	Iron-oxide pigments ^d , ground barite ^d Primary slab zinc ^d	Glass ^d
Saline	3	Coal, crude oil, natural gas	—	—
Sangamon	83	Sand/gravel, crude oil	Iron-oxide pigments	—
Schuyler	34	Coal, crude oil, stone	—	—
Scott	91	Stone	—	—
Shelby	88	Crude oil, stone	—	—
Stark	102	—	—	—
Stephenson	72	Stone, sand/gravel	—	—
Tazewell	68	Sand/gravel	—	—
Union	55	Stone	—	—
Vermilion	52	Stone, sand/gravel	—	—
Wabash	7	Coal, crude oil, sand/gravel	—	—
Warren	75	Stone	—	—
Washington	16	Coal, crude oil, stone	—	—
Wayne	24	Crude oil	—	—
White	11	Coal, crude oil, sand/gravel	—	—
Whiteside	67	Peat, stone, sand/gravel	—	—
Will	20	Stone, sand/gravel	Sulfur, expanded perlite	Glass ^d
Williamson	14	Coal, crude oil, natural gas	—	—
Winnebago	59	Stone, sand/gravel	—	—
Woodford	57	Sand/gravel	—	—
Undistributed		Crude oil	—	—

^aSources: U.S. Bureau of Mines, Illinois Department of Mines and Minerals, and Illinois State Geological Survey.^bSince some values are not available by county, ranking cannot be exact.^cStone production; 1990 data were estimated to rank each county.^dValue unknown.

Table 4 Employment and wages in the Illinois mineral industry, 1989-90^a

Industry	1989				1990			
	No. of employees (1000)	Average weekly earnings (\$)	Average hours worked/week	Average hourly earnings (\$)	No. of employees (1000)	Average weekly earnings (\$)	Average hours worked/week	Average hourly earnings (\$)
Mining	19.8	706.13	42.9	16.46	19.6	709.76	41.8	16.98
Bituminous coal	11.9	793.79	42.7	18.59	10.0 ^b	W	W	W
Oil and gas extraction	3.2	571.99	38.7	14.78	W	W	W	W
Other	4.7	575.51	46.3	12.22	W	W	W	W
Processing	63.8	584.14	44.4	13.15	—	—	—	—
Primary metal industries	56.3	572.32	44.4	12.89	55.4	571.99	43.3	13.21
Petroleum refining	7.5	672.84	44.5	15.12	W	W	W	W
Manufacturing	36.9	470.12	41.9	11.22	W	473.62	41.4	11.44
Glass and glass products	2.7	502.53	41.6	12.08	W	W	W	W
Cement and clay products	6.1	515.59	39.6	13.02	7.0	484.69	38.9	12.46
Other stone and clay, glass products	18.5	473.55	41.0	11.55	20.9	482.26	40.8	11.82
Petroleum and coal products	9.6	672.84	44.5	15.12	10.3	692.19	43.1	16.06

^aSource: Illinois Department of Labor, Bureau of Employment Security.^bCoal Production 1990, DOE/EIA-0228.

Table 5 Minerals consumed in Illinois, 1989-90^a

Commodity	Unit	1989			1990		
		U.S.	Illinois	Illinois % of U.S. consumption	U.S.	Illinois	Illinois % of U.S. consumption
Fuels							
Coal	million tons	890.6	30.1	3.38	893.6	32.5	3.64
Coke	million tons	33.9	NA	—	27.8	NA	—
Distillate fuel oils	million bbl	1,152.0	34.6	3.00	1,103.0	42.5	3.85
Gasoline	million bbl	3,228.0	120.2	3.72	3,206.0	124.5	3.88
Kerosene	million bbl	31.0	0.4	1.28	16.0	0.2	1.09
LPG and ethane	million bbl	609.0	13.1	2.15	568.0	13.0	2.29
Natural gas	trillion cu ft	18.8	1.0	5.28	18.7	0.9	5.02
Residual fuel oil	million bbl	500.0	4.0	0.80	449.0	3.6	0.80
Metals							
Pig iron	million tons	58.4	2.6	4.51	56.3	2.9	5.15
Lead	thousand tons	1,283.2	78.7	6.14	1,275.2	72.6	5.69
Zinc (slab)	thousand tons	884.7	137.6	15.55	826.5	130.4	15.78
Construction materials							
Air-cooled slag	million tons	13.8	NA	—	15.1	—	—
Asphalt and road oil	million bbl	165.0	8.1	4.88	176.0	8.3	4.74
Cement	million tons	92.6	3.8	4.08	91.1	3.7	4.10
Sand and gravel	million tons	897.3	33.0	3.68	910.6	32.4	3.56
Stone	million tons	1,213.4	60.8	5.01	1,222.0	62.7	5.13
Agricultural and chemical materials							
Feldspar	thousand tons	644.0	24.9	3.86	599.0	24.0	4.01
Fluorspar	thousand tons	641.9	NA	—	564.5	NA	—
Lime ^b	thousand tons	17,178.0	719.0	4.19	17,481.0	822.0	4.70
Salt							
Evaporated	thousand tons	8,183.0	473.0	5.78	8,764.0	525.0	5.99
Rock	thousand tons	16,947.0	1,464.0	8.64	17,153.0	1,491.0	8.69

^aSource: U.S. Bureau of Mines, U.S. Department of Energy.^bExcludes regenerated lime.

NA = not available.

