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Minerals Yearbook

CENTENNIAL EDITION 1981

Volume II

AREA REPORTS: DOMESTIC

Prepared by staff of the

BUREAU OF MINES

UNITED STATES DEPARTMENT OF THE INTERIOR • James G. Watt, Secretary

BUREAU OF MINES • Robert C. Horton, Director

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities to protect and conserve our land and water, energy and minerals, fish and wildlife, and park and recreation areas, and for the wise use of all those resources. The Department also has a major responsibility for American Indian reservation communities and for the people who live in Island Territories under U.S. administration.

U.S. GOVERNMENT PRINTING OFFICE

WASHINGTON : 1983

Foreword

This edition of the Minerals Yearbook marks the centennial of the first annual publication of comprehensive mineral industry statistics by the Federal Government. The need for complete, reliable mineral statistics on a regular basis was recognized in 1880, when Clarence King, then Director of the United States Geological Survey, stated in his annual report:

"As a whole it is true, and can never be refuted, that the Federal Government alone can successfully prosecute the noble work of investigating and making known the natural mineral wealth of the country, current modes of mining and metallurgy, and the industrial statistics of production."

In response to this suggestion the Forty-seventh Congress, in an appropriations act of August 7, 1882 (22 Stat. 329), placed collection of mineral statistics on an annual basis, stating in the act that "...not to exceed ten thousand dollars of the amount appropriated in this paragraph may be applied under the direction of the Secretary of the Interior to the procuring of statistics in relation to mines and mining other than gold and silver..."

Data on minerals production for 1882, collected under this appropriation, along with census data for 1880 and such data as were available for 1881, were published in a report entitled "Mineral Resources of the United States." That volume began the annual series that has continued unbroken to the present.

"Mineral Resources of the United States" was compiled and published by the Geological Survey from the initial volume through the volume covering 1923. Beginning with the 1924 edition, compilation and publication of this report became the responsibility of the Bureau of Mines, then part of the Department of Commerce. The title "Mineral Resources of the United States" continued in use through the 1931 edition, when after a half century of publication, the title was changed to the current "Minerals Yearbook."

The first "Minerals Yearbook" covered the period 1932-33 and had a statistical appendix. Before the edition was completed, however, the Bureau of Mines was transferred to the Department of the Interior; therefore, the statistical appendix bears the seal of the Department of the Interior, rather than that of the Commerce Department.

Throughout a century of publication, the content, format, and length of these volumes have changed in response to user requirements and a changing industry. Initially a single volume of some 800 pages, the Yearbook became a two-part report "Metals" and "Nonmetals" in 1907 and continued in that format through the 1931 edition. From the combined 1932-33 edition through that of 1951, it returned to single-volume format, although the editions of 1932-33, 1934, and 1935 each had a statistical appendix. Beginning with the 1952 edition, the multivolume format of commodity and geographic area coverage was instituted, continuing through this edition as follows:

1952-62 - Volume I, Metals and Minerals
Volume II, Fuels
Volume III, Area Reports
1963-65 - Volume I, Metals and Minerals
Volume II, Fuels
Volume III, Area Reports, Domestic
Volume IV, Area Reports, International
1966-69 - Volume I—II, Metals, Minerals, and Fuels
Volume III, Area Reports, Domestic
Volume IV, Area Reports, International

1970-76 - Volume I, Metals, Minerals, and Fuels
Volume II, Area Reports, Domestic
Volume III, Area Reports, International
1977-81 - Volume I, Metals and Minerals
Volume II, Area Reports, Domestic
Volume III, Area Reports, International

Commodity coverage has also changed thoughout the period. Some minerals that were given substantial space in the early volumes no longer have separate chapters, and new mineral commodities have been added. The 1882 edition contained 48 commodity or commodity group chapters whereas this edition contains 71. Data on the mineral fuels, included in the Yearbook from its onset, were deleted beginning with the 1977 edition, when responsibilities for those commodities were transferred to the new Department of Energy.

As we move into the second century of publication, our philosophy remains to publish a viable document responsive to the needs of its varied user community. To this end we continue to invite constructive comments and suggestions from our readers.

Robert C. Horton, *Director*

Acknowledgments

The chapters of this volume were written by the State Liaison Officers of the Bureau of Mines, located throughout the country.

The Statistical Summary chapter and the tabular material covering total State mineral production, value of mineral production by county, and economic indicators were prepared in the Office of Geographic Statistics. The Division of Publication reviewed the manuscripts upon which this volume was based to insure statistical consistency among the tables, figures, and text between this volume and Volume I, and between this volume and those of former years.

Compilations contained in this volume were based largely on statistical data and other facts provided by the mineral industries. The Bureau gratefully acknowledges the willing contribution of these essential data by both companies and individuals.

In the collection of statistical and other mineral-industry information, the Bureau of Mines was also assisted by various State agencies through cooperative agreements. Many of the chapters in Volume II were reviewed by staff members of these agencies; in some instances the staff members collaborated in preparing the chapters and are shown as coauthors. Our sincere appreciation for this assistance is extended to the following cooperating organizations:

Alabama: Geological Survey of Alabama.
Alaska: Alaska Department of Natural Resources.
Arizona: Arizona Bureau of Geology and Mineral Technology.
Arkansas: Arkansas Geological Commission.
California: California Division of Mines and Geology, Department of Conservation.
Colorado: Division of Mines of the State of Colorado.
Connecticut: Geological and Natural History Survey of Connecticut, Department of Environmental Protection.
Delaware: Delaware Geological Survey.
Florida: Florida Bureau of Geology.
Georgia: Georgia Geologic Survey, Environmental Protection Division, Department of Natural Resources.
Hawaii: Department of Land and Natural Resources.
Idaho: Idaho Bureau of Mines and Geology, Idaho Department of Lands.
Illinois: State Geological Survey Division, Illinois Department of Energy and Natural Resources.
Indiana: Geological Survey, Indiana Department of Natural Resources.
Iowa: Iowa Geological Survey.
Kansas: State Geological Survey of Kansas.
Kentucky: Kentucky Geological Survey.
Louisiana: Louisiana Geological Survey.
Maine: Maine Geological Survey.
Maryland: Maryland Geological Survey.
Massachusetts: Office of the State Geologist, Massachusetts Department of Environmental Quality.
Michigan: Geological Survey Division, Michigan Department of Natural Resources.
Minnesota: Mineral Resources Research Center, University of Minnesota.
Mississippi: Bureau of Geology and Energy Resources, Mississippi Department of Natural Resources.

Missouri: Department of Natural Resources, Division of Geology and Land Survey.
Montana: Montana Bureau of Mines and Geology.
Nebraska: Conservation and Survey Division of the University of Nebraska, Nebraska Geological Survey.
Nevada: Nevada Bureau of Mines and Geology.
New Hampshire: New Hampshire Department of Resources and Economic Development.
New Jersey: Geological Survey, Division of Water Resources, New Jersey Department of Environmental Protection.
New Mexico: New Mexico Department of Energy and Minerals.
New York: New York Geological Survey.
North Carolina: Division of Land Resources, North Carolina Department of Natural Resources and Community Development.
North Dakota: North Dakota Geological Survey.
Oklahoma: Oklahoma Geological Survey.
Pennsylvania: Pennsylvania Bureau of Topographic and Geologic Survey, Department of Environmental Resources.
Puerto Rico: Department of Natural Resources.
Rhode Island: Department of Environmental Management.
South Carolina: South Carolina Geological Survey, State Division of Research and Statistical Services.
South Dakota: South Dakota Geological Survey.
Tennessee: Tennessee Division of Geology.
Texas: Bureau of Economic Geology, The University of Texas at Austin.
Utah: Utah Geological and Mineral Survey.
Vermont: Office of the State Geologist, Agency of Environmental Conservation.
Virginia: Virginia Division of Mineral Resources.
Washington: Washington Division of Geology and Earth Resources.
West Virginia: West Virginia Geological and Economic Survey.
Wisconsin: Wisconsin Geological and Natural History Survey.
Wyoming: Wyoming Geological Survey.

Albert E. Schreck, *Chief, Division of Publication*

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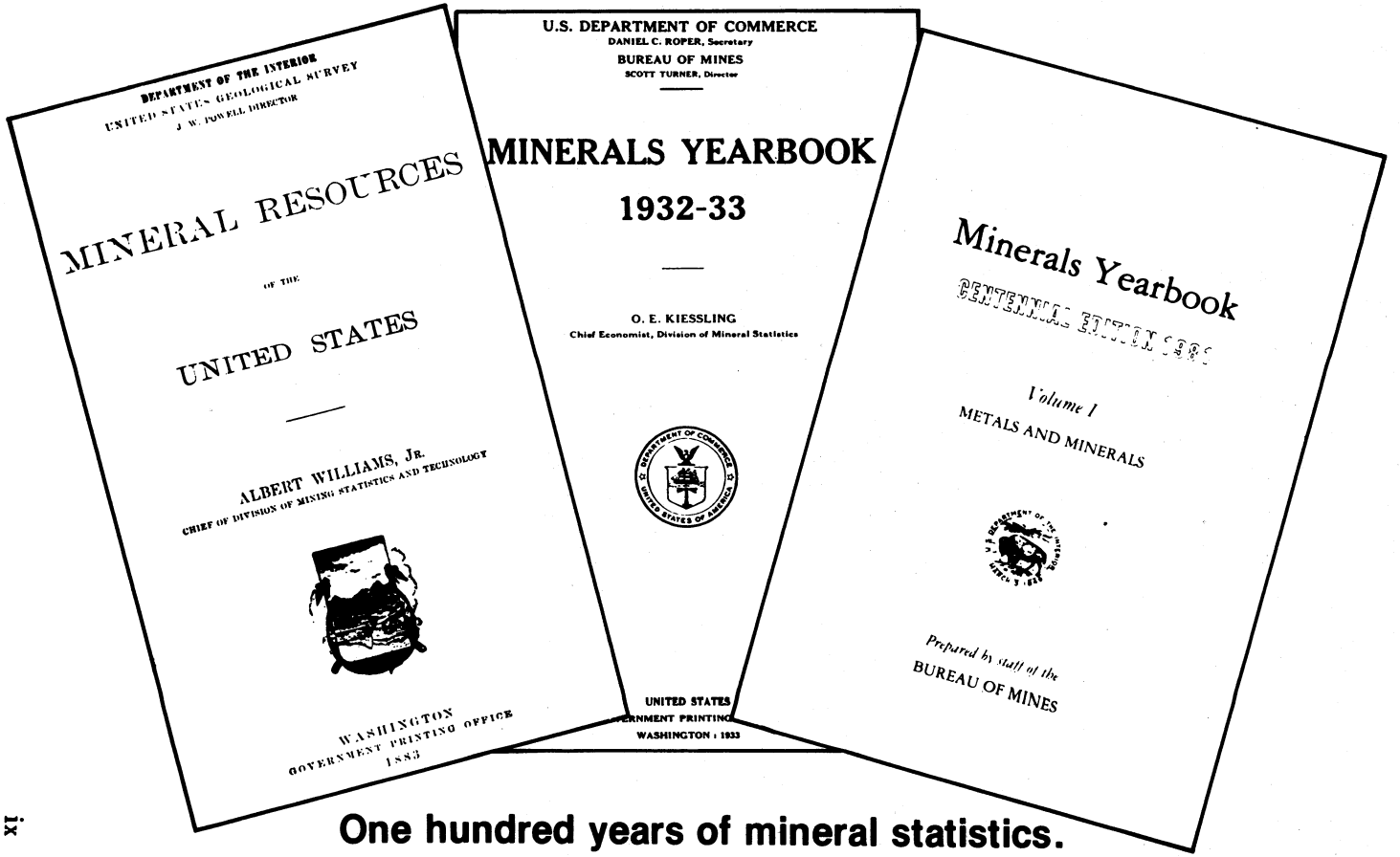

One hundred years of mineral statistics.

Statistical Summary

By Rose L. Ballard[1]

This chapter summarizes data on crude nonfuel mineral production for the United States, its island possessions, and the Commonwealth of Puerto Rico. Included also are the tables that show the principal nonfuel mineral commodities exported from and imported into the United States and that compare world and U.S. mineral production. The detailed data from which these tables were derived are contained in the individual commodity chapters of volume I and in the State chapters of volume II of this edition of the Minerals Yearbook.

Although crude mineral production may be measured at any of several stages of extraction and processing, the stage of measurement used in this chapter is what is ordinarily termed "mine output." It usually refers to minerals or ores in the form in which they are first extracted from the ground, but customarily includes the output from auxiliary processing at or near the mines.

Because of inadequacies in the statistics available, some series deviate from the foregoing definition. For gold, silver, copper, lead, zinc, and tin, the quantities are recorded on a mine basis (as the recoverable content of ore sold or treated). However, the values assigned to these quantities are based on the average selling price of refined metal, not the mine value. Mercury is measured as recovered metal and valued at the average New York price for the metal.

The weight or volume units shown are those customarily used in the particular industries producing the commodities. Values shown are in current dollars, with no adjustments made to compensate for changes in the purchasing power of the dollar.

[1]Statistical specialist, Division of Foreign Data.

Table 1.—Value of crude nonfuel mineral production[1] in the United States, by mineral group

(Million dollars)

	Metals	Nonmetals	Total
1979	r8,536	r15,438	r23,974
1980	r8,922	r16,224	r25,146
1981	8,758	16,415	25,173

rRevised.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Nonfuel mineral production[1] in the United States

