The Mineral Industry of Missouri

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Missouri Department of Natural Resources, Division of Geology and Land Survey, for collecting information on all nonfuel minerals.

By Robert H. Arndt[1]

A new record was established for nonfuel minerals produced in Missouri when mineral output in 1979 was valued at $1.2 billion. Massive increases occurred in the values of produced portland cement, clays, lime, copper, lead, silver, zinc, and usable iron ore. The total value of nonfuel mineral production in 1978 was split about equally between metals and nonmetals. Metals were dominant in 1979.

Output of all metals increased in 1979. Clays were the only nonmetal enjoying increased output. Cement, lime, sand and gravel, and stone, all significant construction materials, were produced in reduced quantities, which caused a reduction in the number of stone and sand and gravel producers and operations and gave substance to a recession in construction in 1979. Viburnum No. 27 lead mine of St. Joe Minerals Corp. (St. Joe) was closed because of ore depletion. St. Joe's Pea Ridge iron mine and pellet plant, closed as uneconomic in 1977, was reorganized as Pea Ridge Iron Ore Co., Inc., and reopened in June 1979. Kennecott Copper Corp. announced plans for expanding the Ozark Lead Co. operations on Sweetwater Branch and the development of the new Milliken mine. Strikes shut down mining, milling, and smelting activities at the Buick mine of the AMAX Lead Co. of Missouri in 1978 and at Ozark Lead Co.'s Sweetwater Branch mine in 1979, with resulting curtailment of lead production. Other consequences were inconveniences to Cominco American, Inc., which utilized the Buick smelting facilities, and an interruption of the lead concentrate supply for ASARCO's smelter at Glover. Noranda Aluminum, Inc., shut down its plant at New Madrid for almost 2 months in early 1978 because of a power shortage. Exploration for lead deposits extended southward from the Viburnum trend into parts of Shannon, Carter, Oregon, Ripley, and Butler Counties. Increased prices for cobalt and nickel resulted in renewed testing and development of formerly mined and unmined lead-cobalt-nickel deposits near Fredericktown in Madison County.

Shortages of cement in 1978 influenced the State to bring price-fixing charges against 15 cement firms and join with other States in a similar suit being tried in Federal court in Arizona.

Environmental and regulatory problems affecting mining drew considerable public attention. Alpha Portland Industries, Inc., continued in litigation over a permit to dredge sand and gravel from the Meramec River valley in St. Louis County. The U.S. Forest Service Roadless Area Review and Evaluation (RARE II) was completed. The review involved possible designation of

Table 1.—Nonfuel mineral production in Missouri[1]

Mineral	1977 Quantity	1977 Value (thousands)	1978 Quantity	1978 Value (thousands)	1979 Quantity	1979 Value (thousands)
Barite ... thousand short tons	117	$4,061	121	$4,661	89	$3,679
Cement:						
Masonry ... do	82	3,286	89	4,112	82	4,159
Portland ... do	4,654	155,945	4,733	175,962	4,430	194,285
Clays ... do	[2]2,373	[2]16,892	[2]2,258	[2]16,880	2,351	20,522
Copper (recoverable content of ores, etc.) metric tons	10,648	15,681	10,818	15,861	13,021	26,705
Gem stones	--	--	NA	15	NA	10
Gold ... troy ounces	--	--	--	--	32	10
Lead (recoverable content of ores, etc.) metric tons	453,824	307,156	461,762	343,070	472,054	547,824
Lime ... thousand short tons	1,723	51,529	1,791	63,642	1,790	70,187
Sand and gravel ... do	14,002	31,473	15,560	33,660	12,558	31,310
Silver (recoverable content of ores, etc.) thousand troy ounces	2,363	10,916	2,056	11,103	2,201	24,410
Stone:						
Crushed ... thousand short tons	49,612	104,700	57,265	130,568	56,380	139,944
Dimension ... do	3	597	1	208	(3)	85
Zinc (recoverable content of ores, etc.) metric tons	74,107	56,203	59,038	40,349	61,682	50,723
Combined value of asphalt (native), clays (fuller's earth, 1977-78), iron ore, and phosphate rock (1977)	XX	67,950	XX	26,373	XX	45,982
Total	XX	826,389	XX	866,464	XX	1,159,835

NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes fuller's earth; value included in "Combined value" figure.
[3]Less than 1/2 unit.

Table 2.—Value of nonfuel mineral production in Missouri, by county[1]

(Thousands)

County	1977	1978	Minerals produced in 1978 in order of value
Andrew	W	W	Stone.
Atchison	$1	W	Sand and gravel.
Audrain	r3,295	$2,485	Clays.
Barry	445	548	Stone.
Barton	W	W	Stone, asphalt.
Bates	W	W	Stone.
Benton	188	698	Do.
Bollinger	54	40	Sand and gravel.
Boone	W	W	Stone, sand and gravel, clays.
Buchanan	W	W	Stone.
Butler	W	W	Sand and gravel, stone, clays.
Caldwell	509	748	Stone.
Callaway	W	7,043	Stone, clays, sand and gravel.
Camden	308	294	Sand and gravel, stone.
Cape Girardeau	13,869	W	Cement, stone, sand and gravel, clays.
Carter	33	--	
Cass	860	1,212	Stone.
Cedar	W	W	Do.
Chariton	W	W	Stone, sand and gravel.
Christian	W	806	Stone.
Clark	W	W	Stone, sand and gravel.
Clay	W	5,764	Do.
Clinton	W	460	Stone.
Cole	W	W	Stone, sand and gravel.
Cooper	W	W	Do.
Crawford	W	W	Lead, sand and gravel, stone, copper, zinc, clays, silver.
Dade	458	W	Stone.
Dallas	5	W	Stone, sand and gravel.
Daviess	W	W	Do.
De Kalb	W	399	Stone.
Dent	16	W	Do.
Douglas	240	976	Sand and gravel, stone.
Franklin	1,355	1,613	Do.
Gasconade	W	W	Clays, sand and gravel.

See footnotes at end of table.

Table 2.—Value of nonfuel mineral production in Missouri, by county[1] —Continued

(Thousands)