Table 6 Fuels and energy consumed in Illinois, 1989–90^a

Fuel	Units	1989	1990	Change	Trillion Btu ^b	
				1989–90 (%)	1989 ^{c,e}	1990 ^d
Coal	thousand tons	30,116	32,461	- 7.8	640.4	690.3
Natural gas	million ft ³	995,532	939,502	- 5.6	1,026.4	968.6
Gasoline	thousand bbl	120,176	124,538	+ 3.6	631.3	654.2
Kerosene	thousand bbl	367	174	- 52.6	2.1	1.0
Distillate fuel oil	thousand bbl	34,565	42,529	+ 23.0	201.3	247.7
Residual fuel oil	thousand bbl	4,031	3,306	- 18.0	25.3	20.8
Liquid petroleum gases	thousand bbl	13,097	13,008	- 0.7	48.2	47.2
Nuclear power	million kWh	74,820	71,887	- 3.9	802.4	767.8
Hydropower	million kWh	67	78	+ 16.4	0.7	0.8
TOTAL					3,378.1	3,398.4
Illinois percentage of total U.S. energy consumption				4.2	4.2	
Percentage of total energy consumed in Illinois						
Coal					18.96	20.31
Natural gas					30.38	28.50
Oil products					26.89	28.57
Nuclear power					23.75	22.59
Hydropower					0.02	0.03
TOTAL PERCENTAGE					100.00	100.00

^a Source: U.S. Department of Energy, Energy Information Administration.

^b Fuel conversion factors: gasoline—5,253,000 Btu/bbl; kerosene—5,670,000 Btu/bbl; distillate fuel oil—5,825,000 Btu/bbl; residual fuel oil—6,287,000 Btu/bbl.

^c 1989 fuel conversion factors: coal—21,266,000 Btu/ton; natural gas—1,031 Btu/Mcf; LPG—3,683,000 Btu/bbl; nuclear power—10,724 Btu/kWh; hydropower—10,253 Btu/kWh.

^d 1990 fuel conversion factors: coal—21,266,000 Btu/ton; natural gas—1,031 Btu/Mcf; LPG—3,628,000 Btu/bbl; nuclear power—10,724 Btu/kWh; hydropower—10,253 Btu/kWh.

^e Revised.

Table 7 Coal production in Illinois counties, 1989-90^a

County	1989 Production					1990 Production				
	No. of mines	Underground (tons)	Surface (tons)	Total (tons)	Value ^b	No. of mines	Underground (tons)	Surface (tons)	Total (tons)	Value ^b
Christian ^c	1	2,049,364	—	2,049,364	57,730,584	1	2,323,416	—	2,323,416	64,428,326
Clinton	1	2,762,147	—	2,762,147	77,809,681	1	2,964,338	—	2,964,338	82,201,093
Coles	1	11,998	—	11,998	337,984	-	—	—	—	—
Douglas	1	1,045,088	—	1,045,088	29,440,129	1	994,746	—	994,746	27,584,307
Edgar	—	—	—	—	—	1	—	1,380,200	1,380,200	38,272,946
Franklin	4	7,539,989	—	7,539,989	212,401,490	4	6,980,658	—	6,980,658	193,573,646
Fulton	1	—	504,005	504,005	14,197,821	1	—	471,325	471,325	13,069,842
Gallatin	3	1,702,186	531,295	2,233,481	62,917,160	3	1,943,747	631,780	2,575,527	71,419,364
Jackson	1	—	2,160,460	2,160,460	60,860,158	0	—	—	—	—
Jefferson	2	3,572,604	—	3,572,604	100,640,255	2	4,271,419	—	4,271,419	118,446,449
Logan	1	1,327,207	—	1,327,207	37,387,421	1	1,314,454	—	1,314,454	36,449,809
Macoupin	2	2,808,596	—	2,808,596	79,118,149	2	3,130,907	—	3,130,907	86,820,051
McDonough	1	—	515,813	515,813	14,530,452	1	—	471,052	471,052	13,062,272
Perry	7	203,790	11,037,541	11,241,331	316,668,294	7	1,050,419	10,240,532	11,290,951	313,098,071
Randolph	4	4,724,923	1,404,000	6,128,923	172,651,761	4	4,970,405	1,416,800	6,387,205	177,117,195
St. Clair	1	1,276,779	—	1,276,779	35,966,865	—	—	—	—	—
Saline	5	4,861,236	1,133,359	5,994,595	168,867,741	6	6,087,431	1,161,874	7,249,305	201,023,228
Schuyler	1	—	552,269	552,269	15,557,418	1	—	645,152	645,152	17,890,065
Wabash	1	3,001,455	—	3,001,455	84,550,987	1	3,228,971	—	3,228,971	89,539,366
Washington	1	1,880,500	—	1,880,500	52,973,685	1	1,989,000	—	1,989,000	55,154,970
White	1	1,751,025	—	1,751,025	49,326,374	1	1,718,467	—	1,718,467	47,653,090
Williamson ^d	2	8,810	1,764,614	1,773,424	49,957,354	3	42,759	2,227,216	2,269,975	62,946,407
TOTAL ^e	42	40,527,697	19,603,356	60,131,053	1,693,891,763	42	43,011,137	18,645,931	61,657,068	1,709,750,496

^aProduction figures from Illinois Department of Mines and Minerals, Annual Coal, Oil and Gas Report.

^bValue calculated at an average of \$28.17/ton for 1989 and \$27.73/ton for 1990.

^cOne mine operated at junction of Christian, Montgomery, and Sangamon Counties; all production placed in the county where tippie is located.

^dOne mine operated at junction of Williamson and Saline Counties; all production placed in county where tippie is located.