Mineral	1979		1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
METALS						
Antimony ore and concentrate short tons, antimony content	722	W	343	W	646	W
Bauxite thousand metric tons, dried equivalent	1,821	$24,875	1,559	$22,353	1,510	$26,489
Copper (recoverable content of ores, etc.) metric tons	1,443,556	2,960,675	r1,181,116	r2,666,931	1,538,160	2,886,440
Gold (recoverable content of ores, etc.) troy ounces	r964,390	r296,550	r969,782	r594,050	1,377,946	633,359
Iron ore, usable (excluding byproduct iron sinter) thousand long tons, gross weight	86,130	2,811,574	69,562	2,543,484	72,158	2,914,689
Iron oxide pigments, crude short tons	74,548	2,578	62,642	4,043	67,214	4,142
Lead (recoverable content of ores, etc.) metric tons	525,569	609,929	r550,366	r515,189	445,535	358,821
Manganiferous ore (5% to 35% Mn) short tons, gross weight	240,696	2,902	173,887	2,444	175,760	2,889
Mercury 76-pound flasks	29,519	8,299	30,657	11,939	27,904	11,549
Molybdenum (content of concentrate) thousand pounds	143,504	871,067	149,311	1,344,181	118,916	945,540
Nickel (content of ore and concentrate) short tons	15,065	W	14,653	W	12,099	W
Silver (recoverable content of ores, etc.) thousand troy ounces	r37,896	r420,261	r32,329	r667,278	40,685	427,943
Titanium concentrate: Ilmenite short tons, gross weight	646,399	32,965	593,704	32,041	523,681	37,013
Tungsten ore and concentrate thousand pounds of contained W	6,646	55,785	6,036	50,575	7,815	62,231
Vanadium (recoverable in ore and concentrate) short tons	5,520	73,892	4,806	64,370	5,126	71,496
Zinc (recoverable content of ores, etc.) metric tons	267,341	219,841	r317,103	r261,671	312,418	306,879
Combined value of beryllium, magnesium chloride for magnesium metal, platinum-group metals (1980-81), rare-earth metals, tin, titanium (rutile), zircon concentrate, and values indicated by symbol W	XX	144,962	XX	141,492	XX	68,195
Total	XX	r8,536,000	XX	r8,922,000	XX	8,758,000
NONMETALS (EXCEPT FUELS)						
Abrasive stones[2] short tons	2,094	2,064	2,131	2,233	4,501	1,176
Asbestos metric tons	93,354	28,925	80,079	30,599	75,618	30,685
Asphalt and related bitumens, native: Bituminous limestone, sandstone, gilsonite thousand short tons	1,614	25,622	1,252	25,030	1,261	27,654
Barite do.	2,113	53,581	2,245	65,957	2,849	102,439
Boron minerals do.	1,590	310,211	1,545	366,760	1,481	435,387
Bromine thousand pounds	497,000	114,500	r380,400	r95,400	389,500	90,200
Calcium chloride short tons	719,709	51,884	581,012	47,950	704,691	61,692
Carbon dioxide, natural thousand cubic feet	2,028,045	3,243	1,628,424	2,561	1,577,053	2,607
Cement:						
Masonry thousand short tons	3,748	204,797	3,040	188,456	2,738	161,819
Portland do.	78,978	3,650,436	71,612	3,613,332	68,197	3,515,600
Clays do.	54,689	846,089	48,790	898,947	44,379	988,845
Diatomite do.	717	90,323	689	100,610	687	113,010
Emery short tons	e10,005	e204	rW	rW	W	W
Feldspar do.	740,472	21,474	e710,000	e23,200	665,000	21,000
Fluorspar do.	109,299	12,162	92,635	12,611	115,404	18,412
Garnet (abrasive) do.	21,240	r1,535	26,909	r1,098	25,451	2,059
Gem stones[e]	NA	8,230	NA	6,930	NA	7,625
Gypsum thousand short tons	14,630	99,868	12,376	r103,059	11,497	98,101
Helium:						
Crude million cubic feet	r537	r6,444	299	3,588	175	2,100
High-purity do.	r1,080	r24,840	1,159	26,657	1,223	31,798
Lime thousand short tons	20,945	862,459	19,010	842,922	18,856	884,197
Mica: Scrap do.	134	7,708	r116	r6,262	133	8,212
Peat do.	798	15,517	788	16,190	757	18,783
Perlite short tons	660,000	16,435	638,000	16,500	591,000	17,418
Phosphate rock thousand metric tons	51,611	1,045,655	54,415	1,256,947	53,624	1,437,986
Potassium salts thousand metric tons, K_2O equivalent	2,388	279,199	2,217	353,862	1,908	328,900
Pumice thousand short tons	r1,172	r4,864	r543	r4,267	499	4,311
Pyrites thousand metric tons	1,049	17,087	847	13,812	797	49,160

See footnotes at end of table.

Table 2.—Nonfuel mineral production[1] in the United States —Continued

Mineral	1979		1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
NONMETALS (EXCEPT FUELS) — Continued						
Salt thousand short tons	45,793	$538,352	40,352	$656,164	38,907	$636,328
Sand and gravel do	979,000	2,427,000	r792,700	r2,289,000	p754,800	p2,290,000
Sodium sulfate (natural) do	533	29,689	583	r36,387	608	43,186
Stone[3] do	r1,100,860	r3,398,703	r984,856	r3,404,736	874,381	3,276,967
Sulfur, Frasch process thousand metric tons	7,507	449,433	7,400	720,511	5,910	715,683
Talc and pyrophyllite thousand short tons	e1,453	e20,364	1,473	25,626	1,343	31,497
Tripoli short tons	[4]116,009	[4]6,279	121,233	676	107,330	617
Vermiculite thousand short tons	346	21,955	337	23,483	320	26,181
Combined value of aplite, graphite (1979), iodine, kyanite, lithium minerals, magnesite, magnesium compounds, marl (greensand), olivine, sodium carbonate (natural), staurolite, wollastonite, and values indicated by symbol W	XX	r740,271	XX	r941,212	XX	933,515
Total	XX	r15,438,000	XX	r16,224,000	XX	16,415,000
Grand total	XX	r23,974,000	XX	r25,146,000	XX	25,173,000

eEstimated. pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; included in "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Grindstones, pulpstones, grinding pebbles, sharpening stones, and tube mill liners.

[3]Excludes abrasive stone and bituminous limestone and sandstone; all included elsewhere in table.

[4]Data represent prepared tripoli.

Table 3.—Nonfuel minerals produced in the United States and principal producing States in 1981

Mineral	Principal producing States, in order of quantity	Other producing States
Antimony ore and concentrate	Idaho and Mont.	
Aplite	Va.	
Asbestos	Calif., Vt., Ariz.	
Asphalt (native)	Tex., Utah, Ala.	
Barite	Nev., Mo., Ark., Ga	Ariz., Ill., Mont., Tenn.
Bauxite	Ark., Ala., Ga.	
Beryllium concentrate	Utah and S. Dak.	
Boron minerals	Calif.	
Bromine	Ark. and Mich.	
Calcium chloride	Mich. and Calif.	
Carbon dioxide (natural)	Colo., N. Mex., Utah, Calif.	
Cement	Tex., Calif., Pa., Mich	All other States except Alaska, Conn., Del., Mass., Minn., N.H., N.J., N. Dak., R.I., Vt.
Clays	Ga., Tex., Wyo., Calif	All other States except Alaska, Del., Hawaii, R.I., Vt., Wis.
Copper (mine)	Ariz., Utah, N. Mex., Mont	Calif., Colo., Idaho, Mich., Mo., Nev., Oreg., S.C., Tenn., Wash.
Diatomite	Calif., Nev., Wash., Oreg.	
Emery	N.Y.	
Feldspar	N.C., Conn., Ga., Calif	Okla. and S. Dak.
Fluorspar	Ill., Nev., Tex.	
Garnet, abrasive	Idaho, N.Y., Maine.	
Gold (mine)	Nev., S. Dak., Utah, Ariz	Alaska, Calif., Colo., Idaho, Mont., N. Mex., Oreg., S.C., Tenn., Wash.
Gypsum	Tex., Calif., Iowa, Okla	Ariz., Ark., Colo., Idaho, Ind., Kans., La., Mich., Mont., Nev., N. Mex., N.Y., Ohio, S. Dak., Utah, Va., Wash., Wyo.
Helium	Kans., Tex., Okla., N. Mex.	
Iodine	Okla. and Mich.	
Iron ore	Minn., Mich., Calif., Wyo	Colo., Mo., Mont., Nev., N.J., N.Y., Tex., Utah, Wis.
Iron oxide pigments (crude)	Mich., Mo., Ga., Va.	
Kyanite	Va. and Ga.	
Lead (mine)	Mo., Idaho, Colo., Utah	Alaska, Ariz., Calif., Ill., Mont., Nev., N. Mex., N.Y., Oreg., Va.
Lime	Ohio, Mo., Pa., Ky	All other States except Alaska, Del., Ga., Maine, Miss., N.H., N.J., N.C., R.I., S.C., Vt.
Lithium minerals	N.C. and Nev.	
Magnesite	Nev.	
Magnesium chloride	Tex.	
Magnesium compounds	Mich., Calif., Fla., N.J	Del., Tex., Utah.
Manganiferous ore	Minn., S.C., N. Mex.	
Marl, greensand	N.J.	
Mercury	Nev. and Calif.	
Mica, scrap	N.C., N. Mex., S.C., Ga	Conn., Pa., S. Dak.
Molybdenum	Colo., Ariz., Utah, N. Mex	Calif.
Nickel	Oreg.	
Olivine	N.C. and Wash.	
Peat	Mich., Fla., Ind., Ill	Calif., Colo., Ga., Iowa, Maine, Md., Mass., Minn., Mont., N.J., N.Y., N. Dak., Ohio, Pa., Wash., Wis.
Perlite	N. Mex., Ariz., Calif., Idaho	Colo., Nev., Utah.
Phosphate rock	Fla., Idaho, N.C., Tenn	Ala., Mont., Utah.
Platinum-group metals	Alaska.	
Potassium salts	N. Mex., Calif., Utah.	
Pumice	Oreg., Calif., N. Mex., Idaho	Ariz., Hawaii, Kans., Okla.
Pyrites, ore and concentrate	Tenn., Colo., Ariz.	
Rare-earth metal concentrate	Calif. and Fla.	
Salt	La., Tex., N.Y., Ohio	Ala., Ariz., Calif., Colo., Kans., Mich., Nev., N. Mex., N. Dak., Okla., Utah, W. Va.
Sand and gravel	Calif., Alaska, Tex., Ohio	All other States.
Silver (mine)	Idaho, Ariz., Nev., Colo	Calif., Ill., Mich., Mo., Mont., N. Mex., N.Y., Oreg., S. Dak., Tenn., Utah, Wash.
Sodium carbonate (natural)	Wyo. and Calif.	
Sodium sulfate (natural)	Calif., Tex., Utah.	
Staurolite	Fla.	
Stone	Tex., Fla., Pa., Ill	All other States except Del. and N. Dak.
Sulfur (Frasch)	Tex. and La.	
Talc and pyrophyllite	Mont., Tex., Vt., N.Y	Ark., Calif., Ga., N.C., Oreg., Va.
Tin	Alaska and Colo.	
Titanium concentrate	N.J., N.Y., Fla.	
Tripoli	Ill., Okla., Ark., Pa.	
Tungsten concentrate	Calif., Colo., Nev., Mont	Alaska, Ariz., Idaho, Utah, Wash.
Vanadium	Colo., Utah, Idaho, Ark	Ariz. and N. Mex.
Vermiculite	Mont., S.C., Va.	
Wollastonite	N.Y. and Calif.	
Zinc (mine)	Tenn., Mo., N.Y., Idaho	Ariz., Calif., Colo., Ill., Ky., Mont., Nev., N.J., N. Mex., Pa., Utah, Va.
Zircon concentrate	Fla.	

Table 4.—Value of nonfuel mineral production in the United States and principal nonfuel minerals produced in 1981

State	Value (thousands)	Rank	Percent of U.S. total	Principal minerals, in order of value
Alabama	$312,657	22	1.24	Cement, stone, lime, clays.
Alaska	127,541	38	.51	Sand and gravel, stone, gold, tin.
Arizona	2,565,840	1	10.19	Copper, molybdenum, cement, silver.
Arkansas	281,548	25	1.12	Bromine, cement, stone, sand and gravel.
California	1,975,016	3	7.85	Cement, boron minerals, sand and gravel, stone.
Colorado	965,766	7	3.84	Molybdenum, cement, sand and gravel, silver.
Connecticut	62,691	43	.25	Stone, sand and gravel, feldspar, lime.
Delaware	[1]2,800	50	.01	Magnesium compounds, sand and gravel.
Florida	1,725,589	4	6.85	Phosphate rock, stone, cement, clays.
Georgia	804,455	9	3.20	Clays, stone, cement, sand and gravel.
Hawaii	58,727	44	.23	Stone, cement, sand and gravel, lime.
Idaho	430,748	18	1.71	Silver, phosphate rock, zinc, lead.
Illinois	428,316	19	1.70	Stone, sand and gravel, cement, lime.
Indiana	258,832	26	1.03	Stone, cement, sand and gravel, lime.
Iowa	232,311	29	.92	Cement, stone, sand and gravel, gypsum.
Kansas	249,060	27	.99	Cement, salt, stone, helium.
Kentucky	207,759	31	.83	Stone, lime, cement, sand and gravel.
Louisiana	573,959	14	2.28	Sulfur, salt, sand and gravel, cement.
Maine	38,369	46	.15	Cement, sand and gravel, stone, gem stones.
Maryland	178,655	34	.71	Stone, cement, sand and gravel, clays.
Massachusetts	97,037	39	.39	Stone, sand and gravel, lime, clays.
Michigan	1,438,355	6	5.71	Iron ore, cement, magnesium compounds, salt.
Minnesota	2,151,871	2	8.55	Iron ore, sand and gravel, stone, lime.
Mississippi	91,791	41	.36	Cement, sand and gravel, clays, stone.
Missouri	870,326	8	3.46	Lead, cement, stone, lime.
Montana	305,071	23	1.21	Copper, cement, silver, gold.
Nebraska	73,995	42	.29	Cement, sand and gravel, stone, lime.
Nevada	503,649	16	2.00	Gold, barite, silver, diatomite.
New Hampshire	25,510	47	.10	Sand and gravel, stone, clays, gem stones.
New Jersey	142,012	37	.56	Stone, sand and gravel, zinc, titanium concentrate.
New Mexico	694,677	12	2.76	Copper, potassium salts, gold, cement.
New York	491,971	17	1.95	Stone, cement, salt, sand and gravel.
North Carolina	376,530	21	1.50	Phosphate rock, stone, sand and gravel, cement.
North Dakota	22,445	48	.09	Sand and gravel, salt, lime, clays.
Ohio	554,190	15	2.20	Stone, lime, sand and gravel, salt.
Oklahoma	236,612	28	.94	Cement, stone, sand and gravel, iodine.
Oregon	146,847	36	.58	Stone, sand and gravel, cement, nickel.
Pennsylvania	633,056	13	2.51	Cement, stone, lime, sand and gravel.
Rhode Island	[e]5,279	49	.02	Sand and gravel, stone, gem stones.
South Carolina	205,476	32	.82	Cement, stone, clays, sand and gravel.
South Dakota	193,374	33	.77	Gold, stone, cement, sand and gravel.
Tennessee	417,618	20	1.66	Zinc, stone, pyrites, cement.
Texas	1,658,203	5	6.59	Cement, sulfur, stone, sand and gravel.
Utah	783,232	10	3.11	Copper, gold, molybdenum, potassium salts.
Vermont	51,019	45	.20	Stone, asbestos, sand and gravel, talc.
Virginia	282,533	24	1.12	Stone, cement, lime, sand and gravel.
Washington	212,478	30	.84	Cement, sand and gravel, stone, lime.
West Virginia	96,447	40	.38	Sand and gravel, stone, cement, salt.
Wisconsin	156,333	35	.62	Sand and gravel, stone, iron ore, lime.
Wyoming	770,338	11	3.06	Sodium carbonate, clays, iron ore, cement.
Total	25,173,000	XX	100.00	

[e]Estimated. XX Not applicable.
[1]Incomplete total.