County	1977	1978	Minerals produced in 1978 in order of value
Gentry	W	W	Stone, sand and gravel.
Greene	W	W	Lime, stone.
Grundy	W	W	Stone, sand and gravel.
Harrison	W	W	Do.
Henry	W	W	Stone.
Hickory	W	W	Do.
Holt	W	W	Stone.
Howard	W	W	Stone, sand and gravel.
Howell	$695	$997	Sand and gravel, stone.
Iron	W	W	Lead, zinc, iron ore, copper, silver, stone.
Jackson	W	W	Cement, stone, sand and gravel.
Jasper	W	W	Stone, sand and gravel.
Jefferson	W	W	Cement, stone, sand and gravel, clays.
Johnson	492	406	Stone.
Knox	W	W	Do.
Laclede	W	542	Stone, sand and gravel.
LaFayette	W	W	Do.
Lawrence	W	W	Stone.
Lewis	W	W	Sand and gravel, stone.
Lincoln	W	W	Stone, sand and gravel.
Livingston	W	W	Stone, clays, sand and gravel.
McDonald	W	W	Sand and gravel, stone.
Macon	263	263	Sand and gravel.
Madison	W	W	Sand and gravel, stone.
Marion	W	131	Stone, sand and gravel.
Mercer	676	847	Stone.
Miller	W	797	Sand and gravel, stone.
Moniteau	240	W	Stone.
Monroe	W	W	Stone, clays.
Montgomery	W	W	Clays, stone, sand and gravel.
Morgan	154	123	Stone.
Newton	549	506	Stone, sand and gravel.
Nodaway	W	W	Do.
Oregon	W	W	Sand and gravel, stone.
Osage	W	W	Clays, stone, sand and gravel.
Ozark	W	W	Sand and gravel.
Pemiscot	243	297	Do.
Perry	W	W	Stone, sand and gravel.
Pettis	W	W	Stone.
Phelps	W	1,046	Stone, sand and gravel.
Pike	W	W	Cement, stone, clays, sand and gravel.
Platte	W	W	Stone, clays.
Polk	216	217	Stone.
Pulaski	808	1,055	Stone, sand and gravel.
Putnam	W	W	Stone.
Ralls	W	W	Cement, stone, clays.
Randolph	556	W	Stone.
Ray	1,237	1,298	Sand and gravel, stone.
Reynolds	W	163,554	Lead, zinc, copper, silver, sand and gravel.
Ripley	249	306	Sand and gravel.
St. Charles	W	W	Stone, sand and gravel, clays.
St. Clair	W	W	Stone.
St. Francois	W	W	Lime, stone, sand and gravel.
St. Louis	W	W	Cement, stone, sand and gravel, clays.
St. Louis City	W	711	Sand and gravel.
Ste. Genevieve	W	W	Lime, stone, sand and gravel.
Saline	1,339	2,176	Stone.
Scotland	W	W	Do.
Scott	W	W	Stone, clays, sand and gravel.
Shannon	202	384	Stone.
Shelby	W	809	Do.
Stoddard	1,288	1,121	Sand and gravel.
Stone	W	W	Stone.
Sullivan	--	286	Do.
Taney	W	W	Sand and gravel, stone.
Texas	187	285	Stone, sand and gravel.
Vernon	1,421	1,132	Stone.
Warren	W	W	Clays, stone.
Washington	85,608	47,426	Lead, iron ore, barite, copper, zinc, silver, sand and gravel.
Wayne	2,580	3,219	Stone.
Webster	80	W	Stone, sand and gravel.
Worth	W	489	Stone.
Wright	W	W	Do.
Undistributed[2]	705,673	612,954	
Total[3]	826,389	866,464	

[r]Revised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]The following counties are not listed because no nonfuel mineral production was reported: Adair, Carroll, Dunklin, Linn, Maries, Mississippi, New Madrid, and Schuyler.

[2]Includes value of stone and gem stones that cannot be assigned to specific counties and values indicated by symbol W.

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

Table 3.—Indicators of Missouri business activity

	1977	1978	1979[p]	1978-79 percent change
Employment and labor force, annual average:				
Total civilian labor force ... thousands	2,228.0	2,256.0	2,293.0	+1.6
Unemployment ... do	131.0	114.0	104.0	-8.8
Employment (nonagricultural):				
Mining[1] ... do	8.4	7.6	8.0	+5.3
Manufacturing ... do	439.6	456.8	459.7	+.6
Contract construction ... do	77.8	87.3	92.0	+5.4
Transportation and public utilities ... do	129.7	136.3	142.4	+4.5
Wholesale and retail trade ... do	446.1	465.8	475.4	+2.1
Finance, insurance, real estate ... do	98.0	103.7	108.2	+4.3
Services ... do	340.7	360.0	378.0	+5.0
Government ... do	321.5	335.6	339.2	+1.1
Total nonagricultural employment[1] ... do	1,861.8	1,953.1	2,002.9	+2.5
Personal income:				
Total ... millions	$31,726	$35,413	$39,581	+11.8
Per capita	$6,579	$7,287	$8,132	+11.6
Construction activity:				
Number of private and public residential units authorized	28,081	[2]29,065	19,509	-32.9
Value of nonresidential construction ... millions	$423.3	$486.5	$512.1	+5.3
Value of State road contract awards ... do	$240.0	$160.0	$281.0	+75.6
Shipments of portland and masonry cement to and within the State ... thousand short tons	1,835	2,153	1,914	-11.1
Nonfuel mineral production value:				
Total crude mineral value ... millions	$826.4	$866.5	$1,159.8	+33.8
Value per capita, resident population	$171	$178	$238	+33.7
Value per square mile	$11,859	$12,434	$16,644	+33.8

[p]Preliminary.
[1]Includes bituminous coal and oil and gas extraction.
[2]Series revised in 1978; data not comparable with those of prior years.

Sources: U.S. Department of Commerce, U.S. Department of Labor, Highway and Heavy Construction Magazine, and U.S. Bureau of Mines.

75,000 acres of potential mineral lands in the Mark Twain National Forest as Wilderness and made them inaccessible for prospecting during the review process. The Environmental Protection Agency (EPA) promulgated national standards for lead in the atmosphere and at plant boundaries, and the Occupational Safety and Health Administration (OSHA) proposed standards for occupational exposure to lead in the atmosphere at a workplace. Members of industry, the Governor, and State senators opposed the standards. The economics of solving air and water pollution problems in addition to market problems at National Lead Industries' titanium pigment plant in St. Louis caused the firm to abandon that plant. A lawsuit over pollution of Big River by Dresser Industries remained in litigation. Efforts continued to abate an erosion problem on lead mine tailings and resulting siltation in Big River in St. Francois County. Carthage experienced another collapse of an abandoned mine shaft and a 90-foot-deep hole appeared in the middle of a street. Fifteen dams were declared unsafe in a survey by the U.S. Army Corps of Engineers. One retained a lake on property of Anschutz Corp., Inc., near Fredericktown.

Legislation and Government Programs.—The Legislature gave the State powers through House Bill 932 (1978) to administer an interim program of surface mine reclamation required under Public Law 95-87, the Surface Mining Control and Reclamation Act of 1977. By passing House Bill 459 (1979), the Legislature separated reclamation requirements for coal from those for barite and tar sands as provided in previous legislation. The State gained control over safety of dams and over erosion processes when House Bill 603 was passed in 1979.

The Division of Geology and Land Survey (Missouri Department of Natural Resources) was engaged in field studies of the State's limestone and shale resources and the distribution, petrology, petrography, and geochemistry of buried Precambrian igneous and mineralized rocks of southeast Missouri. An inventory of lands affected by mining interfaced with the State's land reclamation program and provided data cooperatively for the Bureau of Mines Mineral Industry Location System (MILS). Con-

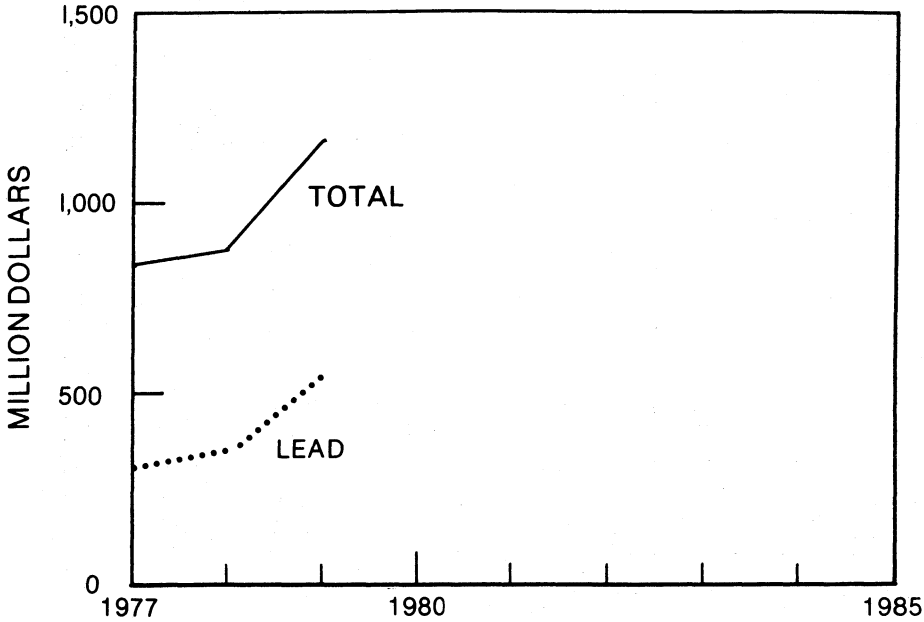

Figure 1.—Value of lead and total value of nonfuel mineral production in Missouri.