^eMay not add up because of independent rounding.

Table 8 Cumulative coal production in Illinois counties, 1833–1990^a

County	Cumulative total surface production (tons)	Cumulative total production (tons)	County	Cumulative total surface production (tons)	Cumulative total production (tons)
Adams	338,147	341,924	Macoupin	—	329,428,699
Bond	—	7,355,569	Madison	37,843	164,295,772
Brown	41,761	74,068	Marion	—	39,247,722
Bureau	11,094,808	53,823,055	Marshall	4,779	12,516,141
Calhoun	—	96,247	McDonough	4,242,044	6,850,525
Cass	—	212,477	McLean	—	5,544,139
Christian	—	351,986,656	Menard	—	13,462,005
Clark	4,482	4,482	Mercer	67,080	15,519,862
Clay	801	801	Monroe	—	8,284
Clinton	—	70,995,535	Montgomery	—	141,824,660
Coles	—	210,930	Morgan	13,564	190,787
Crawford	17,315	45,400	Moultrie	—	2,032,236
Douglas	—	43,770,620	Peoria	32,702,938	96,718,740
Edgar	1,587,442	2,295,898	Perry	370,514,018	470,436,912
Effingham	—	796	Pike	2,224	5,081
Franklin	—	687,607,034	Pope	34,704	36,266
Fulton	239,531,413	316,126,799	Putnam	—	10,071,893
Gallatin	10,279,645	46,669,391	Randolph	101,464,901	224,666,391
Greene	71,090	693,191	Richland	35	154
Grundy	1,635,422	40,872,430	Rock Island	—	3,846,169
Hamilton	—	6,172,927	St. Clair	116,444,567	367,370,806
Hancock	459,329	771,281	Saline	63,310,954	304,363,371
Hardin	—	40	Sangamon	—	233,449,607
Henry	9,065,783	22,910,053	Schuyler	9,782,535	11,485,951
Jackson	60,531,911	128,204,823	Scott	3,790	612,476
Jasper	—	23,739	Shelby	925	4,119,763
Jefferson	5,353,358	157,517,385	Stark	8,342,056	9,569,336
Jersey	2,290	120,350	Tazewell	—	17,633,802
Johnson	72,781	314,325	Vermilion	30,651,670	165,878,433
Kankakee	18,284,342	19,192,105	Wabash	12,082	37,769,110
Knox	62,601,174	65,896,605	Warren	132	685,466
La Salle	2,345,878	65,547,638	Washington	—	33,097,137
Livingston	139,091	10,111,437	White	—	10,450,694
Logan	—	22,481,844	Will	29,333,708	37,553,733
Macon	—	11,000,468	Williamson	102,332,231	459,317,385
			Woodford	—	7,810,160
Total cumulative surface production, 1911–1990			Estimated production, all counties, 1833–1881		
1,292,757,043			73,386,123		
Total cumulative production, 1882–1990			Total cumulative production, 1833–1990		
5,371,317,991			5,444,704,114		

^aSource: Illinois Department of Mines and Minerals, Annual Coal, Oil and Gas Reports. This table has been revised with production placed in county where tipple is located.

Table 9 Employment and production by method of coal mining in Illinois, 1979-90^a

Year	Underground				Surface			
	No. of mines	No. of employees	Average production/ mine (tons)	Average no. employees/ mine	No. of mines	No. of employees	Average production/ mine (tons)	Average no. employees/ mine
1979	31	13,200	1,054,233	426	40	5,299	671,422	132
1980	31	13,219	1,128,022	426	35	5,065	787,821	145
1981	31	13,351	943,081	431	27	4,797	835,672	178
1982	32	10,554	1,115,121	330	28	4,397	919,439	157
1983	31	10,514	1,076,464	339	23	4,245	1,087,096	185
1984	31	10,857	1,288,564	350	21	3,946	1,206,843	188
1985	32	11,386	1,207,769	356	20	3,445	1,091,432	172
1986	31	10,379	1,320,375	335	20	3,170	1,115,084	159
1987	28	9,263	1,399,588	331	19	2,925	1,135,416	154
1988	27	8,830	1,477,178	327	16	2,684	1,248,037	168
1989	27	8,729	1,501,026	323	15	2,376	1,306,890	158
1990	26	7,740	1,654,275	298	16	2,389	1,165,371	149

^aSource: Illinois Department of Mines and Minerals, Annual Coal, Oil and Gas Report.