Table 5.—Value of nonfuel mineral production per capita and per square mile in 1981, by State

State	Area (square miles)	1981 population (thousands)	Value of mineral production				
			Total (thousands)	Per square mile		Per capita	
				Dollars	Rank	Dollars	Rank
Alabama	51,609	3,890	$312,657	6,058	27	80	24
Alaska	586,412	400	127,541	217	50	319	10
Arizona	113,909	2,718	2,565,840	22,525	4	944	2
Arkansas	53,104	2,286	281,548	5,302	30	123	17
California	158,693	23,669	1,975,016	12,446	12	83	22
Colorado	104,247	2,889	965,766	9,264	17	334	9
Connecticut	5,009	3,108	62,691	12,516	10	20	46
Delaware	2,057	595	[1]2,800	1,361	46	5	50
Florida	58,560	9,740	1,725,589	29,467	1	177	12
Georgia	58,876	5,464	804,455	13,664	8	147	15
Hawaii	6,450	965	58,727	9,105	19	61	28
Idaho	83,557	944	430,748	5,155	31	456	7
Illinois	56,400	11,418	428,316	7,594	21	38	39
Indiana	36,291	5,490	258,832	7,132	23	47	36
Iowa	56,290	2,913	232,311	4,127	35	80	23
Kansas	82,264	2,363	249,060	3,028	39	105	19
Kentucky	40,395	3,661	207,759	5,143	32	57	29
Louisiana	48,523	4,204	573,959	11,828	13	137	16
Maine	33,215	1,125	38,369	1,155	47	34	41
Maryland	10,577	4,216	178,655	16,891	6	42	38
Massachusetts	8,257	5,737	97,037	11,752	14	17	48
Michigan	58,216	9,258	1,438,355	24,707	3	155	14
Minnesota	84,068	4,077	2,151,871	25,597	2	528	6
Mississippi	47,716	2,521	91,791	1,924	44	36	40
Missouri	69,686	4,917	870,326	12,489	11	177	13
Montana	147,138	787	305,071	2,073	43	388	8
Nebraska	77,227	1,570	73,995	958	48	47	37
Nevada	110,540	799	503,649	4,556	33	630	3
New Hampshire	9,304	921	25,510	2,742	41	28	45
New Jersey	7,836	7,364	142,012	18,123	5	19	47
New Mexico	121,666	1,300	694,677	5,710	28	534	5
New York	49,576	17,557	491,971	9,924	15	28	44
North Carolina	52,586	5,874	376,530	7,160	22	64	27
North Dakota	70,665	653	22,445	318	49	34	42
Ohio	41,222	10,797	554,190	13,444	9	51	33
Oklahoma	69,919	3,025	236,612	3,384	37	78	25
Oregon	96,981	2,633	146,847	1,514	45	56	30
Pennsylvania	45,333	11,867	633,056	13,964	7	53	31
Rhode Island	1,214	947	[e]5,279	4,348	34	6	49
South Carolina	31,055	3,119	205,476	6,616	25	66	26
South Dakota	77,047	690	193,374	2,510	42	280	11
Tennessee	42,244	4,591	417,618	9,886	16	91	21
Texas	267,338	14,228	1,658,203	6,203	26	117	18
Utah	84,916	1,461	783,232	9,224	18	536	4
Vermont	9,609	511	51,019	5,310	29	100	20
Virginia	40,817	5,346	282,533	6,922	24	53	32
Washington	68,192	4,130	212,478	3,116	38	51	34
West Virginia	24,181	1,950	96,447	3,988	36	49	35
Wisconsin	56,154	4,705	156,333	2,784	40	33	43
Wyoming	97,914	471	770,338	7,867	20	1,636	1
Total[2] or average	3,615,055	225,864	25,173,000	6,963	XX	111	XX

XX Not applicable.
[1]Incomplete total.
[2]Excludes Washington, D.C. (which has no mineral production), with an area of 67 square miles and a population of 638,000.

Table 6.—Nonfuel mineral production[1] in the United States, by State

Mineral	1979		1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
ALABAMA						
Cement:						
Masonry thousand short tons	303	$13,930	242	$13,012	193	$10,721
Portland do	2,578	103,187	2,491	108,438	2,270	89,216
Clays[2] do	2,571	33,824	2,022	29,832	1,910	25,406
Gem stones	NA	2	NA	1	NA	1
Lime thousand short tons	1,273	54,182	1,128	53,685	1,219	59,454
Sand and gravel do	13,747	31,319	r11,076	r25,504	p10,382	p23,064
Stone:						
Crushed do	26,443	83,566	23,433	82,270	20,706	88,377
Dimension do	12	2,071	11	2,259	7	2,130
Combined value of asphalt (native), bauxite, clays (bentonite), mica (scrap, 1979-80), phosphate rock, and salt	XX	14,286	XX	13,373	XX	14,288
Total	XX	336,367	XX	r328,374	XX	312,657
ALASKA						
Gem stones	NA	60	NA	50	NA	60
Gold (recoverable content of ores, etc.) troy ounces	6,675	2,053	r12,881	r7,890	25,316	11,636
Lead metric tons	--	--	31	29	W	W
Sand and gravel thousand short tons	50,900	104,905	44,911	85,214	p46,400	p87,500
Silver (recoverable content of ores, etc.) thousand troy ounces	(3)	5	8	172	2	25
Stone (crushed) thousand short tons	3,656	15,458	3,990	19,978	5,359	26,855
Tin metric tons	W	W	W	W	136	1,200
Combined value of barite (1979-80), platinum-group metals (1980-81), tungsten, and values indicated by symbol W	XX	1,384	XX	1,983	XX	265
Total	XX	123,865	XX	r115,316	XX	127,541
ARIZONA						
Clays thousand short tons	138	642	151	1,151	148	1,105
Copper (recoverable content of ores, etc.) metric tons	946,002	1,940,211	r770,118	r1,738,908	1,040,813	1,953,142
Gem stones	NA	4,000	NA	3,100	NA	3,250
Gold (recoverable content of ores, etc.) troy ounces	101,840	31,316	r79,631	r48,779	100,339	46,120
Gypsum thousand short tons	231	1,245	209	2,017	213	2,594
Lead (recoverable content of ores, etc.) metric tons	354	411	r162	r152	993	800
Lime thousand short tons	673	27,186	514	23,904	538	29,913
Molybdenum (content of concentrate) thousand pounds	35,101	213,065	35,668	341,965	35,808	254,345
Pumice thousand short tons	r1	r5	r9	r13	1	3
Sand and gravel do	430,520	474,716	24,399	73,773	p22,679	p69,855
Silver (recoverable content of ores, etc.) thousand troy ounces	7,479	82,941	r6,268	r129,363	8,055	84,728
Stone:						
Crushed thousand short tons	r6,708	r23,763	r6,205	r24,780	6,315	26,263
Dimension do	5	110	W	45	W	578
Zinc metric tons	W	W	W	W	138	135
Combined value of asbestos, barite (1981), cement, fluorspar (1979), perlite, pyrites, salt, tungsten, vanadium (1980-81), and values indicated by symbol W	XX	90,870	XX	r83,037	XX	93,009
Total	XX	2,490,481	XX	r2,470,987	XX	2,565,840
ARKANSAS						
Abrasives short tons	273	1,520	280	1,686	W	W
Bauxite thousand metric tons	1,430	20,555	1,299	19,252	1,242	22,185
Clays thousand short tons	1,044	7,686	1,150	14,402	880	9,333
Gem stones	NA	150	NA	140	NA	200
Lime thousand short tons	160	6,287	175	7,785	149	8,102
Sand and gravel do	16,465	35,200	r13,017	r34,562	p12,742	p40,336
Stone:						
Crushed do	19,978	53,723	20,666	61,399	13,834	47,260
Dimension do	14	528	8	355	7	411
Combined value of barite, bromine, cement, gypsum, talc, tripoli, vanadium, and value indicated by symbol W	XX	179,447	XX	r153,061	XX	153,721
Total	XX	305,096	XX	r292,642	XX	281,548

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1979		1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
CALIFORNIA						
Asbestos short tons	76,332	$20,434	W	W	W	W
Boron minerals thousand short tons	1,590	310,211	1,545	$366,760	1,481	$435,387
Cement, portland do.	9,724	541,815	8,797	542,487	7,896	518,966
Clays do.	2,531	18,621	2,558	17,766	2,309	19,118
Diatomite do.	422	60,989	W	W	W	W
Gem stones	NA	240	NA	200	NA	300
Gold (recoverable content of ores, etc.) troy ounces	r5,010	r1,541	r4,078	r2,498	6,271	2,882
Gypsum thousand short tons	1,624	10,354	1,644	12,763	1,456	13,948
Lead (recoverable content of ores, etc.) metric tons	2	2	W	W	W	W
Lime thousand short tons	564	25,545	554	29,444	472	26,834
Mercury 76-pound flasks	151	43	226	88	85	35
Perlite thousand short tons	W	W	W	W	36	1,044
Pumice do.	r121	r1,331	r58	r1,340	98	1,501
Sand and gravel do.	129,348	347,385	r114,663	r363,904	p112,050	p381,669
Silver (recoverable content of ores, etc.) thousand troy ounces	64	712	49	1,017	53	560
Stone:						
Crushed thousand short tons	r39,267	r105,489	r37,760	r118,140	34,560	118,698
Dimension do.	41	2,258	36	1,967	29	1,909
Talc do.	176	6,960	100	1,863	111	5,855
Zinc (recoverable content of ores, etc.) metric tons	W	W	--	--	W	W
Combined value of calcium chloride, carbon dioxide, cement (masonry, 1979), copper, feldspar, iron ore, magnesium compounds, molybdenum, peat, potassium salts, rare-earth concentrates, salt, sodium carbonates, sodium sulfate, tungsten, wollastonite (1981), and values indicated by symbol W	XX	312,925	XX	r411,619	XX	446,310
Total	XX	r1,766,855	XX	r1,871,856	XX	1,975,016
COLORADO						
Clays thousand short tons	2521	2,717	336	2,223	276	1,734
Copper (recoverable content of ores, etc.) metric tons	362	742	461	1,041	W	W
Gem stones	NA	70	NA	70	NA	80
Gold (recoverable content of ores, etc.) troy ounces	13,850	4,259	39,447	24,164	51,069	23,473
Gypsum thousand short tons	275	1,727	227	3,409	203	2,346
Lead (recoverable content of ores, etc.) metric tons	7,554	8,767	10,272	9,615	11,431	9,207
Molybdenum thousand pounds	W	W	102,498	915,304	73,615	636,037
Peat thousand short tons	33	299	29	327	33	299
Sand and gravel do.	25,680	456,263	427,433	474,452	p 425,700	p 472,300
Silver (recoverable content of ores, etc.) thousand troy ounces	2,809	31,151	2,987	61,653	3,009	31,650
Stone:						
Crushed thousand short tons	rW	rW	rW	rW	6,969	24,083
Dimension do.	3	163	6	259	1	64
Zinc (recoverable content of ores, etc.) metric tons	9,910	8,149	13,823	11,406	W	W
Combined value of carbon dioxide, cement, clays (bentonite, 1979), iron ore, lime, perlite, pyrites, salt, sand and gravel (industrial), tin, tungsten concentrate, vanadium, and values indicated by symbol W	XX	r711,791	XX	r160,592	XX	164,493
Total	XX	826,098	XX	1,264,515	XX	965,766
CONNECTICUT						
Clays thousand short tons	112	435	92	482	73	391
Lime do.	33	2,053	19	1,352	16	1,190
Sand and gravel[4] do.	9,990	23,612	7,103	18,692	p6,500	p18,100
Stone:						
Crushed do.	8,271	38,767	7,977	40,283	7,247	38,115
Dimension do.	13	475	15	723	19	910
Combined value of feldspar, gem stones, mica, and industrial sand	XX	3,894	XX	4,231	XX	3,985
Total	XX	69,236	XX	65,763	XX	62,691

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1979 Quantity	1979 Value (thousands)	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
DELAWARE						
Clays thousand short tons	11	$9	--	--	[p]1,200	[p]$2,800
Sand and gravel do	1,674	3,281	1,075	$2,398		
Total	XX	[5]3,290	XX	[5]2,398	XX	[p][5]2,800
FLORIDA						
Cement:						
Masonry thousand short tons	255	13,098	285	22,074	288	20,757
Portland do	2,957	126,562	3,574	182,590	3,518	199,064
Clays do	681	[2]31,308	614	[2]24,164	731	[2]35,319
Gem stones	NA	4	NA	5	NA	6
Lime thousand short tons	210	11,440	195	12,434	191	11,343
Peat do	153	2,190	154	2,398	157	2,885
Sand and gravel do	21,708	39,520	[r][4]14,412	[r][4]28,766	[p]14,149	[p]32,719
Stone (crushed) do	[r]63,787	[r]188,896	66,209	215,972	65,067	226,192
Combined value of clays (kaolin), magnesium compounds, phosphate rock, rare-earth concentrate, sand and gravel (industrial, 1980), staurolite, titanium concentrates (ilmenite and rutile), and zircon concentrates	XX	[r]856,589	XX	[r]1,020,855	XX	1,197,304
Total	XX	[r]1,269,607	XX	[r]1,509,258	XX	1,725,589
GEORGIA						
Cement:						
Masonry thousand short tons	102	5,172	89	5,464	89	4,392
Portland do	1,335	55,117	1,231	55,463	1,150	45,423
Clays do	8,322	437,671	8,283	500,555	8,029	553,726
Gem stones	NA	20	NA	20	NA	20
Sand and gravel[4] thousand short tons	5,014	10,792	4,858	11,898	[p]4,700	[p]12,000
Stone:						
Crushed do	40,902	154,021	40,884	162,642	35,730	153,751
Dimension do	244	17,908	231	17,466	268	17,894
Talc do	W	W	25	116	26	182
Combined value of barite, bauxite, feldspar, iron oxide pigments (crude), kyanite, mica, peat, sand and gravel (industrial), and value indicated by symbol W	XX	18,870	XX	[r]17,663	XX	17,067
Total	XX	699,571	XX	[r]771,287	XX	804,455
HAWAII						
Cement:						
Masonry thousand short tons	12	1,077	13	960	10	807
Portland do	469	29,346	358	23,722	302	23,024
Sand and gravel do	1,081	3,063	1,035	2,855	[p]1,100	[p]2,900
Stone:						
Crushed do	[r]W	[r]W	[r]W	[r]W	6,036	31,403
Dimension do	1	W	W	11	([3])	4
Combined value of gem stones, lime, pumice, salt, and values indicated by symbol W	XX	[r]30,418	XX	[r]32,169	XX	589
Total	XX	63,904	XX	[r]59,717	XX	58,727
IDAHO						
Antimony ore and concentrate, antimony content short tons	W	W	83	W	432	W
Clays thousand short tons	28	263	27	301	26	288
Copper (recoverable content of ores, etc.) metric tons	3,618	7,421	3,103	7,006	4,245	7,966
Gem stones	NA	60	NA	60	NA	75
Gold (recoverable content of ores, etc.) troy ounces	24,140	7,423	W	W	W	W
Lead (recoverable content of ores, etc.) metric tons	42,636	49,479	38,607	36,139	38,397	30,923
Phosphate rock thousand metric tons	4,880	95,728	4,991	100,873	5,361	108,964
Sand and gravel thousand short tons	7,719	18,149	[4]5,299	[4]14,203	[p]5,100	[p]13,200
Silver (recoverable content of ores, etc.) thousand troy ounces	17,144	190,129	13,695	282,663	16,546	174,033
Stone[6] thousand short tons	[r]W	[r]W	2,007	7,240	1,437	6,206
Zinc (recoverable content of ores, etc.) metric tons	29,660	24,391	27,722	22,876	W	W