siderable effort was expended on review and comment on the RARE II process as it applies to the Mark Twain National Forest, and to wilderness issues in other areas of potential mineral development. Geologic framework studies continued for the U.S. Geological Survey's CUSMAP program in the Rolla 2° quadrangle project and of the seismicity in the New Madrid seismic area for the Nuclear Regulatory Commission. Among the Division of Geology and Land Survey publications on minerals and geology during 1978-79 were a new Geologic Map of Missouri, Geologic Map of the Precambrian of Missouri, and a history of the diaspore industry in Missouri. Results of the Division's efforts in support of the study of the Rolla 2° quadrangle were published largely by the U.S. Geological Survey.

Metallurgical, resource, and other research in minerals was pursued at the Bureau of Mines Rolla Research Center. Among the events significant to the mineral industry in Missouri was publication of results of Bureau of Mines research on cobalt and nickel recovery from chalcopyrite concentrates and their application in a large-scale demonstration at Cominco American's Magmont mill.[2] The research and demonstration were oriented toward recovery of cobalt and nickel from chalcopyrite ores such as those associated with lead deposits near Fredericktown. Research was also supported through contracts, grants, and cooperative projects in academic, State, commercial, and industrial research organizations. State agencies involved were the University of Missouri at Columbia and at Rolla, and the State Division of Geology and Land Survey. Research at the University included problems in electrolytic metal processing, rock-bolt applications, and regional studies of mineral resources. The Division of Geology collected data on all mine sites for entry into the Bureau's MILS system, and provided clay samples for testing by the Bureau. Other research for the Bureau by private organizations treated environmental problems of mining such as handling overburden in strip mining, preventing or inhibiting formation of acid on emergence of waters draining from underground mines, and backfilling techniques. Mine health and safety research was directed toward alle-

viating industrial-type hazards, preventing and controlling fire and explosions, and stabilizing insecure roofs, floors, and pillars in underground mines.

Mineral problems were addressed in the U.S. Geological Survey-Missouri Division of Geology and Land Survey cooperative geologic mineral assessment of the Rolla 2° quadrangle. The study area comprised about 7,500 square miles that includes mined and unmined resources of lead, zinc, iron, and barite, both outside of and within parts of the Mark Twain National Forest. Resulting maps and reports were published or held as open-file reports. Reports described the distribution and character of exposed and buried Precambrian rocks, configuration, thickness, and facies of selected Cambrian strata, and results and interpretations of the chemical and spectrographic analyses of whole rock and insoluble residues from selected drill holes in the area.

During the period, the University of Missouri at Rolla was designated by the Secretary of the Interior as a State Mining and Mineral Resources and Research Institute pursuant to Title III of Public Law 95-87.

REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Aluminum.—Aluminum production was curtailed at the Noranda Aluminum, Inc., smelter in New Madrid because of a shortage of electric power from February 14 to April 7, 1978. Excessive cost of substitute power instigated a complete shutdown of the plant. Reactivation of the plant to full capacity required about 40 days. Aluminum recycling activities were enlarged by the opening of a Coor's "Cash-For-Cans" recycling center in Fenton, Mo., in August 1979. Reynolds Aluminum Recycling Co. announced plans to build a new recycling center in South St. Louis to be opened early in 1980.

Copper.—Copper minerals in the Missouri lead ores provide a significant increment of coproduct copper recovered both as concentrates and in the smelting process, and the historical pattern of copper production is roughly parallel to that of lead. Copper output was high in 1975, fell in 1976, rose slowly in 1977-78, and was followed by a rapid rise in 1979. Value of the output followed a similar pattern, with annual average unit prices of copper ranging from about 64 cents to about 70 cents per pound until 1979 when the average price rose to 93 cents per pound. Coincidentally with the increase in price in 1979, output of copper increased by more than 20% over the output in 1978, and the lead-to-copper ratio, which is normally highly variable, fell from an annual weighted average of 42.7:1 for Missouri production in 1978 to 36.3:1 in 1979. The individual ratios in ore from all of the mines except one fell at the same time.

Iron Ore.—Pilot Knob Pellet Co. remained the only producer of iron in Missouri in 1978. Consequently, the output of usable iron ore, which had been decreasing annually from about 2.3 million long tons in 1975, fell to less than 1 million tons in 1978, and the value fell similarly. Reactivation of the Pea Ridge operation by St. Joe Minerals Corp. as the Pea Ridge Iron Ore Co. in the summer of 1979 boosted Missouri ore production for that year by more than 60%, and the value of the ore by more than 84% above that of 1978. The average unit value of the ore rose from about $31.50 per ton in 1975 to almost $35.50 per ton in 1978. Improving world markets in 1979 boosted the unit value to more than $40 per ton in 1979.

Pea Ridge Iron Ore Co. was brought into production in stages. Its products are blast-furnace and direct-reduction grade pellets, speciality products for use in magnetic ferrites, printing inks, brake linings, and the heavy-media material made of magnetite for use in washing coal. Proven reserves of ore were reported to be 100 million tons, or enough for about 30 years operation of the mine.

Lead.—Output of lead in the Nation's leading lead-producing State was on an upward trend in 1978-79. Low production in 1977 was the bottom of a decline from record high production in 1974. Despite production of more than 472,000 metric tons of lead, the output in 1979 was 7.4% below that achieved in 1974. The value of the lead in 1975 fell below that in 1974, but subsequently rose to a record high in 1979 in conjunction with the rise of the unit value of lead from about 21 cents per pound in 1975 to almost 53 cents per pound in 1979. The sharp rise in unit value from 1977 to 1979 accompanied increased consumption, decreased imports of lead from foreign countries, and general shortages of lead in the world market.

Mining took place in Crawford, Iron, Reynolds, and Washington Counties in 1978, and in the latter three in 1979. AMAX Lead Co. of Missouri, Cominco American, Inc., St. Joe Minerals Corp., and Ozark Lead Co. were engaged in mining. St. Joe's active mines in 1978-79 included Viburnum No. 28 in Iron County, Brushy Creek and Fletcher in Reynolds County, and Indian Creek and Viburnum No. 29 in Washington County. Viburnum No. 27 in Crawford County was abandoned in 1978. AMAX operated the Buick mine and Cominco the Magmont mine in Iron County both years. The Ozark or Sweetwater Branch mine of Ozark Lead Co. in Reynolds County operated both years, but was incorporated in the expansion and renamed Milliken Mine and Mill complex in 1979. The Missouri Department of Labor and Industrial Relations reported that these operations employed 1,520 people in mining in 1979. Production was the greatest in Iron County both years, and St. Joe's combined production exceeded all others. Buick mine had the largest individual output.