Table 10 Coal production of Illinois companies, 1989-90^a

1989							1990					
Rank	Company	No. of mines		Production (tons)	Percentage of total production	No. of employees	Rank	No. of mines		Production (tons)	Percentage of total production	No. of employees
		Under- ground	Surface					Under- ground	Surface			
1	Peabody Coal	5	1	9,804,305	16.31	2,133	2	4	2	10,728,546	17.40	2,037
2	Consolidation Coal	1	3	7,935,943	13.20	969	4	1	2	6,122,053	9.93	887
3	Old Ben Coal ^b	4	0	7,539,989	12.54	1,495	—	—	—	—	—	—
4	Arch of Illinois	0	3	7,126,873	11.85	841	3	0	3	6,414,416	10.40	685
5	AMAX Coal	1	1	4,766,069	7.93	1,035	5	1	1	5,443,148	8.83	932
6	Monterey Coal	2	0	4,588,939	7.63	1,077	6	2	0	4,946,171	8.02	999
7	Zeigler Coal	3	0	3,860,611	6.42	537	1	7	0	10,921,707	17.71	1,479
8	Freeman United Coal Mining	2	2	3,205,406	5.33	827	7	2	2	3,595,608	5.83	838
9	Kerr-McGee Coal	1	0	2,843,124	4.73	580	8	1	0	3,021,851	4.90	555
10	White County Coal	1	0	1,751,025	2.91	253	9	1	0	1,718,467	2.79	258
11	Kenellis Energies	1	0	1,420,683	2.36	268	10	1	0	1,697,849	2.75	253
12	Turris Coal	1	0	1,327,207	2.21	270	11	1	0	1,314,454	2.13	258
13	Sahara Coal	1	1	1,108,521	1.84	372	12	1	1	1,132,420	1.84	362
14	Equality Mining	0	1	622,267	1.03	43	17	0	1	619,444	1.01	44
15	Triad Mining	0	1	552,269	0.92	43	15	0	1	645,152	1.05	55
16	Jader Coal	0	1	531,295	0.88	79	16	0	1	631,780	1.03	85
17	Mid State Coal	0	1	504,005	0.84	100	18	0	1	471,325	0.76	85
18	Arclar Company	1	0	417,924	0.70	55	14	1	0	777,741	1.26	97
19	Cutler Mining	1	0	203,790	0.34	117	13	1	0	1,050,419	1.70	136
20	Amco-Illinois Mining	1	0	11,998	0.02	10	—	—	—	—	—	—
21	Lorenzo Mining	1	0	8,810	0.01	1	20	1	0	42,759	0.07	8
—	Sugar Camp Coal	—	—	—	—	—	19	1	0	348,719	0.57	64
—	Phoenix Mining	—	—	—	—	—	21	0	1	13,039	0.02	12
TOTAL		27	15	60,131,053	100.0	11,105		26	16	61,657,068	100.00	10,129

^aSource: Illinois Department of Mines and Minerals, Annual Coal, Oil and Gas Report.^bZeigler Coal purchased Old Ben Coal in 1990.

Table 11 Coal shipped from Illinois to other states, 1986-90^a

Consumers	Wisconsin	Minnesota & Michigan	Iowa	Missouri	Indiana	Kentucky (1,000 tons)	Georgia & Florida	Other states ^b	Exports and miscellaneous	Illinois	Total
Electric utilities											
1986	1,523	123	2,045	12,824	9,130	847	6,318	6,028	—	16,822	55,659
1987	1,757	296	1,621	12,945	9,282	61	9,140	2,364	—	15,909	53,375
1988	2,058	79	2,217	12,871	7,871	136	9,791	2,951	—	14,372	52,344
1989	1,359	57	2,072	13,109	8,247	424	9,055	4,163	—	14,911	53,397
1990	1,062	45	1,340	12,132	9,483	453	9,019	5,210	—	16,021	54,765
Coke and gas plants											
1986	—	—	—	10	1,536	—	—	—	—	281	1,827
1987	—	—	—	—	1,531	—	—	—	—	294	1,826
1988	—	—	—	—	1,414	—	—	e	—	94	1,508
1989	—	—	—	—	1,116	—	—	—	—	425	1,541
1990	—	—	—	—	937	—	—	—	—	193	1,131
Retail dealers											
1986	3	e	2	47	1	—	—	e	—	201	273
1987	—	—	11	44	4	—	—	17	—	200	291
1988	—	—	e	45	e	—	—	33	—	197	285
1989	—	—	e	228	e	—	—	16	—	217	471
1990	—	—	31	155	e	—	—	1	4	199	387
Others											
1986	341	46	177	835	204	—	—	186	7	1,692	3,530
1987	287	31	389	754	269	—	—	91	—	2,211	4,063
1988	260	7	313	740	223	—	—	120	7	2,587	4,270
1989	290	—	290	619	145	1	—	140	16	2,005	3,510
1990	300	5	221	779	151	—	—	126	—	2,286	3,868
Totals^c											
1986	1,867	169	2,224	13,716	10,871	847	6,318	6,213	202 ^d	18,996	61,493 ^d
1987	2,044	326	2,020	13,743	11,087	61	9,140	2,472	345 ^d	18,614	59,899 ^d
1988	2,317	85	2,530	13,656	9,508	136	9,791	3,104	494 ^d	17,250	58,901 ^d
1989	1,649	57	2,362	13,956	9,508	424	9,055	4,319	488 ^d	17,558	59,464 ^d
1990	1,362	51	1,592	13,067	10,571	453	9,019	5,336	442 ^d	18,700	60,592 ^d

^a Sources: U.S. Department of Energy, Coal Distribution, 1986-1990.^b Includes AL (1986-1990), MS (1986-90), TN (1986-90), LA (1986-87,89), OH (1986-89^e, 1990), PA (1986,89,90^e, 87-88), KS (1986-88,90), TX (1986-88), CA (1986-88), AR (1986-88,90), MA (1986^e-90^e), ND (1986^e), MT (1987, 90^e), NY (1990^e), WY (1990).^c Totals may not add up because of independent rounding.^d Includes shipments with no breakdown by consuming sector: 195,000 tons foreign, 7,000 tons U.S. in 1986, 343,000 tons foreign, 2,000 U.S. in 1987, 487,000 tons in 1988, 472,000 tons in 1989, 370,000 tons foreign and 68,000 U.S. in 1990.^e Quantity is less than 500 tons.