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1979 Quantity	1979 Value (thousands)	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
IDAHO—Continued						
Combined value of cement, garnet (abrasives), gypsum, lime, perlite, pumice, sand and gravel (industrial), stone (dimension), tungsten ore (1980-81), vanadium, and values indicated by symbol W	XX	r$44,839	XX	$50,734	XX	$89,093
Total	XX	r437,882	XX	522,095	XX	430,748
ILLINOIS						
Cement, portland thousand short tons	1,889	79,604	1,649	75,315	1,574	61,536
Clays[2] do.	542	2,355	459	1,919	322	1,540
Gem stones	NA	15	NA	15	NA	15
Peat thousand short tons	86	1,610	79	1,505	46	1,502
Sand and gravel do.	45,448	134,190	31,725	122,332	p28,546	p118,986
Stone:						
Crushed do.	63,551	188,130	53,309	180,656	44,159	165,218
Dimension do.	3	128	2	103	2	85
Combined value of barite, cement (masonry), clays (fuller's earth), fluorspar, lead, lime, silver, tripoli, and zinc	XX	70,498	XX	61,436	XX	79,434
Total	XX	476,530	XX	443,281	XX	428,316
INDIANA						
Cement:						
Masonry thousand short tons	W	W	W	W	252	10,972
Portland do.	2,389	95,549	1,769	73,049	1,538	59,344
Clays do.	1,185	2,341	932	1,930	691	1,602
Gem stones	--	--	--	--	NA	1
Peat thousand short tons	76	1,242	84	1,414	105	3,140
Sand and gravel do.	427,050	455,842	22,031	52,939	p20,457	p49,979
Stone:						
Crushed do.	r34,147	r92,630	30,910	92,106	25,349	79,910
Dimension do.	r181	r10,504	161	14,046	145	13,672
Combined value of abrasives (natural), gypsum, lime, sand and gravel (industrial, 1979), and values indicated by symbol W	XX	59,036	XX	52,986	XX	40,212
Total	XX	r317,144	XX	288,470	XX	258,832
IOWA						
Cement:						
Masonry thousand short tons	69	3,844	48	3,340	41	3,227
Portland do.	2,371	109,628	1,998	101,008	1,779	92,099
Clays do.	870	2,883	754	2,555	476	2,375
Gem stones	--	--	--	--	NA	1
Gypsum thousand short tons	1,695	13,777	1,468	13,136	1,383	12,706
Peat do.	11	270	11	276	10	453
Sand and gravel do.	17,495	39,686	412,683	432,722	p 412,100	p 432,000
Stone:						
Crushed do.	32,471	103,215	26,542	92,603	22,424	82,891
Dimension do.	10	508	10	509	W	W
Combined value of other nonmetals and value indicated by symbol W	XX	4,090	XX	5,727	XX	6,559
Total	XX	277,901	XX	251,876	XX	232,311
KANSAS						
Cement:						
Masonry thousand short tons	89	4,525	60	3,310	51	2,835
Portland do.	2,086	88,619	1,835	86,103	1,641	81,792
Clays do.	21,061	22,636	886	2,325	915	4,756
Gem stones	--	--	--	--	NA	1
Salt[7] thousand short tons	1,900	61,184	1,572	64,276	1,410	60,148
Sand and gravel do.	14,280	26,490	412,124	423,817	p10,600	p21,000
Stone:						
Crushed do.	19,308	56,038	17,398	54,731	14,143	45,738
Dimension do.	W	W	18	937	14	605

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1979 Quantity	1979 Value (thousands)	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
KANSAS—Continued						
Combined value of clays (bentonite, 1979), gypsum, helium (crude and high-purity), lime, pumice, salt (brine), sand and gravel (industrial, 1980-81), and value indicated by symbol W	XX	$25,074	XX	$26,094	XX	$32,185
Total	XX	264,566	XX	261,593	XX	249,060
KENTUCKY						
Clays thousand short tons	794	3,259	748	3,692	490	2,395
Gem stones	NA	1	NA	1	NA	1
Sand and gravel[4] thousand short tons	11,726	23,721	7,767	17,637	[p]7,000	[p]15,547
Stone (crushed) do.	W	W	W	W	32,433	108,257
Zinc (recoverable content of ores, etc.) metric tons	--	--	--	--	W	W
Combined value of cement, clays (ball clay), lime, sand and gravel (industrial), and values indicated by symbol W	XX	180,946	XX	182,970	XX	81,559
Total	XX	207,927	XX	204,300	XX	207,759
LOUISIANA						
Clays thousand short tons	416	6,073	380	5,841	[2]380	[2]6,338
Gem stones	--	--	--	--	NA	1
Salt thousand short tons	14,207	113,167	12,662	132,182	12,565	113,190
Sand and gravel do.	[4]20,446	[4]54,081	18,505	66,413	[p]18,293	[p]66,426
Stone (crushed) do.	W	W	W	W	[6]7,228	[6]34,566
Sulfur (Frasch) thousand metric tons	2,858	W	2,590	W	2,235	W
Combined value of cement, clays (bentonite, 1981), gypsum, lime, sand and gravel (1979), and values indicated by symbol W	XX	281,955	XX	379,330	XX	353,438
Total	XX	455,276	XX	583,766	XX	573,959
MAINE						
Clays thousand short tons	90	163	78	174	57	166
Gem stones	NA	W	NA	W	NA	W
Peat thousand short tons	3	202	8	534	W	W
Sand and gravel do.	11,022	20,534	6,978	15,434	[p]7,100	[p]14,400
Stone (crushed) do.	2,069	7,492	1,130	3,969	1,375	5,532
Combined value of other nonmetals and values indicated by symbol W	XX	17,507	XX	16,856	XX	18,271
Total	XX	45,898	XX	36,967	XX	38,369
MARYLAND						
Clays[2] thousand short tons	975	2,854	733	2,267	597	1,984
Gem stones	--	--	--	--	NA	2
Lime thousand short tons	12	444	12	497	9	441
Peat do.	3	W	4	W	W	W
Sand and gravel do.	13,988	39,033	10,732	33,625	[p]10,900	[p]35,000
Stone:						
Crushed do.	21,561	80,550	18,945	77,431	16,485	74,289
Dimension do.	30	1,150	15	612	34	1,002
Combined value of cement, clays (ball clay), and values indicated by symbol W	XX	68,931	XX	71,703	XX	65,937
Total	XX	192,962	XX	186,135	XX	178,655
MASSACHUSETTS						
Clays thousand short tons	156	367	210	870	259	1,322
Lime do.	198	9,918	180	10,806	170	10,793
Peat do.	2	56	W	W	W	W
Sand and gravel do.	[4]16,705	[4]37,164	[4]13,925	[4]34,459	[p]13,087	[p][4]33,600
Stone:						
Crushed do.	8,586	39,570	7,316	36,804	7,997	41,037
Dimension do.	48	4,389	51	7,018	50	8,616
Combined value of gem stones, sand and gravel (industrial), and values indicated by symbol W	XX	1,082	XX	1,254	XX	1,669
Total	XX	92,546	XX	91,211	XX	97,037

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1979 Quantity	1979 Value (thousands)	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
MICHIGAN						
Cement:						
Masonry thousand short tons	262	$16,455	206	$14,292	173	$10,584
Portland do	5,682	252,058	4,651	224,685	3,871	180,641
Clays do	2,072	7,430	1,982	7,212	1,610	5,862
Gem stones	NA	10	NA	10	NA	15
Gypsum thousand short tons	2,526	14,633	1,383	8,605	1,066	6,762
Iron ore (usable), thousand long tons, gross weight	17,196	596,478	15,895	634,355	14,193	W
Lime thousand short tons	1,057	43,373	836	36,750	807	36,800
Peat do	258	4,847	253	4,739	237	4,540
Salt do	3,080	82,540	2,406	104,842	2,321	103,293
Sand and gravel do	50,169	116,597	36,597	98,354	p32,893	p95,787
Stone:						
Crushed do	39,809	99,832	32,121	91,727	30,013	94,324
Dimension do	9	166	7	144	6	129
Combined value of bromine, calcium chloride, copper, iodine, iron oxide pigments (crude), magnesium compounds, silver, and value indicated by symbol W	XX	272,107	XX	r259,435	XX	899,618
Total	XX	1,506,526	XX	r1,485,150	XX	1,438,355
MINNESOTA						
Clays thousand short tons	2135	21,905	94	1,206	84	1,077
Gem stones	NA	5	NA	5	NA	5
Iron ore (usable), thousand long tons, gross weight	59,682	1,965,710	45,472	1,686,839	50,176	2,062,118
Lime thousand short tons	140	5,133	162	3,562	155	3,818
Manganiferous ore short tons	181,503	W	119,029	W	139,571	W
Peat thousand short tons	21	827	25	1,140	25	940
Sand and gravel[4] do	30,939	55,427	25,110	49,180	p23,200	p46,800
Stone:						
Crushed do	9,751	22,175	8,606	21,731	6,995	18,438
Dimension do	38	11,543	44	14,189	41	14,298
Combined value of abrasive stone, clays (kaolin, 1979), sand and gravel (industrial), and values indicated by symbol W	XX	5,265	XX	4,458	XX	4,377
Total	XX	2,067,990	XX	1,782,310	XX	2,151,871
MISSISSIPPI						
Clays thousand short tons	1,820	21,841	1,596	21,714	1,218	23,309
Lime do	70	1,571	31	707	--	--
Sand and gravel[4] do	16,940	37,797	11,710	31,606	p10,400	p28,800
Stone (crushed) do	W	W	W	W	1,984	5,451
Combined value of cement, magnesium compounds (1979-80), sand and gravel (industrial), stone (crushed, 1981), and values indicated by symbol W	XX	46,480	XX	49,913	XX	34,231
Total	XX	107,689	XX	103,940	XX	91,791
MISSOURI						
Barite thousand short tons	89	3,679	117	5,570	185	9,725
Cement:						
Masonry do	82	4,159	62	3,117	103	5,495
Portland do	4,430	194,285	3,515	156,368	3,732	168,567
Clays do	2,351	20,522	1,817	16,798	1,747	18,414
Copper (recoverable content of ores, etc.) metric tons	13,021	26,705	13,576	30,655	8,411	15,783
Gem stones	NA	10	NA	15	NA	10
Gold (recoverable content of ores, etc.) troy ounces	32	10	W	W	--	--
Lead (recoverable content of ores, etc.) metric tons	472,054	547,824	497,170	465,393	389,721	313,870
Lime thousand short tons	1,790	70,187	1,667	63,733	W	W
Sand and gravel do	12,558	31,310	8,900	26,753	p8,778	p18,702
Silver (recoverable content of ores, etc.) thousand troy ounces	2,201	24,410	2,357	48,653	1,837	19,322
Stone:						
Crushed thousand short tons	56,380	139,944	48,296	130,254	40,910	116,297
Dimension do	(3)	85	W	W	W	W
Zinc (recoverable content of ores, etc.) metric tons	61,682	50,723	r62,886	r51,893	52,904	51,966

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1979 Quantity	1979 Value (thousands)	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
MISSOURI—Continued						
Combined value of asphalt (native, 1979-80), gold (1980), iron ore, iron oxide pigments (crude), and values indicated by symbol W	XX	$46,706	XX	$55,633	XX	$132,175
Total	XX	1,160,559	XX	r1,054,835	XX	870,326
MONTANA						
Antimony—short tons	W	W	260	W	214	W
Clays—thousand short tons	424	11,508	626	22,200	601	23,111
Copper (recoverable content of ores, etc.)—metric tons	69,854	143,268	37,749	85,236	62,485	117,257
Gem stones	NA	100	NA	90	NA	100
Gold (recoverable content of ores, etc.)—troy ounces	24,050	7,395	48,366	29,627	54,267	24,943
Lead (recoverable content of ores, etc.)—metric tons	258	299	295	276	194	157
Lime—thousand short tons	216	8,965	223	9,001	194	7,621
Sand and gravel—do	7,012	15,106	46,639	416,057	p 46,100	p 414,900
Silver (recoverable content of ores, etc.)—thousand troy ounces	3,302	36,618	2,024	41,773	2,989	31,437
Stone (crushed)—thousand short tons	2,527	7,806	1,962	6,302	1,582	5,137
Talc—do	343	5,940	312	11,310	W	W
Zinc (recoverable content of ores, etc.)—metric tons	104	86	71	59	25	24
Combined value of barite, cement, gypsum, iron ore (1979 and 1981), peat, phosphate rock, sand and gravel (industrial, 1980-81), stone (dimension), tungsten, vermiculite, and values indicated by symbol W	XX	54,196	XX	57,619	XX	80,384
Total	XX	291,287	XX	279,550	XX	305,071
NEBRASKA						
Clays—thousand short tons	156	454	154	456	136	409
Gem stones	NA	W	NA	W	NA	W
Sand and gravel—thousand short tons	16,197	33,001	10,538	22,981	p10,319	p22,844
Stone (crushed)—do	4,995	19,362	3,775	16,301	3,139	14,024
Combined value of cement, lime, and values indicated by symbol W	XX	46,364	XX	40,736	XX	36,718
Total	XX	99,181	XX	80,474	XX	73,995
NEVADA						
Barite—thousand short tons	1,804	35,707	1,918	47,800	2,482	79,716
Clays—do	76	1,163	64	2,082	73	2,948
Gem stones	NA	1,000	NA	900	NA	1,000
Gold (recoverable content of ores, etc.)—troy ounces	250,097	76,905	r278,495	r170,595	524,802	241,220
Gypsum—thousand short tons	1,075	6,771	852	8,276	778	6,914
Iron ore—thousand long tons	W	W	W	W	99	e1,490
Lead (recoverable content of ores, etc.)—metric tons	24	28	26	24	W	W
Mercury—76-pound flasks	29,368	8,256	30,431	11,851	27,819	11,514
Molybdenum—pounds	39,826	242	--	--	--	--
Perlite—thousand short tons	5	71	6	92	W	W
Sand and gravel[4]—do	10,498	21,387	8,439	18,360	p6,000	p12,800
Silver (recoverable content of ores, etc.)—thousand troy ounces	560	6,215	r940	r19,402	3,039	31,970
Stone (crushed)—thousand short tons	rW	rW	rW	rW	1,343	5,664
Zinc (recoverable content of ores, etc.)—metric tons	W	W	2	2	W	W
Combined value of cement (portland), copper, diatomite, fluorspar, lime, lithium compounds, magnesite, pumice (1979), salt, sand and gravel (industrial), talc (1979-80), tungsten and values indicated by symbol W	XX	r102,501	XX	r114,846	XX	108,413
Total	XX	260,246	XX	r394,230	XX	503,649

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1979 Quantity	1979 Value (thousands)	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
NEW HAMPSHIRE						
Sand and gravel thousand short tons	7,086	$15,301	6,334	$15,837	p5,800	p$15,900
Stone:						
Crushed do	866	2,172	590	2,281	665	2,599
Dimension do	86	5,774	103	7,167	89	6,889
Combined value of other nonmetals	XX	11	XX	121	XX	122
Total	XX	23,258	XX	25,406	XX	25,510
NEW JERSEY						
Clays thousand short tons	67	559	63	525	62	563
Gem stones	NA	1	NA	1	NA	1
Lime thousand short tons	W	W	--	--	--	--
Peat do	23	549	20	564	26	1,476
Sand and gravel do	10,781	44,682	8,596	45,535	p8,105	p45,838
Stone (crushed)[6] do	13,950	63,174	11,830	61,886	10,434	57,819
Zinc (recoverable content of ores, etc.) metric tons	31,118	25,589	28,859	23,814	16,198	15,911
Combined value of iron ore (1981), magnesium compounds, marl (greensand), stone (dimension), titanium concentrate (ilmenite), and value indicated by symbol W	XX	17,135	XX	17,123	XX	20,404
Total	XX	151,689	XX	149,448	XX	142,012
NEW MEXICO						
Clays[2] thousand short tons	74	124	60	114	64	119
Copper (recoverable content of ores, etc.) metric tons	164,281	336,934	149,394	337,328	154,114	289,204
Gem stones	NA	180	NA	150	NA	200
Gold (recoverable content of ores, etc.) troy ounces	r14,966	r4,602	r15,847	r9,707	65,749	30,221
Gypsum thousand short tons	251	3,244	182	1,688	166	2,256
Lead (recoverable content of ores, etc.) metric tons	43	49	--	--	W	W
Manganiferous ore (5% to 35% Mn) short tons	33,152	W	35,198	W	12,741	W
Mica (scrap) thousand short tons	17	W	W	W	W	W
Peat do	2	40	2	40	--	--
Perlite do	588	14,874	539	14,404	489	14,983
Potassium salts thousand metric tons	2,005	228,776	1,869	289,011	1,601	261,200
Pumice thousand short tons	r191	r1,181	r84	r814	93	919
Sand and gravel do	7,141	18,245	7,050	17,676	p7,300	p18,000
Silver (recoverable content of ores, etc.) thousand troy ounces	W	W	W	W	1,632	17,170
Stone:						
Crushed thousand short tons	r3,001	r9,112	r2,581	r9,473	4,162	12,485
Dimension do	20	117	18	91	26	173
Combined value of barite (1979-80), carbon dioxide, cement, clays (fire clay), helium (high-purity, 1980-81), lime, molybdenum, salt, vanadium, zinc, and values indicated by symbol W	XX	r72,383	XX	r85,113	XX	47,747
Total	XX	r689,861	XX	r765,609	XX	694,677
NEW YORK						
Clays[2] thousand short tons	836	3,027	596	2,479	597	2,310
Emery short tons	10,005	204	rW	rW	W	W
Gem stones	NA	20	NA	20	NA	30
Lead (recoverable content of ores, etc.) metric tons	458	532	876	820	968	780
Peat thousand short tons	38	630	43	917	39	811
Salt do	6,387	77,751	5,509	99,395	5,597	103,668
Sand and gravel do	4,26,242	4,55,889	4,21,918	4,53,276	p21,255	p 4,56,300
Silver (recoverable content of ores, etc.) thousand troy ounces	11	117	21	427	29	303
Stone:						
Crushed thousand short tons	37,499	114,174	34,483	120,764	30,681	117,689
Dimension do	27	2,626	25	2,414	21	2,291
Zinc (recoverable content of ores, etc.) metric tons	12,133	9,977	33,629	27,750	36,889	36,235