Two mines suffered major strikes during the biennium. Contracts of the United Steel Workers of America at the Buick mine and mill complex of the AMAX Lead Co. of Missouri and Homestake Mining Co. expired in late May, and workers were on strike from May 31 to August 9, 1978. The workers returned on August 10 after agreeing to settlement involving wages, cost of living, and premium pay adjustments. Half of the capacity at the Buick smelter was dedicated to processing concentrates from the Cominco American Magmont mine and mill. Cominco adjusted by sending out one-third of its concentrates to Bunker Hill and stockpiling the remainder. Output from the Buick mine apparently suffered as its lead production in 1979 rose approximately 17% above production in the strike year. A similar strike over new contract provisions occurred at Ozark Lead Co.'s Sweetwater Branch from March 1 to June 4, 1979. Estimated losses in production were 28,000 to 30,000 tons of concentrates as the recoverable lead in ores from the mine in 1979 decreased more than 20% from output in the previous year. Interruption of the supply of lead concentrates from the Sweetwater Branch to ASARCO's smelter at Glover prevented ASARCO from making full delivery of committed lead and caused the firm to declare a force majeure on its commitments for delivery for several months in the spring and early summer of 1979.

Viburnum No. 27 mine, which had been opened in 1960 by St. Joe, was closed in 1978 because of depletion of the ore supply. The firm's Indian Creek mill in Washington County was shut down in October 1978, and reopened late in the winter in 1979, after repairs had been made. Renewed vigor was given to the Ozark Lead Co. when Kennecott Copper Corp. announced plans to expand the existing plant at Sweetwater Branch and to add a new mine. The facility, renamed the Frank R. Milliken mine, was dedicated in August 1979. The firm planned to increase output of concentrates by 28,000 short tons per year, raising the plant's capability to 96,000 tons per year. Mine output would be increased 33% above the existing yearly capacity of 1,500,000 tons of crude ore, and the work force was expected to increase 25% on completion in the early 1980's. Plans called for adding two shafts, excavating 2 miles of underground tunnel from the existing mine to the site of the new mine, adding new hoisting facilities with a capacity of 2,500 tons per day in an existing air shaft, building a surface belt conveyor from the shaft to the concentrator 2,900 feet away, and enlarging crushing and concentrating facilities. The project was expected to cost $25 million. The firm considered ore reserves in the Milliken mine grading 5% to 6% lead and 1% zinc to be sufficient for 25 to 30 years mining at the expected rate.

Silver.—Missouri was fifth among the States in production of silver in 1979, when 2,201,112 troy ounces of silver were recovered in the smelting of Missouri lead concentrates. After an irregular decline in the output of silver from 1975 through 1978, production increased slightly in 1979. The value of the silver, likewise falling from the value in 1975, turned upward in 1978 and escalated rapidly in 1979 as the average annual unit prices increased from $5.40 per troy ounce to $11.09 per troy ounce. Buick mine in Iron County produced the most silver.

Zinc.—Although zinc is a coproduct of mining and milling lead ores, Missouri's output was exceeded nationally only by that in Tennessee in 1979. Output in 1978, the lowest in the 5-year period 1975-79, also generated the lowest value in any year during that period. Both production and value of zinc increased in 1979. The relatively depressed production during the biennium accompanied the low unit value of zinc, about 31 cents per pound in 1978 increasing to 37 cents per pound in 1979.

Iron County and the Buick mine were the leading sources of zinc.

Other Metals.—A rapid increase of the price of cobalt from about $6.40 per pound in February 1978, to about $25 per pound in March 1979, created new interest in reopening the Madison mine near Fredericktown. The mine is in lead-rich ores that have associated nickel, cobalt, and iron-nickel sulfides. It was last operated by National Lead Co. from 1954 to 1961 to provide cobalt for government stockpiles. Anschutz Corp. purchased the former National Lead Co. properties from Nedlog Technology Group of Arvada, Colo., in March 1979, with the intention of testing the feasibility of recovering cobalt from tailings and from ore in the mine. The firm, which expected that research would identify proper ore treatment procedures, envisioned an output of 1.5 to 2 million pounds per year of cobalt. Research in extraction technology and evaluation of the ore body continued through 1979.

Table 4.—Tenor of lead ore milled and concentrates produced in Missouri

		1978	1979
Total material	metric tons	7,962,153	8,262,993
Metal content of ore:[1]			
Copper	percent	0.15	0.17
Lead	do	6.00	5.90
Zinc	do	0.84	0.85
Concentrates produced and average content:			
Copper	metric tons	20,410	28,066
Recovery ratio	percent	0.26	0.34
Average copper content	do	26.39	27.47
Lead	metric tons	643,086	652,970
Recovery ratio	percent	8.08	7.90
Average lead content	do	73.80	73.99
Zinc	metric tons	107,394	113,189
Recovery ratio	percent	1.35	1.37
Average zinc content	do	58.57	57.52

[1]Figures represent metal content of crude ore only as contained in the concentrate.

Table 5.—Production and value of lead in Missouri and the United States

Year	Missouri			United States	
	Quantity (metric tons)	Value (thousands)	Percent of U.S. production	Quantity (metric tons)	Value (thousands)
1975	468,069	$221,862	83.0	563,783	$267,230
1976	454,492	231,458	82.2	552,971	281,610
1977	453,824	307,156	84.4	537,499	363,789
1978	461,762	343,070	87.2	529,662	393,516
1979	472,054	547,824	89.8	525,569	609,929

Table 6.—Missouri: Mine production (recoverable) of gold, silver, copper, lead, and zinc

		1977	1978	1979
Mines producing: Lode		9	9	8
Material sold or treated: Lead ore	thousand metric tons	8,097	7,962	8,263
Production:				
Quantity:				
Gold	troy ounces	--	--	32
Silver	do	2,362,752	2,056,053	2,201,112
Copper	metric tons	10,648	10,818	13,021
Lead	do	453,824	461,762	472,054
Zinc	do	74,107	59,038	61,682
Value:				
Gold	thousands	--	--	$10
Silver	do	$10,916	$11,103	$24,410
Copper	do	$15,681	$15,861	$26,705
Lead	do	$307,156	$343,070	$547,824
Zinc	do	$56,203	$40,349	$50,723
Total[1]	do	$389,956	[1]$410,382	$649,672

[1]Data do not add to total shown because of independent rounding.

NONMETALS

Barite.—A slight upturn in the amount of barite produced in 1978 interrupted a 6-year sequence of decreasing production. However, the decline resumed in 1979, when the output was almost 32,000 tons less than in 1978, and about 48% below that of 1975. The maximum value of output between 1975 and 1979 was attained in 1978 in conjunction with increased production. However, as with production in 1979, the value of the product that year fell to the lowest level of the 5-year period. These losses in value occurred despite an increase of the average unit price of barite from about $23.30 per ton in 1975 to approximately $41.30 per ton in 1979. The downward trend in both quantity and value contradicted the general high demand for barite in the oil- and gas-drilling industries. Apparently, gradual depletion of Missouri's barite deposits, the generally limited mining and milling facilities, and crowding of the barite industry by expanding urbanization contributed to the fall in production.