Table 12 Sources of coal consumed in Illinois, 1986-90^a

Consumers	Illinois	Western Kentucky	Indiana	Ohio, eastern Pennsylvania, and northern West Virginia ^b	Southern West Virginia, ^c Virginia, and eastern Kentucky (1,000 tons)	Western interior ^d states	Western states ^e	Montana ^f and Washington	Pennsylvania	Total coal consumed in Illinois
Electric utilities										
1986	16,822	1,147	1,313	12	1,431	—	7,198	4,277	—	32,200
1987	15,909	1,154	1,427	—	1,849	—	5,608	3,500	4	29,452
1988	14,372	1,102	1,150	—	1,630	—	4,777	3,876	g	26,908
1989	14,911	111	2,012	7	1,716	—	3,555	2,880	—	25,192
1990	16,021	891	1,892	—	1,823	—	3,662	2,651	—	26,939
Coke and gas plants										
1986	281	—	—	146	1,527	—	—	—	—	1,954
1987	294	—	—	—	1,344	—	—	—	—	1,638
1988	94	—	—	—	1,312	—	—	—	—	1,406
1989	425	—	—	—	1,288	—	—	—	—	1,714
1990	193	—	21	15	1,543	—	—	—	—	1,773
Retail dealers										
1986	201	5	30	g	9	—	—	—	g	245
1987	200	1	49	—	22	—	g	—	1	273
1988	197	7	44	—	7	—	—	—	1	256
1989	217	21	29	—	30	—	—	—	—	298
1990	199	29	34	—	1	—	—	—	—	265
Others										
1986	1,692	577	499	5	918	—	—	—	33	3,690
1987	2,211	528	356	68	820	1	—	—	25	3,999
1988	2,587	387	647	21	659	g	—	—	10	4,311
1989	2,005	238	234	27	395	6	—	g	8	2,913
1990	2,286	305	426	49	319	1	93	—	4	3,483
Total										
1986	18,996	1,738	1,842	162	3,886	—	7,198	4,277	33	38,089
1987	18,614	1,683	1,832	68	4,025	1	5,608	3,500	30	35,362
1988	17,250	1,496	1,841	21	3,609	g	4,777	3,876	11	32,882
1989	17,558	370	2,275	34	3,429	6	3,555	2,880	10	30,116
1990	18,700	1,224	2,373	64	3,687	1	3,756	2,651	5	32,461

^aSources: U.S. Department of Energy, Coal Distribution.^bIncludes Districts 1, 2, 3, 4, and 6 (MD, OH, eastern PA, northern WV).^cIncludes Districts 7, 8, and 13 (AL, GA, eastern KY, NC, TN, VA, southern WV).^dIncludes Districts 14 and 15 (AR, KS, MO, OK, TX).^eIncludes Districts 16, 17, and 19-21 (CO, ID, ND, NM, SD, UT, WY).^fIncludes Districts 22 and 23 (AK, MT, OR, WA).^gQuantity is less than 500 tons.

Table 13 Crude-oil production in Illinois counties between 1889 and 1990; value for 1989 and 1990^a

County	1888-1990 cumulative production (1000 bbl)	1989			1990			1989-90 percent change
		Production (1000 bbl)	% of total Illinois production	Value ^d (\$1000)	Production (1000 bbl)	% of total Illinois production	Value ^d (\$1000)	
Adams	284	2	0.0	37	3	0.0	65	+ 61.8
Bond	8,187	59	0.3	1,110	66	0.3	1,337	+ 10.5
Brown	2,119	53	0.3	983	41	0.2	836	- 22.0
Champaign	7	—	—	—	—	—	—	—
Christian	30,234	292	1.4	5,452	279	1.4	5,687	- 4.4
Clark-Cumberland	94,713	240	1.2	4,484	247	1.2	5,026	+ 2.8
Clay	149,640	1,009	5.0	18,845	996	5.0	20,290	- 1.3
Clinton	88,460	242	1.2	4,523	230	1.2	4,692	- 4.9
Coles	25,270	144	0.7	2,686	142	0.7	2,902	- 0.9
Crawford	253,596	2,040	10.0	38,100	2,072	10.4	42,214	+ 1.6
De Witt	3,843	49	0.2	924	54	0.3	1,106	+ 9.7
Douglas	3,673	2	0.0	46	4	0.0	78	+ 54.7
Edgar	4,674	62	0.3	1,166	67	0.3	1,361	+ 7.0
Edwards	57,333	531	3.1	9,926	536	2.7	10,927	+ 1.0
Effingham	20,071	228	1.1	4,263	243	1.2	4,955	+ 6.6
Fayette	412,018	991	4.9	18,509	972	4.9	19,796	- 1.9
Franklin	81,881	779	3.8	14,560	742	3.7	15,123	- 4.8
Gallatin	56,085	300	1.5	5,606	330	1.7	6,725	+ 10.0
Hamilton	138,351	299	1.5	5,591	367	1.8	7,477	+ 22.6
Jackson	109	4	0.0	79	5	0.0	104	+ 21.2
Jasper	61,343	615	3.0	11,484	712	3.6	14,495	+ 15.7
Jefferson	95,336	964	4.7	18,010	737	3.7	15,007	- 23.6
Lawrence	425,593	2,806	13.8	52,424	2,565	12.9	52,244	- 8.6
Macon	2,625	68	0.3	1,276	61	0.3	1,239	- 11.0
Macoupin	396	9	0.0	174	8	0.0	164	- 13.5
Madison	18,767	80	0.4	1,485	77	0.4	1,566	- 3.3
Marion	435,348	1,116	5.5	20,856	1,188	6.0	24,196	+ 6.4
McDonough-								
Hancock ^c	5,699	3	0.0	61	5	0.0	97	+ 45.8
Monroe	126	17	0.1	323	19	0.1	388	+ 10.2
Montgomery	161	3	0.0	49	2	0.0	40	- 24.9
Morgan	4	1	0.0	12	2	0.0	35	+173.3
Moultrie	136	3	0.0	59	2	0.0	43	- 34.0
Perry	957	7	0.0	138	9	0.0	174	+ 15.3
Piatt	8	f	0.0	6	f	0.0	3	- 52.8
Randolph	5,003	11	0.1	208	9	0.0	174	- 23.4
Richland	112,609	677	3.3	12,653	691	3.5	14,080	+ 2.0
St. Clair	3,658	20	1.4	369	18	1.6	6,645	- 7.2
Saline	24,977	295	0.2	5,511	326	0.3	1,160	+ 10.6
Sangamon	5,185	50	0.1	943	57	0.1	337	+ 12.9
Schuyler	224	16	0.2	300	17	0.3	1,017	+ 3.2
Shelby	2,266	50	0.1	929	50	0.1	374	+ 0.5
Wabash	121,895	1,027	5.0	19,189	1,081	5.4	22,019	+ 5.2
Washington	36,236	383	1.9	7,147	363	1.8	7,391	- 5.2
Wayne	277,689	1,550	7.6	28,959	1,656	8.3	33,729	+ 6.8
White	318,075	1,840	9.0	34,366	1,896	9.5	38,629	+ 3.1
Williamson	2,792	37	0.2	698	40	0.2	806	+ 6.0
Other ^b	17,576	1,401	6.9	26,175	967	4.9	19,711	- 30.9
TOTAL^e	3,405,232	20,380	100.0	380,693	19,954	100.0	406,462	- 2.1