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1979 Quantity	1979 Value (thousands)	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
NEW YORK—Continued						
Combined value of cement, clays (ball clay), garnet (abrasive), gypsum, iron ore, lime, sand and gravel (industrial), talc, titanium concentrate (ilmenite), wollastonite, and values indicated by symbol W	XX	r$190,169	XX	r$187,526	XX	$171,554
Total	XX	r455,116	XX	r495,788	XX	491,971
NORTH CAROLINA						
Clays[2] thousand short tons	3,308	8,385	2,852	7,308	2,110	6,838
Feldspar short tons	523,663	e14,531	e499,600	e15,062	462,864	13,517
Gem stones	NA	50	NA	40	NA	50
Mica, scrap thousand short tons	84	5,847	r77	r4,647	92	6,398
Sand and gravel do	11,203	29,733	9,309	28,735	p8,936	p32,640
Stone:						
Crushed do	39,864	125,319	34,764	125,019	28,833	117,092
Dimension do	49	3,932	55	4,536	30	2,773
Talc and pyrophyllite do	e130	e692	W	W	s104	s825
Combined value of cement, clays (kaolin), lithium compounds, olivine, phosphate rock, and value indicated by symbol W	XX	153,752	XX	194,986	XX	196,397
Total	XX	342,241	XX	r380,333	XX	376,530
NORTH DAKOTA						
Gem stones	NA	1	NA	2	NA	2
Peat thousand short tons	(3)	W	W	31	W	36
Sand and gravel do	6,648	15,128	5,173	14,457	p4,900	p14,100
Combined value of clays, lime, salt, and values indicated by symbol W	XX	6,105	XX	7,886	XX	8,307
Total	XX	21,234	XX	22,376	XX	22,445
OHIO						
Cement:						
Masonry thousand short tons	170	10,869	126	8,549	105	7,129
Portland do	1,921	87,483	1,625	77,696	1,461	69,517
Clays do	3,374	13,495	2,718	11,516	2,217	10,411
Gypsum do	W	W	136	1,346	148	1,566
Lime do	3,392	141,663	2,786	122,817	2,767	127,751
Peat do	8	191	10	166	10	191
Salt do	4,135	79,598	3,228	87,371	3,608	90,254
Sand and gravel do	45,944	121,048	36,972	114,291	p36,087	p118,493
Stone:						
Crushed do	50,717	149,819	42,441	136,929	36,950	125,588
Dimension do	50	1,702	35	1,558	W	W
Combined value of abrasives, gem stones, and values indicated by symbol W	XX	1,452	XX	101	XX	3,290
Total	XX	607,320	XX	562,340	XX	554,190
OKLAHOMA						
Clays thousand short tons	949	1,999	972	2,249	838	2,064
Gem stones	—	—	—	—	NA	2
Gypsum thousand short tons	1,480	9,770	1,326	11,230	1,177	9,870
Helium:						
High-purity million cubic feet	395	9,085	349	8,027	49	1,274
Crude do	35	420	23	276	22	264
Pumice thousand short tons	1	W	1	W	1	W
Sand and gravel do	12,101	32,502	11,881	37,162	p11,700	p38,117
Stone:						
Crushed do	28,312	66,666	28,173	76,267	29,930	83,407
Dimension do	38	1,383	16	678	18	738
Combined value of cement, feldspar, iodine, lime, salt, tripoli, and values indicated by symbol W	XX	80,696	XX	88,244	XX	100,876
Total	XX	202,521	XX	224,133	XX	236,612

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1979		1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
OREGON						
Clays ____ thousand short tons	139	$263	172	$321	176	$300
Copper (recoverable content of ores, etc.) metric tons	2	4	--	--	W	W
Gem stones	NA	500	NA	450	NA	600
Gold (recoverable content of ores, etc.) troy ounces	W	W	rW	rW	2,830	1,301
Lead (recoverable content of ores, etc.) metric tons	(3)	(3)	--	--	W	W
Nickel (content of ores and concentrates) short tons	15,065	W	14,653	W	12,099	W
Pumice ____ thousand short tons	rW	rW	r219	r1,318	W	W
Sand and gravel ____ do	17,874	45,829	16,005	47,300	p14,400	p42,400
Silver (recoverable content of ores, etc.) thousand troy ounces	2	17	1	17	7	79
Stone:						
Crushed ____ thousand short tons	rW	rW	r19,251	r49,606	16,482	46,055
Dimension ____ do	(3)	4	15	231	(3)	5
Combined value of cement, diatomite, lime, talc, and values indicated by symbol W	XX	r118,704	XX	r52,727	XX	56,107
Total	XX	r165,321	XX	r151,970	XX	146,847
PENNSYLVANIA						
Cement:						
Masonry ____ thousand short tons	415	24,177	324	20,298	293	14,799
Portland ____ do	6,508	259,756	5,570	237,684	5,150	215,883
Clays[2] ____ do	2,468	20,099	1,650	12,112	1,246	7,497
Gem stones	--	--	--	--	NA	5
Lime ____ thousand short tons	2,153	96,569	1,768	84,291	1,690	85,418
Mica (scrap) ____ do	4	W	3	W	3	134
Peat ____ do	24	531	26	552	25	647
Sand and gravel ____ do	20,150	71,740	15,603	58,257	p 414,300	p 455,400
Stone:						
Crushed ____ do	71,432	224,014	61,143	218,231	53,258	207,821
Dimension ____ do	77	5,961	65	6,397	51	7,193
Tripoli ____ short tons	W	W	W	W	1,263	W
Zinc (recoverable content of ores, etc.) metric tons	21,447	17,636	22,556	18,613	24,732	24,293
Combined value of clays (kaolin), sand and gravel (industrial, 1981), and values indicated by symbol W	XX	1,237	XX	1,171	XX	13,966
Total	XX	721,720	XX	667,606	XX	633,056
RHODE ISLAND						
Sand and gravel ____ thousand short tons	3,537	6,737	2,506	4,945	p1,900	p4,100
Stone (crushed) ____ do	249	1,148	203	1,208	141	1,116
Combined value of other nonmetals	XX	1	XX	17	XX	63
Total	XX	7,886	XX	6,170	XX	p5,279
SOUTH CAROLINA						
Cement, portland ____ thousand short tons	1,831	79,377	1,704	74,539	1,765	79,407
Clays[2] ____ do	2,272	24,492	2,211	25,169	1,632	28,600
Gem stones	NA	5	NA	5	NA	10
Manganiferous ore ____ thousand short tons	26	W	20	W	23	W
Sand and gravel ____ do	8,321	26,665	5,556	22,855	p5,303	p23,531
Stone:						
Crushed ____ do	16,589	48,352	16,107	49,207	14,825	49,830
Dimension ____ do	9	482	12	703	18	1,109
Combined value of cement (masonry), clays (fuller's earth), copper (1981), gold (1981), mica (scrap), peat (1979), silver (1981), vermiculite, and values indicated by symbol W	XX	22,277	XX	22,301	XX	22,989
Total	XX	201,650	XX	194,779	XX	205,476

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1979		1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
SOUTH DAKOTA						
Cement:						
Masonry thousand short tons	7	$434	6	$377	6	$454
Portland do	670	31,273	459	23,042	450	23,290
Clays do	205	292	[2]169	[2]283	116	209
Gem stones	NA	50	NA	50	NA	70
Gold (recoverable content of ores, etc.) troy ounces	245,912	75,618	[r]267,642	[r]163,947	278,162	127,854
Mica, scrap thousand short tons	([3])	2	([3])	4	W	W
Sand and gravel do	6,001	10,119	4,209	8,243	[p]4,000	[p]7,900
Silver (recoverable content of ores, etc.) thousand troy ounces	58	643	51	1,058	56	587
Stone:						
Crushed thousand short tons	3,891	10,317	3,151	8,942	2,985	9,085
Dimension do	36	13,268	42	15,035	50	17,543
Combined value of beryllium (1981), clays (bentonite, 1980-81), feldspar, gypsum, iron ore (1980), lime, and value indicated by symbol W	XX	6,670	XX	6,873	XX	6,382
Total	XX	148,686	XX	[r]227,854	XX	193,374
TENNESSEE						
Cement:						
Masonry thousand short tons	170	8,600	132	7,241	66	3,209
Portland do	1,335	57,146	1,304	58,827	974	39,378
Clays do	1,561	26,071	1,188	22,844	1,047	23,134
Gem stones	NA	1	NA	1	NA	5
Phosphate rock thousand metric tons	1,873	14,770	1,582	12,765	1,328	16,201
Sand and gravel thousand short tons	11,210	29,056	8,921	24,930	[p]7,942	[p]26,210
Stone:						
Crushed do	45,718	133,727	38,584	126,993	[e]32,497	[e]113,729
Dimension do	12	1,000	10	883	11	1,063
Zinc (recoverable content of ores, etc.) metric tons	85,119	69,995	[r]111,754	[r]92,218	117,684	115,597
Combined value of barite, copper, gold (1981), lead (1979), lime, pyrites, silver, stone (crushed, 1981)	XX	45,378	XX	47,133	XX	79,092
Total	XX	385,744	XX	[r]393,835	XX	417,618
TEXAS						
Cement:						
Masonry thousand short tons	268	15,593	241	18,310	229	15,699
Portland do	9,353	475,836	9,517	535,690	10,262	567,391
Clays do	3,871	21,533	3,763	27,022	4,172	29,135
Gem stones	NA	170	NA	160	NA	200
Gypsum thousand short tons	1,903	11,438	1,681	14,124	1,783	14,900
Helium (high-purity) million cubic feet	38	874	35	805	238	6,188
Lime thousand short tons	1,507	59,520	1,515	67,075	1,393	67,158
Salt do	11,283	67,602	9,978	93,414	8,397	84,240
Sand and gravel do	52,846	167,076	46,704	171,576	[p]45,442	[p]178,492
Stone:						
Crushed do	74,612	188,746	76,483	220,265	72,454	219,086
Dimension do	17	3,636	37	7,095	42	5,543
Sulfur (Frasch) thousand metric tons	4,649	W	4,810	W	3,674	W
Talc and pyrophyllite thousand short tons	207	1,544	401	4,295	282	4,127
Combined value of asphalt (native), fluorspar (1979 and 1981), graphite (1979), helium (crude), iron ore, magnesium chloride, magnesium compounds, sodium sulfate and values indicated by symbol W	XX	391,071	XX	574,820	XX	466,044
Total	XX	1,404,639	XX	1,734,651	XX	1,658,203

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1979 Quantity	1979 Value (thousands)	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
UTAH						
Clays ____ thousand short tons	355	$1,246	365	$1,517	290	$2,296
Copper (recoverable content of ores, etc.) metric tons	193,082	396,003	157,775	356,251	211,276	396,471
Gem stones	NA	75	NA	70	NA	80
Gold (recoverable content of ores, etc.) troy ounces	260,916	80,232	179,538	109,978	227,706	104,663
Gypsum ____ thousand short tons	292	2,450	287	2,612	300	2,705
Iron ore (usable), thousand long tons, gross weight	1,618	19,391	1,307	18,540	691	W
Lead (recoverable content of ores, etc.) metric tons	W	W	rW	rW	1,662	1,338
Lime ____ thousand short tons	198	8,250	259	13,293	333	16,679
Perlite ____ do.	W	W	(3)	2	(3)	4
Pumice ____ do.	(9)	(9)	(9)	(9)	--	--
Salt ____ do.	1,204	14,723	1,157	19,373	1,072	21,775
Sand and gravel[4] ____ do.	10,363	18,621	8,906	17,234	p9,122	p18,186
Silver (recoverable content of ores, etc.) thousand troy ounces	2,454	27,216	r2,203	r45,476	2,883	30,321
Stone:						
Crushed ____ thousand short tons	r3,452	r11,339	r2,954	r12,123	2,840	12,157
Dimension ____ do.	5	216	3	272	3	280
Zinc (recoverable content of ores, etc.) metric tons	W	W	rW	rW	1,576	1,548
Combined value of asphalt (native), beryllium concentrate, carbon dioxide (natural), cement, magnesium compounds, molybdenum, phosphate rock, potassium salts, sand and gravel (industrial, 1979-80), sodium sulfate, tungsten, vanadium, and values indicated by symbol W	XX	169,520	XX	r166,883	XX	174,729
Total	XX	749,282	XX	r763,624	XX	783,232
VERMONT						
Sand and gravel ____ thousand short tons	3,660	6,240	1,900	4,171	p1,900	p4,200
Stone:						
Crushed ____ do.	2,077	13,927	1,320	4,787	1,319	5,144
Dimension ____ do.	180	23,006	169	23,649	207	30,756
Talc ____ do.	346	2,755	318	2,753	W	W
Combined value of other nonmetals and value indicated by symbol W	XX	8,208	XX	7,277	XX	10,919
Total	XX	54,136	XX	42,637	XX	51,019
VIRGINIA						
Clays ____ thousand short tons	1,059	3,512	762	3,172	502	2,016
Gem stones	NA	15	NA	15	NA	20
Lead (recoverable content of ores, etc.) metric tons	1,596	1,852	1,563	1,463	1,607	1,294
Lime ____ thousand short tons	872	34,935	824	33,872	804	35,984
Sand and gravel[4] ____ do.	11,803	32,268	8,264	29,508	p7,400	p27,700
Stone:						
Crushed ____ do.	51,080	165,223	44,615	167,839	37,071	152,630
Dimension ____ do.	9	2,042	27	2,287	4	1,130
Zinc (recoverable content of ores, etc.) metric tons	11,406	9,380	r12,038	9,934	9,731	9,558
Combined value of aplite, cement, gypsum, iron oxide pigments (crude), kyanite, sand and gravel (industrial), silver (1981), talc, and vermiculite	XX	60,562	XX	57,216	XX	52,201
Total	XX	309,789	XX	305,306	XX	282,533
WASHINGTON						
Cement:						
Masonry ____ thousand short tons	10	741	W	W	15	1,284
Portland ____ do.	1,761	98,659	1,546	89,208	1,560	100,845
Clays[2] ____ do.	339	1,549	301	1,571	263	1,524
Gem stones	NA	170	NA	150	NA	200
Peat ____ thousand short tons	11	148	W	W	W	W
Pumice ____ do.	(9)	(9)	(9)	(9)	--	--
Sand and gravel ____ do.	424,258	459,382	419,019	446,731	p18,404	p49,458
Silver ____ thousand troy ounces	W	W	W	W	67	709

See footnotes at end of table.