Primary barite was produced in Missouri in 1978 by six firms from nine mines in Washington County. Leading producers in 1978 were Dresser Industries of Potosi, NL Industries with production from the Cadet mine and the Big Four mine, and Milchem Co., Keys Branch. Dresser Industries produced run-of-mine barite amounting to more than 25% of the State's total output. The other concerns produced beneficiated materials. Imco Services, a division of Halliburton Co., fostered hope for a possible increase in production of Missouri barite by preparing ground for the construction of a new barite-washing plant east of Mineral Point. The planned capacity of the plant, including a circuit for recovering fine barite, was approximately twice that of the average plant in the barite district. Imco intended to open previously untouched barite resources. Galveston-Houston Co. purchased barite properties owned by Pfizer, Inc., and by Thompson and Agers, on which to construct a new barite-washing mill. The new firm was to operate under the name of Desoto Mining Co. Much of the product was destined for the oil- and gas-drilling industry through Gulfcoast Pre-Mix Mud Services, another Galveston-Houston enterprise. At yearend, Milchem Co. stopped mining barite but maintained operations at its grinding mill.

Cement.—Manufacture of cement generated the largest value among nonmetallic, nonfuel minerals produced in Missouri in 1978-79. Output in 1978, which was the highest in any year between 1975 and 1979, declined somewhat in 1979. Maximum value of the product, more than $198 million and about $80 million greater than in 1975, was attained in 1979. The growth in value and output of cement was related to a boom in housing and nonresidential and highway construction that extended into 1978 when the value of nonresidential construction in Missouri was $486.5 million or 14.9% higher than in the previous year. Slackening of the boom, however, was indicated in 1978 by a 2.9% reduction in the number of private and public residential units authorized for construction from the number authorized in 1977. More strikingly, the value of State road contract awards during 1978 was 33.3% less than in 1977. These conditions presaged a decrease in demand for cement in Missouri and other Midwestern and North-central States in 1979.

Cement was manufactured by six firms in the 1978-79 biennium. Individual plants were located at Independence in Jackson County adjacent to the Missouri River, and at Hannibal in Marion County, Clarksville in Pike County, Festus in Jefferson County, Cape Girardeau in Cape Girardeau County, and St. Louis on the Mississippi River. One firm in St. Louis County was landlocked. The industry's five wet-process plants and two dry-process plants utilized eight wet-process kilns and four dry-process kilns that were equipped with three glass-bag dust collectors and 12 electrostatic precipitators for air pollution control. Four of the plants consumed a total of 2.4 billion cubic feet of natural gas in 1979. About 57,000 barrels of oil and 950,000 tons of coal were also utilized. The electric energy requirements of the seven plants were more than 580 million kilowatt-hours in 1979. Consumption of raw materials required for the manufacture of cement in 1978 included about 6.3 million tons of cement rock and limestone; 1.1 million tons of clay and shale for argillaceous material; sandstone and sand for silicious material; almost 5,000 tons of iron ore, plus mill scale for ferriferous material; and almost 228,000 tons of gypsum. Clinker, fly ash, and slag were also used. Products were gray portland cements, including general-purpose moderate-heat, high-early-strength, and portland pozzolan cements. A very small amount of white portland cement was manufactured. The industry also shipped about 89,000 tons of prepared ma-

sonry cement. Portland cement was shipped to users in the following proportions in 1978: ready-mix companies, 77.5%; concrete products manufacturers, 9.5%; highway contractors, 8.4%; building materials dealers, 2.8%; other contractors, 1.8%; miscellaneous users, 0.1%; and government agencies, 0.01%. Distribution in 1979 was approximately the same except for a slight increase in the amount shipped to concrete products manufacturers and a small decrease in the amount shipped to highway contractors. About 85% of the cement shipped from plants to terminals was made in bulk by barge on the Missouri and Mississippi Rivers. Conversely, about 95% of the shipments of portland cement to consumers during the biennium was transported by truck. Rail shipments comprised approximately 5%, and barge shipments to consumers were insignificant.

Gulf & Western's Marquette Co. undertook construction of a new 1-million-ton-per-year cement plant on its Cape Girardeau property. The firm planned to complete this new plant early in 1980. The new system would contain redesigned quarry operations, a primary crusher in the quarry, an enclosed conveyor system to the storage bins, a continuous-blending system, a reinforced suspension preheater of Japanese design, a new grate-type cooler, clinker storage bins, a finishing mill with special mill-discharge dust collectors, and a Raymond coal mill and system to deliver coal both to the discharge end of the kiln and to a calciner in the preheater tower. The cost of the expansion was estimated to be $78 million. In 1979, the River Cement Co. plant at Festus was sold by Missouri Pacific Corp. to IFI International, S.A., of Italy for a price of $78 million.

Shortages of cement and accompanying high prices that appeared in 1978 during a period of maximum production in Missouri were blamed on price fixing and restraint of competition among the manufacturers. Allegedly, customers and territories were allocated to certain companies for the sale of cement, and customers were classified according to eligibility to buy cement. A suit was filed in Federal court in Jefferson City charging such restraint of trade and naming 15 corporations as participants. Alpha Portland Industries, Inc., Dundee Cement Co., Marquette Cement Co., Missouri Portland Cement Co., River Cement Co., and the United States Steel Corp., all producers in Missouri, were among those charged. The Missouri case was transferred along with similar suits from other States to Federal court in Arizona. In August 1979, River Cement Co. of St. Louis agreed to make payments in settlement of the antitrust charges.

Table 7.—Missouri: Portland cement salient statistics

(Short tons)

	1978	1979
Number of active plants	7	7
Production	4,620,003	4,367,519
Shipments from mills:		
Quantity	4,733,117	4,430,370
Value	$175,961,822	$194,284,865
Stocks at mills, Dec. 31	315,701	374,573

Table 8.—Missouri: Masonry cement salient statistics

(Short tons)

	1978	1979
Number of active plants	4	4
Production	83,469	83,042
Shipments from mills:		
Quantity	89,328	81,987
Value	$4,111,611	$4,158,852
Stocks at mills, Dec. 31	6,589	8,766

Clays.—The clay industry of Missouri, the source of a variety of clay products, experienced a fluctuating but distinct upward trend in production from 1975 to 1979. Output of clay in the latter year was more than 8% above that of 1975 and the second highest recorded in the 5-year period. By contrast, the value of produced clay, rising annually through the same 5-year period except in 1978, reached a record high in 1979 of more than $20.5 million, about 55% above the value in 1975. The average unit value of all clays rose correspondingly from about $6 per ton in 1975 to $8.73 per ton in 1979. Produced clays included common clay and shale, fire clay, kaolin, and fuller's earth. Missouri led all other States in the quantity and value of fire clay produced in 1979, but ranked 9th in output and 10th in value of all clay and shale that year.

In 1978, 28 firms obtained clay from 86 mines. The following year, 26 firms mined at 65 sites. About half of the State's output

in both years was achieved by three firms: Dundee Cement Co., Harbison-Walker Refractories, division of Dresser Industries, Inc., and Kaiser Aluminum & Chemical Corp. Clay was mined in 22 counties, most of which are in east-central Missouri. In addition, mining occurred in one county in the north-central part of the State, two counties adjacent to Kansas City, and two counties in the southeast adjacent to the Mississippi River. The leading counties, in order of decreasing output, were Pike (common clay), Gasconade (kaolin and fire clay), Montgomery (fire clay), and Audrain (fire clay). Their combined output in 1979 exceeded 55% of the State's total clay production. Common clay and shale were also produced in Boone, Butler, Cape Girardeau, Crawford, Jackson, Jefferson, Livingston, Platte, Ralls, and St. Louis Counties. Fire clay was also mined in Callaway, Franklin, Maries, Monroe, Montgomery, Osage, St. Charles, and Warren Counties. Fuller's earth was mined in Scott County in 1978. About 63% of all the clay mined was common clay and shale, 34% was fire clay and kaolin, and fuller's earth made up the remainder. Fire clay provided approximately 73% of the value of the clay produced in Missouri, followed by 22% from common clay and shale; the remainder came from kaolin and fuller's earth. Fire clay had an average unit value of about $19 per ton in 1979. The unit values of kaolin and common clay and shale were about $17.83 and $2.91 per ton, respectively. Fuller's earth produced in 1978 had a unit value of about $45 per ton. About 75% of the fire clay was used in the manufacture of fire brick, blocks, and shapes. High-aluminum refractories; refractory grogs; refractory mortar and cement; and medical, pharmaceutical, and cosmetic items were other manufactures from fire clay. Aluminum sulfate (alum) was manufactured from kaolin. Face brick and common brick, portland cement, lightweight aggregate for concrete block, and flower pots were manufactured from common clay and shale. Fuller's earth was used in the preparation of oil and grease absorbents and in pesticide carriers and related products. The manufacture of portland cement utilized about 74% of common clay and shale.