^a Source: Illinois State Geological Survey Oil and Gas Section

^b Could not be assigned to individual field or county.

^c No oil production reported for Hancock County in 1971-1978; 327 bbl was produced in 1989 and 476 bbl in 1990.

^d Value calculated at an estimated average price of \$18.68 per barrel for 1989 and \$20.37 per barrel for 1990.

^e May not add up because of independent rounding.

^f Less than 1,000 bbl.

Table 14 Crude-oil production from major fields (over 200,000 barrels per year) in Illinois, 1989-90^a

Field	County	1989		1990		1989-90 Change (%)
		Production (1000 bbl)	% of Ill. total	Production (1000 bbl)	% of Ill. total	
Lawrence	Lawrence Crawford	2,761.6	13.6	2,510.6	12.6	- 9.1
Clay City Consolidated	Clay Wayne Richland Jasper	2,228.0	10.9	2,335.7	11.7	+ 4.8
Main Consolidated	Crawford Lawrence Jasper	1,988.1	9.8	2,030.6	10.2	+ 2.1
New Harmony Consolidated	White Wabash Edwards	913.0	4.5	980.3	4.9	+ 7.4
Louden	Fayette Effingham	953.5	4.7	888.1	4.5	- 6.9
Salem	Marion Jefferson	947.6	4.6	851.1	4.3	- 10.2
Sailor Springs Consolidated	Clay Jasper Effingham	486.0	2.4	457.3	2.3	- 5.9
Phillipstown Consolidated	White Edwards	378.2	1.9	381.9	1.9	+ 1.0
Roland Consolidated	White Gallatin	254.2	1.2	299.7	1.5	+ 17.9
Albion Consolidated	Edwards White	285.5	1.4	282.0	1.4	- 1.2
Allendale	Wabash Lawrence	281.7	1.4	263.8	1.3	- 6.4
Goldengate Consolidated	Wayne White Edwards	b	b	205.5	1.0	
King North	Jefferson	255.9	1.3	b		
Herald Consolidated	White Gallatin	220.9	1.1	b		
Parkersburg	Edwards Richland	214.7	1.1	b		
Benton	Franklin	204.7	1.0	b		
TOTAL		12,373.6	60.7	11,486.6	57.6	- 7.2

^aSource: Illinois State Geological Survey Oil and Gas Section.^bLess than 200,000 barrels of oil per year.

Table 15 Petroleum products consumed in Illinois, 1986-90^a

	1986 ^d	1987 ^d	1988 ^d (1,000 bbl)	1989 ^d	1990
Motor gasoline ^b	110,906	112,409	120,344	120,176	124,538
Kerosene	405	303	350	367	174
Distillate fuel oil	35,132	34,129	33,662	34,565	42,529
Residual fuel oil	8,316	6,948	5,886	4,031	3,609
Lubricants	3,090	3,493	3,369	3,455	3,556
Liquefied gases	32,529	41,884	45,341	13,097	13,008
Asphalt & road oil	6,185	6,315	5,604	8,052	8,339
Other ^c	23,662	25,513	28,278	28,145	30,692
TOTAL	220,226	230,994	242,834	211,889	226,443

^a Source: State Energy Data Report, U.S. DOE/EIA-0214.

^b Aviation and motor gasoline and jet fuel.

^c Includes natural gasoline, unfractionated stream, plant condensate, petrochemical feedstocks, special naphthas, non-electric utility sector use of petroleum coke, still gas, wax, unfinished oils, motor gasoline and aviation gasoline blending components, and miscellaneous products.

^d Revised.