Table 6.—Nonfuel mineral production[1] in the United States, by State —Continued

Mineral	1979 Quantity	1979 Value (thousands)	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
WASHINGTON—Continued						
Stone:						
Crushed thousand short tons	r15,255	r$35,985	r11,085	rW	9,516	$25,619
Dimension do	4	268	6	$248	15	2,378
Combined value of clays (fire clay), copper (1979 and 1981), diatomite, gold, gypsum, lead (1979-80), lime, olivine, sand and gravel (industrial 1979-80), tungsten (1979 and 1981), and values indicated by symbol W	XX	28,248	XX	r69,454	XX	30,461
Total	XX	225,150	XX	207,362	XX	212,478
WEST VIRGINIA						
Clays[2] thousand short tons	330	592	291	642	220	502
Salt do	1,078	W	W	W	W	W
Sand and gravel[4] do	4,138	18,501	2,728	11,454	p2,700	p11,500
Stone (crushed) do	11,713	37,624	9,766	36,305	7,885	28,399
Combined value of cement, clays (fire clay), lime, sand and gravel (industrial), stone (dimension, 1979), and values indicated by symbol W	XX	61,878	XX	57,885	XX	56,046
Total	XX	118,595	XX	106,286	XX	96,447
WISCONSIN						
Iron ore (usable), thousand long tons, gross weight	736	W	679	W	W	W
Lime thousand short tons	429	19,060	357	17,287	326	17,548
Peat do	11	720	11	535	10	535
Sand and gravel do	32,046	58,576	22,014	r47,571	p20,400	p52,280
Stone:						
Crushed do	23,924	52,804	20,603	49,245	15,189	39,962
Dimension do	54	4,204	45	4,501	40	4,259
Combined value of abrasive stone, cement, clays, lead (1979), zinc (1979), and values indicated by symbol W	XX	44,318	XX	33,151	XX	41,749
Total	XX	179,682	XX	r152,290	XX	156,333
WYOMING						
Clays thousand short tons	3,471	75,096	3,081	71,512	3,855	100,926
Gem stones	NA	200	NA	190	NA	250
Gypsum thousand short tons	366	3,100	312	2,731	299	2,625
Sand and gravel do	5,265	11,419	5,454	12,523	p5,200	p12,400
Stone do	5,013	15,634	4,374	14,835	3,224	9,858
Combined value of cement, feldspar (1979), iron ore, lead (1981), lime, phosphate rock (1979), sand and gravel (industrial, 1979-80), silver (1981), sodium carbonate, and zinc (1981)	XX	484,727	XX	658,755	XX	644,279
Total	XX	590,176	XX	760,546	XX	770,338

eEstimated. pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes certain clays; value included with "Combined value" figure.
[3]Less than 1/2 unit.
[4]Excludes industrial sand and gravel; value included with "Combined value" figure.
[5]Total of items listed.
[6]Excludes certain stones; value included with "Combined value" figure.
[7]Excludes salt in brines; value included with "Combined value" figure.
[8]Excludes talc; value included with "Combined value" figure.
[9]Revised to none.

Table 7.—Mineral production[1] in the islands administered by the United States

(Thousand short tons and thousand dollars)

Area and mineral	1979		1980		1981	
	Quantity	Value	Quantity	Value	Quantity	Value
American Samoa: Stone	3	21	r11	199	6	127
Guam: Stone	669	2,483	529	2,163	332	W
Virgin Islands: Stone	W	2,828	W	W	W	W

rRevised. W Withheld to avoid disclosing company proprietary data.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 8.—Mineral production[1] in the Commonwealth of Puerto Rico

(Thousand short tons and thousand dollars)

Mineral	1979		1980		1981	
	Quantity	Value	Quantity	Value	Quantity	Value
Cement	1,406	70,197	1,482	102,872	1,226	105,420
Clays	260	556	291	677	200	474
Lime	37	3,307	27	4,131	34	3,884
Salt	27	639	--	--	--	--
Sand and gravel	NA	NA	NA	NA	NA	NA
Stone	14,119	59,659	24,046	104,179	20,578	98,263
Total	XX	[2]134,358	XX	[2]211,859	XX	[2]208,041

NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Total does not include value of items not available.

Table 9.—U.S. exports of principal minerals and products, excluding mineral fuels

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
METALS				
Aluminum:				
Ingots, slabs, crude ---- short tons	714,906	$1,107,398	344,161	$526,646
Scrap ---- do	444,681	483,138	241,162	236,204
Plates, sheets, bars, etc ---- do	306,214	715,899	263,672	625,181
Castings and forgings ---- do	7,496	30,626	8,930	40,482
Aluminum sulfate ---- metric tons	11,200	2,476	25,296	3,439
Other aluminum compounds ---- do	48,000	41,200	48,049	37,174
Antimony, metals and alloys, crude ---- short tons	453	1,186	324	908
Bauxite including bauxite concentrate ---- thousand metric tons	28	6,761	41	8,090
Beryllium ---- pounds	58,455	3,867	78,189	3,094
Bismuth, metals and alloys ---- do	128,732	942	78,703	708
Cadmium ---- metric tons	236	464	239	332
Chromium:				
Ore and concentrate:				
Exports ---- thousand short tons	6	1,447	71	5,893
Reexports ---- do	44	8,544	67	9,575
Ferrochromium ---- do	32	22,233	14	10,361
Cobalt ---- thousand pounds	583	14,576	834	16,462
Copper:				
Ore, concentrate, composition metal, unrefined (copper content) ---- metric tons	117,508	226,145	166,293	231,181
Scrap ---- do	61,225	93,059	50,078	70,106
Refined copper and semimanufactures ---- do	105,377	440,967	127,613	517,950
Other copper manufactures ---- do	41,071	94,760	18,451	37,464
Ferroalloys not elsewhere listed:				
Ferrophosphorus ---- short tons	44,692	6,778	7,463	2,031
Ferroalloys, n.e.c ---- do	4,710	10,130	6,358	8,439
Gold:				
Ore and base bullion ---- troy ounces	1,416,634	860,501	1,199,421	570,549
Bullion, refined ---- do	4,702,197	2,787,431	5,237,585	2,501,337
Iron ore ---- thousand long tons	5,689	230,568	5,546	244,685
Iron and steel:				
Pig iron ---- short tons	73,000	8,016	16,274	1,960
Iron and steel products (major):				
Steel mill products ---- do	4,100,718	2,556,619	2,903,863	2,275,267
Other steel products ---- do	407,101	947,094	443,796	1,138,745
Iron and steel scrap:				
Ferrous scrap including rerolling materials, ships, boats, other vessels for scrapping ---- thousand short tons	11,423	1,257,049	6,524	653,118
Lead:				
Ores and concentrates ---- metric tons	27,615	11,118	33,043	18,958
Pigs, bars, anodes, sheets, etc ---- do	164,458	164,835	23,320	25,996
Scrap ---- do	119,651	62,221	59,419	22,388
Magnesium, metal and alloys, scrap, semimanufactured forms, n.e.c ---- short tons	56,761	127,706	34,855	90,853
Manganese:				
Ore and concentrate ---- do	52,537	6,328	65,064	5,132
Ferromanganese ---- do	11,686	7,657	14,925	12,477
Silicomanganese ---- do	6,489	3,468	3,941	2,172
Metal ---- do	12,320	11,460	2,523	3,980
Molybdenum:				
Ore and concentrate (molybdenum content) ---- thousand pounds	68,217	715,431	51,350	406,816
Metals and alloys, crude and scrap ---- do	614	4,870	2,641	9,763
Wire ---- do	705	15,984	543	9,030
Semimanufactured forms, n.e.c ---- do	306	7,471	165	4,768
Powder ---- do	425	4,103	270	2,820
Ferromolybdenum ---- do	1,760	17,104	455	2,983
Compounds ---- do	10,154	89,303	7,328	40,686
Nickel:				
Alloys and scrap including unwrought metal, ingots, bars, sheets, anodes, etc ---- short tons	45,204	285,545	37,671	259,712
Catalysts ---- do	3,530	18,559	3,890	25,601
Nickel-chrome electric resistance wire ---- do	1,087	11,766	660	8,262
Semifabricated forms, n.e.c ---- do	6,854	55,613	4,557	40,093
Platinum-group metals:				
Ore and scrap ---- troy ounces	173,053	68,836	212,426	61,409
Palladium, rhodium, iridium, osmiridium, ruthenium, osmium (metal and alloys including scrap) ---- do	302,457	99,494	259,745	61,136
Platinum (metal and alloy) ---- do	289,454	172,876	391,194	179,344
Rare earths: Ferrocerium and alloys ---- short tons	17	196	11	117
Selenium ---- thousand pounds	180	1,689	133	668
Silicon:				
Ferrosilicon ---- short tons	27,488	18,572	15,768	12,136
Silicon carbide, crude and in grains ---- do	r13,661	r13,264	11,511	11,148
Silver:				
Ore, concentrate, waste, sweepings ---- thousand troy ounces	23,645	582,855	12,772	151,090
Bullion, refined ---- do	57,206	1,326,878	15,131	181,380
Tantalum:				
Ore, metal, other forms ---- thousand pounds	950	65,329	303	20,520
Powder ---- do	251	39,880	97	19,999

See footnotes at end of table.

Table 9.—U.S. exports of principal minerals and products, excluding mineral fuels —Continued

Mineral		1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
METALS —Continued					
Tin:					
Ingots, pigs, bars, etc.:					
Exports	metric tons	595	$10,194	2,361	$31,053
Reexports	do	3,699	62,382	3,719	55,505
Tinplate and ternplate	do	641,401	440,671	345,718	220,993
Titanium:					
Ore and concentrate	short tons	17,830	3,444	7,297	2,099
Unwrought and scrap metal	do	3,757	16,660	3,595	9,506
Intermediate mill shapes and mill products, n.e.c	do	5,123	113,551	6,049	159,454
Pigments and oxides	do	45,795	49,357	62,432	66,402
Tungsten (tungsten content):					
Ore and concentrate	thousand pounds	2,029	15,454	175	1,150
Carbide powder	do	1,440	22,716	1,213	18,158
Alloy powder	do	r1,140	18,308	2,138	32,207
Vanadium:					
Ore and concentrate (vanadium content)	do	92	517	111	575
Pentoxide, etc	do	1,448	2,728	692	2,012
Ferrovanadium	do	1,605	6,995	869	4,397
Zinc:					
Slabs, pigs, or blocks	metric tons	302	664	323	812
Sheets, plates, strips, other forms, n.e.c	do	2,103	3,810	1,500	3,226
Waste, scrap, dust (zinc content)	do	34,054	21,612	35,049	25,452
Semifabricated forms, n.e.c	do	1,289	2,580	1,538	3,230
Ores and concentrates	do	54,457	29,473	54,232	29,280
Zirconium:					
Ore and concentrate	thousand pounds	15,455	2,732	23,260	3,838
Oxide	do	4,778	3,680	1,565	2,254
Metals, alloys, other forms	do	1,388	29,408	1,361	35,015
NONMETALS					
Abrasives:					
Industrial diamond, natural or synthetic:					
Powder or dust	thousand carats	28,534	70,248	28,471	65,777
Other	do	3,569	51,229	2,297	30,978
Diamond grinding wheels	do	730	7,437	694	7,706
Other natural and artificial metallic abrasives and products		NA	r112,286	NA	113,016
Asbestos:					
Exports:					
Unmanufactured	metric tons	r48,219	r20,737	64,126	21,439
Products	do	NA	r141,299	NA	144,531
Reexports:					
Unmanufactured	do	452	330	293	159
Products	do	NA	354	NA	599
Barite:					
Natural barium sulfate and carbonate	short tons	96,819	13,794	62,187	9,947
Boron:					
Boric acid	do	r47,000	23,735	46,184	24,602
Sodium borates, refined	do	324,862	e64,737	227,543	e58,000
Calcium:					
Other calcium compounds including precipitated calcium carbonate	do	25,068	15,589	25,659	11,713
Chloride	do	49,215	9,754	32,794	13,004
Dicalcium phosphate	do	43,314	27,577	55,862	33,434
Cement: Hydraulic and clinker	do	186,404	16,997	302,777	31,564
Clays:					
Kaolin or china clay	thousand short tons	1,392	133,716	1,412	155,999
Bentonite	do	898	62,207	862	64,537
Other	do	924	67,224	877	72,378
Diatomite	do	173	32,238	162	32,933
Feldspar, leucite, nepheline syenite	thousand pounds	25,998	896	28,050	1,110
Fluorspar	short tons	17,865	1,660	11,261	1,194
Gem stones:					
Diamond	thousand carats	1,325	1,041,200	3,215	854,100
Pearls		NA	5,063	NA	5,856
Other		NA	71,460	NA	101,649
Graphite	short tons	8,880	3,695	11,344	4,433
Gypsum:					
Crude, crushed or calcined	thousand short tons	88	11,774	157	14,590
Manufactures, wallboard and plaster articles		NA	15,448	NA	20,844
Helium	million cubic feet	e298	10,629	389	17,084
Lithium hydroxide	thousand pounds	6,681	9,600	6,040	9,542
Lime	short tons	41,843	3,990	28,429	3,996
Magnesium compounds:					
Magnesite, dead-burned	do	56,038	13,279	20,926	4,727
Magnesite, crude, caustic calcined, lump or ground	do	51,703	17,692	36,683	14,559
Mica:					
Sheet, waste, scrap, ground	do	14,462	4,200	10,920	3,437
Manufactured	pounds	NA	r7,665	NA	7,000

See footnotes at end of table.

Table 9.—U.S. exports of principal minerals and products, excluding mineral fuels —Continued

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
NONMETALS —Continued				
Mineral-earth pigments, iron oxide, natural and synthetic ---- short tons	5,046	$9,132	4,967	$11,704
Nitrogen compounds (major) ---- thousand short tons	11,121	1,842,383	8,371	1,397,786
Phosphate rock ---- thousand metric tons	14,320	508,524	10,554	419,999
Phosphatic fertilizers:				
Superphosphates ---- do	34,412	287,366	22,097	245,341
Ammonium phosphates ---- do	4,995	1,095,944	3,942	789,770
Elemental phosphorus ---- metric tons	30,443	45,631	27,929	42,723
Mixed chemical fertilizers ---- thousand metric tons	NA	NA	NA	NA
Pigments and compounds: Zinc oxide (metal content) ---- do	(1)	344	1	1,112
Potash:				
Potassium chloride ---- metric tons	r1,161,640	r131,180	700,420	80,678
Potassium sulfate ---- do	r140,000	r23,113	79,600	16,095
Pumice and pumicite ---- short tons	e1,000	NA	e1,000	NA
Quartz, crystal, natural ---- thousand pounds	91	366	e127	e490
Salt:				
Crude and refined ---- thousand short tons	831	r12,829	1,043	18,070
Shipments to noncontiguous territories ---- do	22	4,296	71	9,145
Sand and gravel:				
Construction:				
Sand ---- do	587	6,661	613	6,298
Gravel ---- do	687	1,480	652	2,454
Industrial: Sand ---- do	1,177	32,519	1,132	27,984
Sodium compounds:				
Sodium sulfate ---- do	129	12,740	124	12,980
Sodium carbonate ---- do	1,094	121,945	1,051	121,107
Stone:				
Crushed ---- do	3,084	21,239	3,598	25,949
Dimension ---- do	176	r15,170	227	17,867
Sulfur: Crude ---- thousand metric tons	1,673	185,866	1,392	187,407
Talc, crude and ground ---- thousand short tons	275	14,963	311	15,095
Total ----	XX	r23,290,651	XX	17,581,927

eEstimated. rRevised. NA Not available. XX Not applicable.
1Less than 1/2 unit.