Table 9.—Missouri: Clays sold or used by producers, by kind

(Thousand short tons and thousand dollars)

Year	Fire clay		Common clay		Other clays		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1975	854	11,285	1,209	1,928	[1]105	W	2,063	[2]13,214
1976	809	11,723	1,256	2,124	[1]68	[1]1,068	2,133	14,915
1977	872	12,529	1,432	3,190	[1]69	[1]1,173	2,373	16,892
1978	773	12,190	1,434	3,817	[1]51	[1]873	2,258	16,880
1979	799	15,194	1,497	4,350	[1]55	[1]978	2,351	20,522

W Withheld to avoid disclosing company proprietary data; excluded from total.
[1]Kaolin.
[2]Data do not add to total shown because of independent rounding.

Lime.—Led by output from the Ste. Genevieve plant of Mississippi Lime Co., the Nation's most productive such plant in 1979, Missouri's lime production ranked third in the Nation. Output of lime had increased annually from 1975 through 1978, but declined slightly in 1979 to a level about 11.5% greater than in 1975. Annual increases of value in 4 successive years brought the value of produced lime in 1979 to about 73% above the 1975 value. Annual average unit value of lime also increased from about $23.30 per short ton in 1975 to $39.21 per short ton in 1979. About 79% of the product and 73% of the product value was quicklime; the remainder was hydrated lime. Valley Mineral Products Corp. at Bonne Terre produced dolomitic quicklime and refractory dolomite; Ash Grove Cement Co. at Springfield and Mississippi Lime Co. at Ste. Genevieve prepared high-calcium lime. Total shipments of lime from all sources to consumers in Missouri were 229,000 tons in 1978 and 223,000 tons in 1979. The principal uses of lime were in steel manufacturing, in water treatment, and for manufacture of chemicals.

Perlite.—J. J. Brouk & Co. in St. Louis and Georgia Pacific Corp. in Cuba expanded perlite in 1979. Production remained essentially unchanged during the 2 years, but the value of the perlite increased as a result of a rise of almost 15% in unit value. The expanded perlite was used in the preparation of plaster and concrete, for low-temperature insulation and cavity fill, as a

horticultural aggregate, fillers, and other uses. Preparation of construction aggregate was the largest single use.

Phosphate Rock.—With the abandonment of mining by Meramec Mining Co. at Pea Ridge, production of apatite concentrates, along with that of iron ore pellets, ceased.

Sand and Gravel.—Sand and gravel output experienced a sequence of fluctuations from 1975 to 1979. The largest output, achieved in 1978, was followed in 1979 by the second lowest output of the 5-year period. Production in 1978 was almost 60% higher than production in 1975. Value of output also culminated in 1978 and declined in 1979, but less sharply than the production. Average unit value of all sand and gravel produced rose from about $1.85 per ton in 1975 to $2.49 per ton in 1979. A drop of 33.3% in the value of State road contract awards in 1978 from the value in 1977 foreshadowed a decrease of about 20% in the output of construction sand and gravel in 1979. Output of industrial sand diminished by less than 1% over the same interval. About 94% of the sand and gravel produced in Missouri during the biennium was used in construction. The remainder was industrial sand. The reduction of output of construction materials was reflected in other statistics. Sand and gravel mining occurred in 61 counties in 1978 and 56 in 1979. The number of companies operating decreased from 130 to 96, and the number of deposits utilized decreased from 136 in 1978 to 101 in 1979. Three firms operating in four mines produced industrial sand in both years. Callaway, Clay, Jefferson, Lewis, St. Louis, and Stoddard Counties, each of which had sand and gravel production exceeding 500,000 tons in 1978, led all others, and accounted for 54.1% of the State's total output. In 1979, operations in Clay, Franklin, Jefferson, and St. Louis Counties provided more than 500,000 tons per year and collectively provided 53.7% of the State output. One hundred and seventeen individual deposits, yielding as much as 300,000 tons each, provided about 67% of the State's output in 1978. Ninety-one deposits in the same size category provided about 55% of the State's output in 1979. The remaining sand and gravel in 1978 was produced from nine deposits, one of which exceeded 1 million tons in annual output. In 1979, 10 deposits provided the remaining output, with one exceeding 1 million tons in annual production. Eighty-three deposits having individual production of less than 100,000 tons provided almost 16% of the output in 1978, while 66 deposits in the same size category provided 19% of the output in 1979.

More than 70% of the sand and gravel produced in 1978 was obtained in counties adjacent to the Missouri and Mississippi Rivers because those counties have relatively abundant stream, flood plain, and terrace deposits of sand and gravel and relatively large concentrations of population. Eight of Missouri's 10 major cities are in counties adjacent to the rivers and provide demands for housing, municipal, industrial, and commercial construction utilizing large quantities of sand and gravel. Construction sand and gravel were used in many ways. In 1979, about 71% of the sand and gravel was used in aggregates, almost 14% was used for roadbase, about 10% comprised fill, and 4% for manufacture of concrete products. Other identifiable uses were for plaster and gunite sands, and as an antiskid material on icy highways. Industrial sand was dedicated to various uses in the following manner: glass products, almost 53%; foundry sand, 23%; manufacture of fiberglass, about 7%; and other minor uses such as manufacture of refractories, silicon carbide, scouring cleansers, pottery, porcelain and tile, and as a flux in smelting metals, as abrasive in sand blasting, as a propping material in hydraulic fracturing, and in roofing granules and fillers. Uses for construction and industrial sand and gravel in 1979 were essentially similar. Trucks hauled about 74% of the sand and gravel shipped in 1978. About 4% was shipped by railroad, and 1% went by other means. Almost 21% was used where it was recovered. Shipments in 1979 involved a percentage decrease in the amount of material carried by truck and an increase in the amount of sand and gravel carried by railway, waterway, and other means of transportation.

Holliday Sand and Gravel Co. operated its first full season with a newly installed barge-mounted plant and dredge at its Randolph site in 1978. The dredge and plant can recover 700 tons per hour of lignite-free sand and gravel for transportation to the shore installations.

Table 10.—Missouri: Construction sand and gravel sold or used, by major use category

Use	1977			1978			1979		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Concrete aggregate	6,514	$13,263	$2.04	8,451	$16,314	$1.93	6,949	$15,304	$2.20
Plaster and gunite sands	NA	NA	NA	50	120	2.40	18	52	2.88
Concrete products	904	2,113	2.34	617	1,492	2.42	225	467	2.08
Asphaltic concrete	1,618	3,312	2.05	1,941	3,809	1.96	2,051	4,265	2.08
Roadbase and coverings	2,479	4,006	1.62	2,014	3,327	1.65	1,392	2,353	1.69
Fill	1,402	1,586	1.13	1,433	1,813	1.27	726	1,078	1.48
Snow and ice control	NA	NA	NA	72	144	1.99	108	238	2.22
Railroad ballast	W	W	W	--	--	--	--	--	--
Other uses	81	154	1.90	119	262	2.20	231	445	1.92
Total[1] or average	12,998	24,435	1.88	14,700	27,280	1.86	11,699	24,201	2.07

NA Not available. W Withheld to avoid disclosing company proprietary data; included in "Other uses."
[1]Data may not add to totals shown because of independent rounding.