Table 16 Natural gas production in Illinois, 1983-90^a

Year	Withdrawals (million cu ft)		
	Gas wells	Oil wells	Total
1983	858.0	172.0	1,030
1984	1,399.6	130.4	1,530
1985	1,228.0	96.0	1,324
1986	1,545.9	341.6	1,888
1987	1,215.2	155.8	1,371
1988	1,289.5	181.2	1,471
1989	1,268.0	209.0	1,477
1990	653.0	24.0	677

^a Source: Illinois State Geological Survey Oil and Gas Section.

Table 17 Natural gas production from large fields in Illinois counties, 1988–90^a

Gas field	County	Production (million cu ft)			Change (%)	
		1988	1989	1990	1988–89	1989–90
Liberty	Adams	132.8	188.6	181.7	+ 42.0	- 3.7
Stolletown	Clinton	75.6	43.1	33.3	- 43.0	- 22.7
Mattoon	Coles	226.9	148.7	60.6	- 34.5	- 59.2
Ashmore East	Edgar	56.9	47.8	28.2	- 16.0	- 41.0
Omaha	Gallatin	—	—	58.3	—	—
Prentice	Morgan	505.6	549.1	—	+ 8.6	—
Fishhook	Pike	136.5	151.2	—	+ 10.8	—
St. Libory	St. Clair	—	56.5	104.6	+174.3	+ 85.1
Raleigh South	Saline	57.9	33.7	12.2	- 41.8	- 63.8
Keenville	Wayne	170.4	199.3	—	+ 17.0	—
Pittsburg	Williamson	b	b	133.9	—	—
Other ^b		108.0	58.9	64.1	- 45.5	+ 8.8
TOTAL^c		1,470.7	1,476.9	676.9	+ 0.4	- 54.2

^a Source: Illinois State Geological Survey. Fields producing 50 million cu ft or more.

^b Louden, Fayette and Effingham Counties; Eden, Randolph County; Eldorado Consolidated and Eldorado West, Saline County; (1988, 1989, 1990); New Athens and St. Libory, St. Clair County; Rushville, Schuyler County (1988); Pittsburg, Eldorado East, Gallatin County; Williamson County (1988, 1989).

^c Totals may not add up because of rounding.

Table 18 Natural gas consumed in Illinois, 1989–90^a

Consumers	1989		1990		1989–90 change (%)
	Quantity (million cu ft)	% of total consumption	Quantity (million cu ft)	% of total consumption	
Residential	499,984	50.2	442,163	47.1	-11.6
Commercial	196,171	19.7	200,267	21.3	+ 2.1
Industrial	278,826	28.0	275,630	29.3	- 1.1
Electric utilities	6,967	0.7	9,195	1.0	+32.0
Vehicle fuel	NA	—	5	0	—
Total delivered to consumers	981,948	98.6	927,260	98.7	- 5.6
Other uses^b	13,584	1.4	12,242	1.3	- 9.9
Total consumption	995,532	100.0	939,502	100.0	- 5.6

^a Source: U.S. Department of Energy.

^b Includes lease and plant fuel, pipeline fuel, and extraction loss.

NA = not available.

Table 19 Production and value of Illinois sand and gravel by district^a, 1990^b

County			Companies	Operations	Total quantity (1000 ton)	Value (\$1000)
District 1						
Boone	Jo Davies	Rock Island				
Bureau	Kane	Stephenson				
Cook	Lake	Whiteside	46	56	20,519	68,907
De Kalb	McHenry	Will				
Du Page	Ogle	Winnebago				
Henry						
District 2						
Adams	Peoria	Sangamon				
Fulton	Pike	Tazewell	15	19	3,129	10,578
Logan						
District 3						
Champaign	Kankakee	McLean				
Clark	Kendall	Moultrie				
Coles	La Salle	Piatt	37	45	6,164	17,915
Cumberland	Livingston	Putnam				
Ford	Macon	Vermilion				
Grundy	Marshall	Woodford				
District 4						
Alexander	Gallatin	Randolph				
Bond	Jackson	St. Clair				
Clinton	Lawrence	Wabash	22	23	2,569	7,328
Crawford	Madison	White				
Fayette	Pulaski					
TOTAL			120 ^c	143	32,380	104,728

^aSee figure 9.^bSource: U.S. Bureau of Mines.^cThere are 105 different companies; however, some operate several pits that may be in more than one county. Each pit is counted separately.**Table 20** Illinois sand and gravel production by size of operation, 1988 and 1990^a

Size of operation (tons/year)	1988			1990		
	No. of operations	Production (1000 tons)	Percent of total	No. of operations	Production (1000 tons)	Percent of total
less than 25,000	36	293	1.0	31	227	0.7
25,000 to 49,999	21	748	2.5	17	628	1.9
50,000 to 99,999	33	2,451	8.1	28	2,121	6.6
100,000 to 199,999	26	3,630	12.1	32	4,757	14.7
200,000 to 299,999	18	4,464	14.8	14	3,402	10.5
300,000 to 399,999	4	1,403	4.7	6	2,067	6.4
400,000 to 999,999	11	6,733	22.3	6	3,388	10.4
1,000,000 and over	6	10,376	34.5	9	15,790	48.8
TOTAL	155	30,098	100.0	143	32,380	100.0

^a Source: U.S. Bureau of Mines. Because of the canvassing procedure used for sand and gravel production, 1989 information is not available.