Table 10.—U.S. imports for consumption of principal minerals and products, excluding mineral fuels

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
METALS				
Aluminum:				
Metal, short tons	580,515	$777,606	710,656	$990,869
Scrap, do	59,802	59,718	81,994	79,141
Plates, sheets, bars, etc, do	72,723	152,136	142,512	308,677
Aluminum oxide (alumina), metric tons	4,358,000	782,902	3,978,000	837,932
Antimony:				
Ore and concentrate (antimony content), short tons	5,235	11,646	5,168	9,095
Sulfide including needle or liquated, do	34	216	106	249
Metal, do	2,590	7,277	2,631	6,569
Oxide, do	12,224	15,771	12,170	19,922
Arsenic:				
White (As_2O_3 content), do	12,528	7,352	18,958	13,126
Metallic, do	266	1,524	323	2,079
Bauxite, crude, thousand metric tons	14,087	NA	12,802	NA
Beryllium ore, short tons	1,703	1,168	2,138	2,002
Bismuth, metal and alloys, gross weight, pounds	2,217,359	5,364	2,436,249	4,883
Cadmium: Metal, metric tons	2,617	14,181	p3,090	p13,369
Calcium:				
Metal, pounds	227,814	582	235,436	751
Chloride, short tons	46,439	2,071	86,865	4,088
Cesium compounds, pounds	r11,822	619	24,415	1,049
Chromium:				
Ore and concentrate (Cr_2O_3 content), thousand short tons	410	56,525	368	49,948
Ferrochromium (gross weight), do	297	153,487	428	213,611
Ferrochromium-silicon, do	5	r2,313	11	6,000
Metal, do	4	r28,369	4	24,626
Cobalt:				
Metal, thousand pounds	14,992	358,583	13,906	238,820
Oxide (gross weight), do	414	7,630	444	5,375
Salts and compounds (gross weight), do	655	r3,572	1,249	4,969
Columbium ore, do	4,595	20,289	1,882	10,102
Copper (copper content):				
Ore and concentrate, metric tons	r52,360	72,636	39,132	56,548
Matte, do	392	719	2,718	3,232
Blister, do	44,537	86,284	30,124	68,083
Refined in ingots, etc, do	426,948	935,262	330,625	582,085
Scrap, do	22,769	40,865	27,002	40,705
Ferroalloys not elsewhere listed, includes spiegeleisen, short tons	r8,933	r36,390	7,055	38,730
Gallium, kilograms	6,175	2,637	5,536	2,472
Germanium, do	3,329	3,004	22,350	12,328
Gold:				
Ore and base bullion, troy ounces	451,509	243,230	487,675	214,927
Bullion, do	4,090,488	2,506,889	4,164,476	1,942,560
Hafnium, pounds	600	32	5,310	126
Indium, thousand troy ounces	299	5,103	461	3,152
Iron ore, thousand long tons	25,058	772,844	28,328	947,977
Iron and steel:				
Pig iron, short tons	400,031	63,036	468,125	71,013
Iron and steel products (major):				
Steel mill products, do	15,495,075	6,887,462	19,898,371	10,247,660
Other products, do	753,181	825,702	822,396	954,618
Scrap including tinplate, thousand short tons	582	61,192	556	62,126
Lead:				
Ore, flue dust, matte (lead content), metric tons	29,615	23,927	27,206	20,196
Base bullion (lead content), do	296	509	449	340
Pigs and bars (lead content), do	81,300	87,629	100,108	87,026
Reclaimed scrap, etc. (lead content), do	2,868	2,905	2,661	2,220
Sheet, pipe, shot, do	950	1,508	474	726
Magnesium:				
Metallic and scrap, short tons	3,324	5,048	6,122	10,182
Alloys (magnesium content), do	344	1,770	625	2,652
Sheets, tubing, ribbons, wire, other forms (magnesium content), do	89	1,443	150	4,804
Manganese:				
Ore (35% or more contained manganese), do	697,516	46,413	639,141	42,643
Ferromanganese, do	605,703	211,365	671,178	226,618
Ferrosilicon-manganese (manganese content), do	74,975	29,291	129,005	49,754
Metal, do	7,915	r8,032	8,343	8,419
Mercury:				
Compounds, pounds	32,371	222	37,258	273
Metal, 76-pound flasks	9,416	2,841	12,408	5,005

See footnotes at end of table.

Table 10.—U.S. imports for consumption of principal minerals and products, excluding mineral fuels —Continued

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
METALS —Continued				
Molybdenum:				
Ore and concentrate (molybdenum content) thousand pounds	1,825	$10,475	1,988	$9,911
Waste and scrap (gross weight) do	373	7,246	NA	2,674
Metal:				
Unwrought (molybdenum content) do	163	2,637	153	2,893
Wrought (gross weight) do	137	4,031	93	2,557
Ferromolybdenum (gross weight) do	45	243	1,175	6,353
Material in chief value molybdenum (molybdenum content) do	1,953	18,701	1,651	9,574
Compounds do	4,431	27,034	5,164	18,052
Nickel:				
Ore short tons	1,124	13	513	42
Pigs, ingots, shot, cathodes do	116,193	708,693	123,141	747,920
Plates, bars, etc do	5,831	54,947	3,864	36,897
Slurry do	77,459	208,742	94,796	223,060
Scrap do	3,572	18,481	5,226	17,496
Powder and flakes do	15,244	98,666	14,124	93,325
Ferronickel do	51,741	104,156	69,853	119,321
Oxide do	4,182	21,753	4,330	21,779
Platinum-group metals:				
Unwrought:				
Grains and nuggets (platinum) troy ounces	15,427	6,768	1,891	862
Sponge (platinum) do	1,191,803	560,642	888,995	424,780
Sweepings, waste, scrap do	376,500	76,543	235,379	58,462
Iridium do	26,090	12,974	11,110	6,203
Palladium do	1,202,342	252,075	1,114,313	142,180
Rhodium do	109,591	84,421	73,738	45,847
Ruthenium do	98,488	4,220	180,438	6,833
Other platinum-group metals do	122,454	105,559	44,337	16,455
Semimanufactured:				
Platinum do	230,344	130,537	179,321	83,972
Palladium do	114,246	23,256	116,548	13,717
Rhodium do	686	594	1,733	657
Other platinum-group metals do	13,811	2,834	1,814	288
Rare-earth metals:				
Ferrocerium and other cerium alloys short tons	72	902	92	1,249
Monazite do	r5,675	1,850	8,233	3,158
Metals including scandium and yttrium pounds	r8,468	307	3,750	168
Rhenium:				
Metal including scrap do	513	668	580	574
Ammonium perrhenate do	4,991	7,889	9,089	3,297
Selenium and selenium compounds do	625,472	7,966	686,887	7,766
Silicon:				
Metal (over 96% silicon content) short tons	21,839	53,117	29,636	58,034
Ferrosilicon do	71,152	42,640	155,648	80,317
Silver:				
Ore and base bullion thousand troy ounces	9,700	187,019	9,769	100,422
Bullion do	r64,762	1,331,877	75,921	837,174
Sweepings, waste, doré do	4,237	87,114	8,425	90,853
Tantalum ore thousand pounds	2,510	78,829	1,952	57,726
Tellurium pounds	64,860	1,629	83,671	1,811
Thallium do	176	14	882	87
Tin:				
Concentrate (tin content) metric tons	840	11,089	232	2,975
Dross, skimmings, scrap, residue, tin alloys, n.s.p.f. do	1,312	4,215	2,583	3,387
Tinfoil, powder, flitters, etc	NA	9,154	NA	8,666
Tin scrap and other tin-bearing material excluding tinplate scrap	NA	13,819	NA	16,357
Tin compounds metric tons	171	2,285	170	2,098
Titanium:[1]				
Ilmenite short tons	552,482	27,088	505,042	36,215
Rutile do	281,605	62,619	202,373	59,024
Metal do	10,052	108,777	11,637	139,801
Ferrotitanium and ferrosilicon titanium do	623	1,679	615	1,582
Pigments do	97,590	91,986	124,906	127,396
Tungsten ore and concentrate (tungsten content) thousand pounds	11,372	87,129	11,752	91,195
Vanadium (vanadium content):				
Ferrovanadium do	525	3,477	1,968	13,288
Vanadium pentoxide do	1,711	8,364	669	3,344
Vanadium-bearing materials do	3,572	9,535	4,870	11,751

See footnotes at end of table.

Table 10.—U.S. imports for consumption of principal minerals and products, excluding mineral fuels —Continued

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
METALS —Continued				
Zinc:				
Ore (zinc content) metric tons	182,370	$74,033	245,710	$110,253
Blocks, pigs, slabs do	410,163	319,288	612,007	549,326
Sheets, etc do	1,342	1,041	332	472
Fume (zinc content) do	25	7	184	61
Waste and scrap do	3,470	1,361	5,782	2,578
Dross, skimmings do	4,062	1,732	7,629	4,090
Dust, powder, flakes do	3,928	3,672	7,993	9,519
Manufactures	NA	254	NA	438
Zirconium:				
Ore including zirconium sand short tons	113,784	10,595	91,108	8,378
Metal, scrap, compounds do	1,934	25,026	1,647	22,122
NONMETALS				
Abrasives:				
Diamond (industrial) thousand carats	21,848	110,566	20,404	110,510
Other	NA	r158,276	NA	188,667
Asbestos metric tons	327,296	91,809	337,618	103,893
Barite:				
Crude and ground thousand short tons	1,854	102,401	1,946	108,599
Witherite short tons	22,207	736	99	87
Chemicals do	25,097	10,623	22,309	11,938
Boron:				
Boric acid do	9,938	6,393	1,124	763
Calcium borate, crude do	r69,400	6,218	98,100	15,202
Cement: Hydraulic and clinker thousand short tons	5,263	195,573	3,997	151,240
Clays short tons	34,052	6,688	33,314	7,895
Cryolite do	17,086	9,442	7,188	4,679
Feldspar:				
Crude do	232	112	108	44
Ground and crushed do	172	21	98	18
Fluorspar do	899,219	94,103	826,783	104,938
Gem stones:				
Diamond thousand carats	4,161	2,251,195	4,407	2,201,262
Emeralds do	3,601	141,413	2,298	131,560
Other	NA	r342,123	NA	433,428
Graphite short tons	61,318	15,765	68,708	23,998
Gypsum:				
Crude, ground, calcined thousand short tons	7,367	35,895	7,595	39,605
Manufactures	NA	15,985	NA	12,115
Iodine, crude thousand pounds	6,234	28,848	6,099	36,231
Lime:				
Hydrated short tons	62,423	3,129	65,717	3,471
Other do	417,792	16,044	438,623	18,092
Lithium:				
Ore do	r3,893	r460	e4,000	NA
Compounds do	62	r1,841	280	1,845
Magnesium compounds:				
Crude magnesite do	46	20	12	2
Lump, ground, caustic-calcined magnesia do	12,406	2,122	12,065	2,177
Refractory magnesia, dead-burned, fused magnesite, dead-burned dolomite do	72,719	16,830	76,810	23,114
Compounds do	36,124	5,907	35,382	6,241
Mica:				
Uncut sheet and punch thousand pounds	11,877	3,305	11,558	2,747
Scrap do	73	7	352	23
Manufactures do	831	3,487	664	3,059
Mineral-earth pigments, iron oxide pigments:				
Ocher, crude and refined short tons	1	1	150	80
Siennas, crude and refined do	244	116	98	42
Umber, crude and refined do	4,434	686	5,919	944
Vandyke brown do	687	260	1,070	340
Other natural and refined do	817	298	971	970
Synthetic do	33,262	18,674	31,453	16,539
Nepheline syenite:				
Crude do	6,760	71	2,780	25
Ground, crushed, etc do	497,580	11,193	503,320	11,504
Nitrogen compounds (major) including urea thousand short tons	5,110	583,808	4,844	610,574
Peat:				
Fertilizer-grade short tons	344,363	r38,223	291,732	37,955
Poultry- and stable-grade do	57,204	r5,997	50,198	6,845
Phosphate, crude thousand metric tons	486	12,856	13	420
Phosphatic materials:				
Fertilizer and fertilizer materials thousand metric tons	32	5,737	16	3,112
Ammonium phosphates used as fertilizers do	294	53,053	--	--
Elemental phosphorus do	(2)	928	(2)	1,247
Other do	77	16,630	92	15,509

See footnotes at end of table.

Table 10.—U.S. imports for consumption of principal minerals and products, excluding mineral fuels —Continued

Mineral	1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)
NONMETALS —Continued				
Pigments and salts:				
Lead pigments and compounds ____ metric tons	12,934	$15,225	15,186	$15,233
Zinc pigments and compounds ____ do ____	38,628	30,062	38,615	33,501
Potash ____ do ____	8,193,000	648,000	7,903,300	750,400
Pumice:				
Crude or unmanufactured ____ short tons	4,618	133	2,954	70
Wholly or partly manufactured ____ do ____	r189,700	r1,085	89,329	601
Manufactured, n.s.p.f ____	NA	92	NA	126
Quartz crystal (Brazilian pebble) ____ thousand pounds	816	402	389	233
Salt ____ thousand short tons	5,263	44,071	4,974	49,157
Sand and gravel:				
Industrial sand ____ do ____	39	1,575	5	621
Other sand and gravel ____ do ____	502	1,143	333	1,987
Sodium compounds:				
Sodium bicarbonate ____ do ____	2	425	3	680
Sodium carbonate ____ do ____	18	2,389	12	1,625
Sodium sulfate ____ do ____	230	13,242	275	19,135
Stone:				
Crushed ____ do ____	r3,590	r10,576	3,355	9,300
Dimension ____ do ____	NA	88,948	NA	131,416
Calcium carbonate fines ____ do ____	294	3,248	270	4,577
Strontium:				
Mineral ____ short tons	38,646	2,147	49,699	3,206
Compounds ____ do ____	2,932	1,888	4,627	3,400
Sulfur and compounds, sulfur ore and other forms, n.e.s ____ thousand metric tons	2,523	138,852	2,522	209,766
Talc, unmanufactured ____ thousand short tons	21	3,720	27	4,562
Total ____	XX	r26,096,469	XX	28,828,659

eEstimated. pPreliminary. rRevised. NA Not available. XX Not applicable.
[1]Includes titanium slag averaging about 70% TiO_2. For detail, see Titanium chapter.
[2]Less than 1/2 unit.