Table 11.—Missouri: Sand and gravel sold or used by producers, by use

Use	1977			1978			1979		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:									
Sand	8,067	$14,941	$1.85	9,737	$17,542	$1.80	7,871	$15,977	$2.03
Gravel	4,931	9,483	1.93	4,961	9,740	1.96	3,828	8,224	2.15
Total[1] or average	12,998	24,435	1.88	14,700	27,280	1.86	11,699	24,201	2.07
Industrial sand	1,004	7,039	7.01	865	6,378	7.37	859	7,109	8.28
Grand total[1] or average	14,002	31,473	2.25	15,560	33,660	2.16	12,558	31,310	2.49

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

Stone.—Missouri ranked fifth among the States in the production of crushed stone in both 1978 and 1979. Maximum annual output in the period extending from 1975 through 1979, about 57.3 million tons, was attained in 1978. The maximum value of output in that period, almost $140 million, was attained in 1979. The growth in value of the stone was related to both the increase in production and to an increase in unit value from about $2 per ton in 1975 to almost $2.50 per ton in 1979. The decrease in the output of stone in 1979 from that in 1978 is attributed to slowing construction. During that period, housing starts declined, the value of State road contract awards made in 1978 was more than 33% below the value in 1977, and the quantity of various aggregates, cement, roofing materials, and other stone used in the construction of highways, building, and other structures declined almost 7%. Dimension stone produced amounted to less than 0.01% of 1% of the quantity and 0.2% of the value of the crushed stone.

Limestone was the most extensively used stone for crushing. Granite, marble, and sandstone were also crushed for special purposes. In approximate order of output, St. Louis, Ste. Genevieve, Jackson, Jefferson, Ralls, St. Charles, and Pike Counties were the leading sources of limestone, each with production of more than 2 million tons in one or both years. Output of the leading five counties was about 38% of the State's crushed stone in both 1978 and 1979. Stone was quarried for crushing in 94 counties in 1978 and 93 in 1979, and by 165 and 151 firms, respectively, for those years. Operations involved 277 quarries in 1978 and 257 in 1979. Output of stone from individual quarries ranged widely in size from a few

thousand tons to more than 1 million tons. In 1978, 143 quarries individually produced less than 100,000 tons, 255 quarries produced less than 500,000 tons and accounted for 55% of the stone production. Fourteen quarries were in the size range of 500,000 to 900,000 tons, and production from 11 quarries exceeded 900,000 tons. In 1979, with a decrease in the number of operating quarries, 231 operations each with tonnages of less than 500,000, produced 52% of the stone output. Fifteen quarries were in the category 500,000 to 900,000 tons, and 12 quarries exceeded output of 900,000 tons, providing almost 31% of the State output. Each year about half of the State's quarries were in the lowest size category, but produced less than 10% of the stone quarried. Quarrying occurred in all but 21 counties in 1978. The industry was active, however, and produced the largest quantities of stone in the counties along the Mississippi River north and south of St. Louis and in the vicinities of Jefferson City and Columbia, Kansas City, Springfield, and Joplin. Most of the stone was limestone. Granite (felsite) was produced in Wayne County for railroad ballast and in Iron County for roofing granules. Granite was quarried in Iron County as dimension stone for monuments. Marble quarried in Jefferson County was crushed for terrazzo and exposed aggregate. Sandstone for use as industrial sand was mined in St. Louis and St. Charles Counties. It was also mined in Jefferson County for use in the manufacture of cement. Flagstone was quarried in Shannon County. Crushed stone was used for a variety of purposes. Among those uses that required more than 1 million tons per year in 1978 and 1979 were the various construction aggregates and roadstone, amounting to about 63% of the State's total output. Cement consumed almost 10%, and about 7.5% was used as agricultural limestone. Preparation of lime required almost 6%. Riprap and jetty stone and railroad ballast were also significant uses. In 1978, almost 93% of the shipments of stone were made by truck, about 4% went by railroad, and 2% by water. In 1979, about 88% was shipped by truck; railroads and barges combined transported almost 11%; and about 1% was transported by other means.

Table 12.—Missouri: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1977		1978		1979	
	Quantity	Value	Quantity	Value	Quantity	Value
Agricultural limestone	3,571	8,342	4,174	10,464	4,401	11,879
Poultry grit and mineral food	56	330	W	W	W	W
Concrete aggregate	[2]6,869	r15,209	8,417	20,086	8,658	22,079
Bituminous aggregate	3,748	8,721	4,668	11,407	4,629	13,287
Macadam aggregate	3,405	5,754	4,885	8,135	3,482	6,649
Dense-graded roadbase stone	5,429	r12,132	6,039	14,019	7,092	18,263
Surface treatment aggregate	2,727	6,565	3,279	8,839	3,775	12,056
Other construction aggregate and roadstone	7,866	r17,702	10,023	25,102	6,790	18,967
Riprap and jetty stone	3,180	5,660	2,917	6,288	4,871	8,725
Railroad ballast	1,408	2,336	1,312	2,651	1,134	2,105
Filter stone	24	49	37	89	47	115
Manufactured fine aggregate (stone sand)	W	W	W	W	131	447
Terrazzo and exposed aggregate	4	216	5	225	5	240
Cement manufacture	6,095	r10,469	6,142	11,175	6,120	12,062
Lime manufacture	3,103	5,294	3,200	5,608	3,230	6,116
Dead-burned dolomite	W	86	W	125	W	W
Flux stone	W	394	W	W	W	W
Asphalt filler	76	198	W	W	75	229
Other fillers	52	264	--	--	--	--
Glass manufacture	W	W	445	1,724	W	W
Sulfur removal from stack gases	596	1,310	404	904	W	W
Other uses[3]	1,402	3,671	1,319	3,725	1,941	6,723
Total[4]	49,612	104,700	57,265	130,568	56,380	139,944

r Revised. W Withheld to avoid disclosing company proprietary data; included with "Other uses."

[1] Includes limestone, granite, marble, and sandstone.

[2] Includes manufactured fine aggregate (stone sand).

[3] Includes stone used for mine dusting, whiting, chemicals, roofing granules, unspecified uses, and uses indicated by symbol W.

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

Sulfur.—Sulfur was recovered by Amoco Oil Co. at its Sugar Creek oil refinery in Jackson County. It was also recovered as sulfuric acid in the smelting of lead ores at the smelters of St. Joe Minerals Corp. and AMAX Lead Co. of Missouri at Hercula-

neum and Boss. Production in 1979 was somewhat less than in 1978. Conversely, the value of the sulfur was higher in 1979.

Vermiculite.—Preparation of concrete aggregate, loose fill and block insulation, packing insulation, horticultural soils, soil conditioning, and soil fertilization were applications of the exfoliated vermiculite produced by J. J. Brouk & Co. and W. R. Grace & Co. in plants in St. Louis. The quantity of exfoliated vermiculite sold or used remained virtually unchanged from 1978 to 1979. The value, however, increased as the unit value of the exfoliated vermiculite increased about 6%. Fireproofing was also a use of the material.