Table 21 Use of sand and gravel produced in Illinois, 1988 and 1990^a

	1988		1990		1988-90 change in quantity (%)	1988-90 change in value (%)
	Quantity (1000 tons)	Value (\$1000)	Quantity (1000 tons)	Value (\$1000)		
Construction aggregates						
Sand and gravel						
Construction operations						
Building	10,287	30,774	16,427	47,969	+ 59.7	+ 55.9
Paving	7,589	29,320	7,638	31,525	+ 0.6	+ 7.5
Fill	4,120	9,896	3,700	9,354	- 10.2	- 5.5
Other uses ^b	8,102	23,514	4,616	15,880	43.0	- 32.5
Total ^c	30,098	93,504	32,380	104,728	+ 7.6	+ 12.0
Industrial sand ^d						
Total ^c	4,039	52,133	4,328	56,142	+ 7.2	+ 7.7
Total sand and gravel ^c	34,680	146,739	36,867	167,259	+ 6.3	+ 14.2

^aSource: U.S. Bureau of Mines.^bIncludes railroad ballast and other unspecified materials^cNumbers are rounded and totals may not add up.^dData is no longer received by use for industrial sand.**Table 22** Portland cement manufactured in Illinois, 1989-90^a

	1989	1990	Change (%) 1989-90
No. of active plants	4	4	—
Production (tons)	2,700,192	2,662,350	- 1.4
Shipments from mills			
Quantity (tons)	2,775,813	2,841,724	+ 2.4
Value (\$)	117,223,528	116,781,410	- 0.4
Average value/ton	42.23	41.10	- 2.7
Stocks at mills, Dec. 31			
(tons)	283,450	301,002	+ 6.2

^a Source: U.S. Bureau of Mines.

Table 23 Mineral production data for 1990 compared with preliminary data for 1991^a

		1990		1991		Percentage of change from 1990 to 1991	
Minerals extracted	Unit	Quantity	Value (\$ 1000)	Quantity	Value (\$ 1000)	Quantity	Value
Fuels							
Coal	thousand	61,657	1,709,750	60,036	1,620,959 ^b	- 2.6	- 5.2
Crude oil	thousand bbl	19,954	406,462	19,069 ^b	326,843 ^b	- 4.4	- 19.6
Natural gas	thousand Mcf	677	1,428	466 ^b	1,011 ^b	- 31.1	- 29.2
Industrial and construction materials							
Stone ^c	thousand tons	62,700	283,100	58,000	262,300	- 7.5	- 7.3
Sand and gravel	thousand tons	36,866	167,259	31,700	150,400	- 14.0	- 10.1
Clay ^d	thousand tons	660	2,516	180	1,102	- 72.7	- 56.2
Metals, gemstones and other undisclosed ^e							
			54,352		47,196		- 13.2
Total value of minerals extracted			\$2,624,867		\$2,409,811		- 8.2

^a Source: U.S. Bureau of Mines and Illinois Department of Mines and Minerals^b Estimated by Illinois State Geological Survey^c Dimension stone included with values that cannot be disclosed.^d Excludes fuller's earth; included with values that cannot be disclosed.^e Includes fluorspar, zinc, barite, peat, gemstones, fuller's earth, sandstone, and dimension stone for 1990 and 1991, and copper, lead, silver, tripoli for 1990 with no estimate for 1991.**Table 24** Illinois coal shipped to consumers in the United States, 1989-91^a

Consumers	1989	1990	1991	1989-90 change (%)	1990-91 change (%)
	Jan-Sept (1000 tons)	Jan-Sept (1000 tons)	Jan-Sept (1000 tons)		
Electric utilities	40,508	41,299	39,624	+ 2.0	- 4.1
Coke and gas plant	1,215	966	498	- 20.5	- 48.4
Retail dealers	339	307	258	- 9.4	- 16.0
Others	2,539	2,731	2,775	+ 7.6	+ 1.6
Used at mine	25	62	7	+148.0	- 88.7
Mine stock (adjusted)	1,802	1,914	1,954	- 6.2	+ 2.1
Foreign	418	342	846	- 18.2	+147.4
TOTAL	45,044	45,707	44,008	+ 1.5	- 3.7

^a Source: U.S. Department of Energy, Coal Distribution, January-September, 1989, 1990, and 1991.

Table 25 Coal shipments from Illinois to other states, 1989-91^a

Consumers	1989 Jan-Sept	1990 Jan-Sept (1000 tons)	1991 Jan-Sept	1989-90 change (%)	1990-91 change (%)
Illinois	12,802	13,994	13,838	+ 9.3	- 1.1
Missouri	10,737	9,717	9,569	- 9.5	- 1.5
Indiana	7,299	7,690	7,556	+ 5.4	- 1.7
Wisconsin	1,409	1,094	639	- 22.4	- 41.6
Georgia	3,891	3,576	3,049	- 8.1	- 14.7
Iowa	1,887	1,313	1,330	- 30.4	+ 1.3
Alabama	663	897	269	+ 35.3	- 70.0
Florida	2,859	3,147	3,327	+ 10.1	+ 5.7
Tennessee	1,206	1,637	1,105	+ 35.7	- 32.5
Mississippi	1,031	893	1,179	- 13.4	+ 32.0
Other states ^b	842	1,407	1,301	+ 67.1	- 7.5
Exports	418	342	846	- 18.2	+147.4
TOTAL	45,044	45,707	44,008	+ 1.5	- 3.7

^a Source: U.S. Department of Energy, Coal Distribution, January-September, 1989, 1990, and 1991.

^b Arkansas, Kansas, Michigan, Minnesota, Ohio, Pennsylvania (1989, 1990, 1991), California, Louisiana, New York, West Virginia (1989), Massachusetts, Wyoming (1990), Montana (1990, 1991), North Dakota, Texas (1989, 1991), Kentucky, (1989, 1990), Virginia (1991).