[1]State mineral specialist, Bureau of Mines, Denver, Colo.

[2]Clifford, R. K., and L. W. Higley, Jr. Cobalt and Nickel Recovery From Missouri Lead Belt Chalcopyrite Concentrates. BuMines RI 8321, 1978, 14 pp.

Table 13.—Principal producers

Commodity and company	Address	Type of activity	County
Asphalt, native:			
Bar-Co-Roc Asphalt Co	Box 11 Iantha, MO 64753	Mine	Barton.
Barite:			
Dresser Industries	Box 8 Potosi, MO 63604	Mine and mill	Washington.
General Barite Co	402 South 2d St. Desoto, MO 63020	Mine	Do.
Milchem, Inc	Mineral Point, MO 63660	Mine and mill	Do.
NL Industries, Inc	Box 2808 St. Louis, MO 63111	do	St. Louis and Washington.
Cement:			
Alpha Portland Cement Co.[1 2]	15 South 3d St. Easton, PA 18043	Plant and quarry	St. Louis.
Dundee Cement Co.[1 2]	Box 317 Dundee, MI 48131	do	Pike.
Marquette Cement Manufacturing Co.[1 2]	7751 Carondelet Ave. St. Louis, MO 63105	do	Jackson and St. Louis.
River Cement Co.[2]	Festus, MO 63028	do	Jefferson.
United States Steel Corp.[1 2]	600 Grant St. Pittsburgh, PA 15230	do	Ralls.
Clays:			
Allied Chemical Corp., Industrial Chemicals Div.	Box 517 Owensville, MO 65066	Mine and plant	Gasconade.
Carter-Waters Corp	GPO Box 19676 Kansas City, MO 64141	do	Platte.
Dresser Industries, Inc., Harbison-Walker Refractories Co.	2 Gateway Center Pittsburgh, PA 15222	do	Callaway, Gasconade, Montgomery, Warren.
Kaiser Aluminum & Chemical Corp	Box 499 Mexico, MO 65265	do	Audrain, Callaway, Gasconade, Montgomery, Warren.
Midland Brick & Tile Co	Box 428 Chillicothe, MO 64601	do	Livingston.
United States Gypsum Co., A. P. Green Refractories Co.	Green Boulevard Mexico, MO 65265	do	Audrain and Osage.
Industrial sand:			
Martin Marietta Corp	110 East Main St. Rockton, IL 61072	Plant and pit	Jefferson.
Master Bros. Silica Sand Co	Route 1, Box 204 Pevely, MO 63070	do	Do.
Pennsylvania Glass Sand Corp	Box 187 Berkley Springs, WV 25411	do	St. Charles and St. Louis.
Iron:			
Hanna Mining Co.-National Steel Corp., Pilot Knob Pellet Co.	Box 26 Ironton, MO 63650	Underground mine and plant.	Iron.
St. Joe Minerals Corp., Pea Ridge Iron Ore Co.	Route 4 Sullivan, MO 63080	do	Washington.
Lead:			
AMAX Lead Co. of Missouri & Homestake Mining Co.[3]	Boss, MO 65440	do	Iron.
Cominco American, Inc.[3]	Bixby, MO 65439	do	Do.
Kennecott Copper Corp., Ozark Lead Co.[3]	Sweetwater, MO 63680	do	Reynolds.
St. Joe Minerals Corp., St. Joe Lead Co.[3]	Viburnum, MO 64105	do	Crawford, Iron, Reynolds, Washington.
Lime:			
Ash Grove Cement Co.[2]	1000 Tenmain Center Kansas City, MO 64105	Plant	Greene.
Mississippi Lime Co.[2]	7 Alby St. Alton, IL 62002	do	Ste. Genevieve.
Valley Mineral Products Corp.[2]	902 Syndicate Trust Bldg. St. Louis, MO 63101	do	St. Francois.

See footnotes at end of table.

Table 13.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Perlite, expanded:			
J. J. Brouk & Co	1367 South Kingshighway Blvd. St. Louis, MO 63110	Plant	St. Louis.
Sand and gravel:			
Barnhart, L. Construction Co	Business Route Hwy. 50 East Jefferson City, MO 65101	Pit and plant	Crawford, Franklin, Jefferson.
Callaway County Sand & Gravel Co	Box 125 Mokane, MO 65059	Dredge	Callaway.
Capitol Sand Co., Inc	Box 156 Cedar City, MO 65022	Pit and plant	Do.
Davis Street Sand Co	Foot of Davis St. St. Louis, MO 63111	do	St. Louis.
Doss & Harper Stone Co	Box 274 West Plains, MO 65775	do	Howell.
Eureka Sand & Gravel Co., Inc	Box 260 Eureka, MO 63025	Dredge and plant	St. Louis.
Green Quarries, Inc	Box 257 Carrollton, MO 64633	Dredge	Ray, Carroll, Chariton.
Holliday Sand & Gravel Co	6811 West 63d St. Overland Park, KS 66202	Pit and plant	Clay.
Keener Gravel Co., Inc	Box 72 Dexter, MO 63841	do	Ripley and Stoddard.
Lemons Gravel Co	106 West Stoddard St. Dexter, MO 63841	do	Stoddard.
Martin Marietta Aggregates	RFD 4, Box 287 Festus, MO 63028	do	Jefferson.
Missouri Gravel Co	313 16th St. Moline, IL 61265	do	Lewis.
Pennsylvania Glass Sand Corp	Box 187 Berkley Springs, WV 25411	do	St. Charles and St. Louis.
Riverside Sand & Dredging	5000 Bussen Rd. St. Louis, MO 63129	Dredge	St. Louis.
Sanders & Sons Rock Products Co	Box 305 Ava, MO 65608	Pit and plant	Douglas.
St. Charles Sand Co	Route 1, Box 252 St. Louis, MO 63129	Dredge and plant	St. Louis.
Stewart Sand & Material Co	3001 East 83d St. Kansas City, MO 64132	do	Jackson.
West Lake Ready Mix Co	Route 1, Box 206 Bridgeton, MO 63044	do	St. Louis.
Winter Bros. Material Co	13098 Gravois Rd. St. Louis, MO 63127	do	Do.
Stone:			
Gordon Bros. Quarries	Box 127 Forest City, MO 64451	Quarries	Andrew, Gentry, Holt.
Griesemer Stone Co	Route 2, Box 52 Springfield, MO 65804	do	Greene, Jasper, Lawrence.
Midwest Precote Co	4th and Randolph Kansas City, MO 64119	do	Clay and Platte.
Missouri Pacific Corp	210 North 13th St. St. Louis, MO 63103	Quarry	Wayne.
Moline Consumers Co	313 16th St. Moline, IL 61265	Quarries	Jefferson, Knox, Lewis, Ralls, St. Louis, Shelby.
St. Charles Quarry Co., Inc	Box 40 St. Charles, MO 63301	do	St. Charles.
Tower Rock Stone Co	Box 69 Columbia, IL 62236	Quarry	Ste. Genevieve.
Fred Weber, Inc	7929 Alabama Ave. St. Louis, MO 63111	Quarries	Jefferson, St. Charles, St. Louis.
West Lake Quarry & Material Co	Route 1, Box 206 Bridgeton, MO 63042	do	Cape Girardeau, Cole, St. Louis, Scott.
Vermiculite, exfoliated:			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 01109	Plant	St. Louis.

[1]Also clays.
[2]Also stone.
[3]Also silver, copper, and zinc.