Table 11.—Comparison of world and U.S. production of selected nonfuel mineral commodities

(Thousand short tons unless otherwise specified)

Mineral	1980			1981[p]		
	World production[1]	U.S. production	U.S. percent of world production	World production[1]	U.S. production	U.S. percent of world production
METALS, MINE BASIS						
Antimony (content of ore and concentrate) short tons	71,727	343	(2)	65,246	646	1
Arsenic, white[3] do	31,666	W	NA	31,651	W	NA
Bauxite[4] thousand metric tons	88,786	1,559	2	85,729	1,510	2
Beryl[3] short tons	2,767	W	NA	2,903	W	NA
Bismuth thousand pounds	7,162	W	NA	7,159	W	NA
Chromite	10,746	--	--	10,225	--	--
Cobalt (content of ore and concentrate) short tons	33,738	--	--	34,449	--	--
Columbium-tantalum concentrate (gross weight) thousand pounds	81,071	NA	NA	84,958	NA	NA
Copper (content of ore and concentrate) thousand metric tons	7,656	1,181	15	8,171	1,538	19
Gold (content of ore and concentrate) thousand troy ounces	39,141	970	2	40,785	1,378	3
Iron ore (gross weight) thousand long tons	881,720	69,613	8	847,184	73,174	9
Lead (content of ore and concentrate) thousand metric tons	3,428	550	16	3,353	446	13
Manganese ore (35% or more Mn, gross weight)	29,091	--	--	25,985	--	--
Mercury thousand 76-pound flasks	204	31	15	207	28	14
Molybdenum (content of ore and concentrate) thousand pounds	241,745	150,686	62	240,387	139,900	58
Nickel (content of ore and concentrate)	821	15	2	772	12	2
Platinum-group metals[3] thousand troy ounces	6,836	3	(2)	6,823	6	(2)
Silver (content of ore and concentrate) do	339,800	32,329	10	364,912	40,685	11
Tin (content of ore and concentrate) metric tons	246,493	W	NA	252,509	W	NA
Titanium concentrates (gross weight):						
Ilmenite	4,019	549	14	3,979	509	13
Rutile	460	W	NA	398	W	NA
Tungsten concentrate (contained tungsten) thousand pounds	114,059	6,072	5	108,351	7,948	7
Vanadium (content of ore and concentrate) short tons	38,281	4,806	13	38,933	5,126	13
Zinc (content of ore and concentrate) thousand metric tons	5,775	317	5	5,841	312	5
METALS, SMELTER BASIS						
Aluminum (primary only)	17,006	5,130	30	16,613	4,948	30
Cadmium metric tons	18,130	1,578	9	17,721	1,603	9
Cobalt short tons	33,227	500	2	31,278	447	1
Copper smelter (primary and secondary)[5] thousand metric tons	7,939	1,053	13	8,325	1,378	17
Iron, pig	562,534	68,699	12	552,037	73,755	13
Lead, smelter (primary and secondary)[6] thousand metric tons	5,134	1,223	24	4,981	1,136	23
Magnesium (primary only)	350	169	48	328	143	44
Nickel[7]	806	44	5	770	49	6
Selenium[8] thousand pounds	3,018	311	10	2,954	555	19
Steel, raw	787,477	[9]111,835	14	776,398	[9]119,912	15
Tellurium[8] thousand pounds	321	W	NA	279	W	NA
Tin metric tons	250,099	[10]3,000	1	242,097	[10]2,000	1
Zinc (primary and secondary) thousand metric tons	6,057	370	6	6,140	393	6
NONMETALS						
Asbestos do	4,887	80	2	4,726	76	2
Barite	8,069	[11]2,245	28	8,715	[11]2,849	33
Boron minerals	3,091	1,545	50	3,252	1,481	46
Bromine thousand pounds	760,569	[11]378,100	50	760,597	[11]378,200	50
Cement, hydraulic	974,825	[12]76,709	8	978,919	[12]72,932	7
Clays:						
Bentonite[8]	6,669	[11]4,185	63	7,443	[11]4,947	66
Fuller's earth[8]	1,941	[11]1,534	79	1,998	[11]1,656	83
Kaolin[3]	25,941	[11]7,879	30	25,452	[11]7,660	30
Corundum	32	--	--	32	--	--
Diamond thousand carats	42,107	--	--	39,121	--	--

See footnotes at end of table.

Table 11.—Comparison of world and U.S. production of selected nonfuel mineral commodities —Continued

(Thousand short tons unless otherwise specified)

Mineral	1980			1981[p]		
	World production[1]	U.S. production	U.S. percent of world production	World production[1]	U.S. production	U.S. percent of world production
NONMETALS —Continued						
Diatomite	1,645	[11]689	42	1,638	[11]687	42
Feldspar[3]	3,480	710	20	3,444	665	19
Fluorspar	5,436	93	2	5,508	115	2
Graphite	654	--	--	655	--	--
Gypsum	86,310	12,376	14	84,982	11,497	14
Iodine, crude thousand pounds	25,521	W	NA	26,517	W	NA
Lime (sold or used)	130,779	[12]19,037	15	128,908	[12]18,890	15
Magnesite	12,489	W	NA	12,272	W	NA
Mica (including scrap and ground[8]) thousand pounds	[13]730,840	[13]454,000	62	[13]772,976	[13]500,000	65
Nitrogen, N content of ammonia	78,673	16,244	21	78,778	15,648	20
Peat	224,711	785	([2])	224,959	686	([2])
Perlite	1,628	[11]638	39	1,585	[11]591	37
Phosphate rock thousand metric tons	138,333	54,415	39	138,630	53,624	39
Potash (K_2O equivalent) do	27,673	2,239	8	27,357	2,156	8
Pumice[8 14]	14,021	[11]543	4	14,084	[11]499	4
Salt	185,788	[11 12]40,378	22	183,106	[11 12]38,915	21
Sodium compounds, natural and manufactured:						
Sodium carbonate	31,442	8,275	26	31,214	8,281	27
Sodium sulfate	4,791	1,139	24	4,848	1,143	24
Strontium[8] short tons	94,560	--	--	93,665	--	--
Sulfur, all forms thousand metric tons	56,635	11,866	21	55,669	12,145	22
Talc and pyrophyllite	7,428	1,240	17	7,292	1,343	18
Vermiculite[8]	588	337	57	576	320	56

[p]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.

[1]For those commodities for which U.S. data are withheld to avoid disclosing company proprietary data, the world total excludes U.S. output and the U.S. percent of world production cannot be reported.

[2]Less than 0.5%.

[3]World total does not include an estimate for output in China.

[4]U.S. figures represent dried bauxite equivalent of crude ore; to the extent possible, individual country figures that are included in the world total are also on the dried bauxite equivalent basis, but for some countries, available data are insufficient to permit this adjustment.

[5]Primary and secondary blister and anode copper, including electrowon refined copper that is not included as blister or anode.

[6]Includes bullion.

[7]Refined nickel plus nickel content of ferronickel, and nickel oxide.

[8]World total does not include estimates for output in the U.S.S.R. or China.

[9]Data from American Iron and Steel Institute. Excludes production of castings by companies that do not report steel ingot.

[10]Includes tin content of alloys made directly from ore.

[11]Quantity sold or used by producers.

[12]Includes Puerto Rico.

[13]Excludes sericite mica.

[14]Excludes volcanic cinder (included in previous editions).

The Mineral Industry of Alabama

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey of Alabama for collecting information on all nonfuel minerals.

By James R. Boyle[1] and Ernest A. Mancini[2]

The value of Alabama's nonfuel mineral production in 1981 was $312.7 million, a decrease of $15.7 million from that of 1980. Output of most nonfuel minerals declined; cement, crushed stone, lime, clays, and sand and gravel were the major commodities produced in the State.

Alabama led the Nation in the production of crushed marble; was second in bauxite; third in native asphalt, kaolin, and oyster shell; fourth in bentonite, dimension marble, and fire clay; fifth in masonry cement; and sixth in common clay, ferroalloys, and lime.

Trends and Developments.—The State's economy was dependent upon exporting goods to other regions; therefore, a national recession had a profound impact on the State's economy and mineral industry. A 2-year slump in the State's manufacturing and construction industries left Alabama with one of the highest unemployment rates in the Southeast, 12.5% by yearend. Although there was no basic change in mining employment from 1980 to 1981, layoffs of 1,000 in the stone and clay industries and 2,500 in the primary metals industry reflected the downturn in these industries. Other mineral industries supplying raw or finished materials to these industries experienced periodic reductions in sales during the year.

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

Mineral	1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry thousand short tons	242	$13,012	193	$10,721
Portland do	2,491	108,438	2,270	89,216
Clays[2] do	2,022	29,832	1,910	25,406
Gem stones	NA	1	NA	1
Lime thousand short tons	1,128	53,685	1,219	59,454
Sand and gravel do	r11,076	r25,504	p10,382	p23,064
Stone:				
Crushed do	23,433	82,270	20,706	88,377
Dimension do	11	2,259	7	2,130
Combined value of asphalt (native), bauxite, clays (bentonite), mica (crude, 1980), phosphate rock, and salt	XX	13,373	XX	14,288
Total	XX	r328,374	XX	312,657

pPreliminary. rRevised. NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes bentonite; value included with "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Autauga	W	W	Sand and gravel.
Baldwin	W	W	Clays.
Barbour	W	W	Clays, bauxite.
Bibb	W	W	Stone, clays, sand and gravel.
Blount	W	W	Cement, stone.
Calhoun	W	W	Stone, clays, sand and gravel.
Cherokee	$175	$153	Sand and gravel.
Chilton	W	W	Sand and gravel, clays.
Clarke	942	W	Sand and gravel.
Clay	16	14	Do.
Coffee	135	89	Do.
Colbert	W	W	Stone, native asphalt, sand and gravel.
Conecuh	W	W	Sand and gravel.
Coosa	--	1,048	Stone.
Crenshaw	W	71	Sand and gravel.
Dale	W	W	Do.
Dallas	2,288	1,576	Sand and gravel, clays.
De Kalb	862	848	Stone.
Elmore	1,994	W	Sand and gravel, clays.
Escambia	W	466	Sand and gravel.
Etowah	W	W	Stone, sand and gravel.
Fayette	W	W	Sand and gravel.
Franklin	W	W	Stone, sand and gravel.
Geneva	417	366	Sand and gravel.
Greene	W	W	Do.
Hale	233	45	Do.
Henry	W	W	Clays, bauxite.
Houston	W	--	
Jackson	W	W	Stone.
Jefferson	W	W	Cement, stone, clays.
Lamar	W	W	Sand and gravel.
Lawrence	638	571	Stone.
Lee	W	W	Do.
Limestone	W	W	Phosphate rock.
Lowndes	W	W	Clays, sand and gravel.
Macon	2,287	1,950	Sand and gravel.
Madison	W	W	Stone, sand and gravel, clays.
Marengo	W	W	Cement, stone.
Marion	361	359	Sand and gravel, clays.
Marshall	W	W	Stone, clays.
Mobile	W	W	Cement, stone, sand and gravel, clays.
Monroe	164	185	Sand and gravel, stone.
Montgomery	W	W	Sand and gravel, clays.
Morgan	2,082	W	Stone.
Randolph	W	W	Mica.
Russell	W	W	Sand and gravel, clays.
St. Clair	W	W	Cement, clays, stone, sand and gravel.
Shelby	W	101,739	Lime, cement, stone, clays.
Sumter	W	W	Clays, sand and gravel.
Talladega	W	15,029	Stone.
Tuscaloosa	1,137	W	Sand and gravel.
Walker	--	W	Clays.
Washington	W	W	Salt, stone, sand and gravel.
Wilcox	64	213	Stone.
Undistributed[2]	322,573	203,650	
Total[3]	336,367	328,374	

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: Bullock, Butler, Chambers, Choctaw, Cleburne, Covington, Cullman, Lauderdale, Perry, Pickens, Pike, Tallapoosa, and Winston.

[2]Includes 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.

The Alabama State Docks at the Port of Mobile handled over 23 million tons of material during fiscal year 1981. Bulk material shipments comprised the major activity at the facility, with iron ore and bauxite two of the major materials handled. These ores were vital to the operation of many heavy industries in the State. Imports of most raw materials were less than that of 1980 because of adverse economic conditions.

Major imports through the State Dock facilities included iron ore (1,333,520 tons), bauxite (1,011,414 tons), manganese ore (106,700 tons), and ilmenite (117,462 tons). Other minerals handled included oyster shell, gypsum, sand, gravel, clays, and cement. In addition to direct handling of raw materials, port tonnage through private facilities included 2,409,521 tons, mostly iron ore.

Table 3.—Indicators of Alabama business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	1,637.1	1,639.5	+0.1
Unemployment	do.	139.9	198.8	+42.1
Employment (nonagricultural):				
Mining[1]	do.	16.9	15.4	-8.9
Manufacturing	do.	362.0	362.2	+.1
Contract construction	do.	72.1	66.2	-8.2
Transportation and public utilities	do.	71.5	71.7	+.3
Wholesale and retail trade	do.	273.3	271.4	-.7
Finance, insurance, real estate	do.	58.6	59.3	+1.2
Services	do.	204.4	210.9	+3.2
Government	do.	299.5	292.7	-2.3
Total nonagricultural employment[1]	do.	1,358.3	1,349.8	-.6
Personal income:				
Total	millions	$28,988	$32,122	+10.8
Per capita		$7,434	$8,200	+10.3
Construction activity:				
Number of private and public residential units authorized		16,719	11,298	-32.4
Value of nonresidential construction	millions	$386.9	$371.6	-4.0
Value of State road contract awards	do.	$230.0	$260.0	+13.0
Shipments of portland and masonry cement to and within the State	thousand short tons	1,226	1,064	-13.2
Nonfuel mineral production value:				
Total crude mineral value	millions	$328.4	$312.7	-4.8
Value per capita, resident population		$84	$80	-4.8
Value per square mile		$6,368	$6,058	-4.9

[p]Preliminary.
[1]Includes bituminous coal and oil and gas extraction.

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

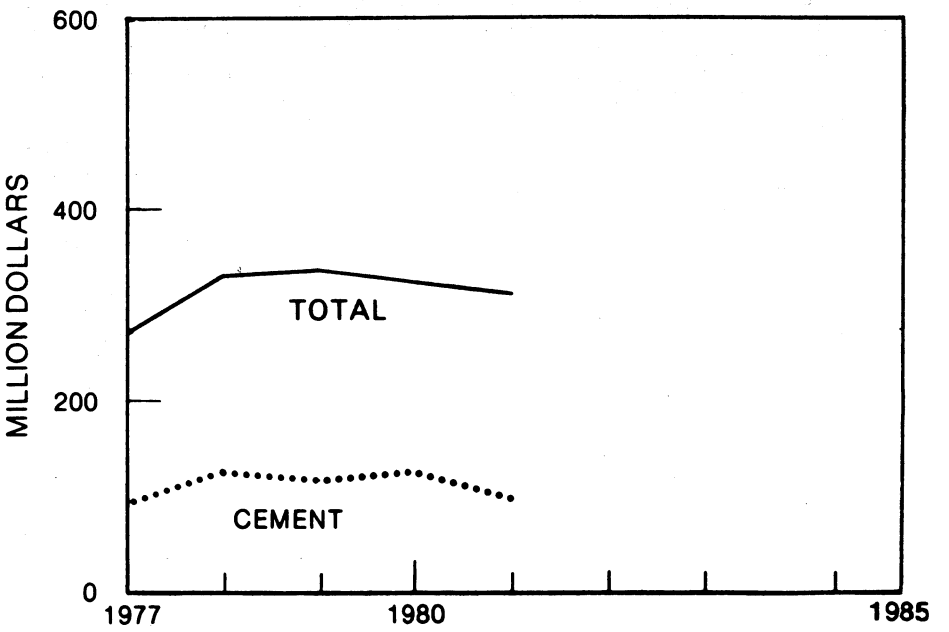

Figure 1.—Value of cement and total value of nonfuel mineral production in Alabama.

The Dock's bulk-materials handling plant has been under a major renovation program for more than 4 years. A second 1,500-ton-per-hour unloading tower was installed during the year. Total cost of the overall modernization program was $26.3 million.

Construction continued on the Tennessee-Tombigbee Waterway that will connect the Tennessee River to the gulf via Mobile. Crushed stone and sand and gravel operations along the waterway have operated at full capacity to meet the construction demands. By the end of 1981, however, some of these operators were reducing output because of completion of their construction commitments. With reduced demand because of economic conditions, some operators were forced to shut down. Projections indicated that the waterway, when completed in 1986, should open up markets for nonfuel mineral producers in the area by providing a relatively inexpensive transportation system for their material.

Although economic conditions in 1981 were unfavorable for many of the State's mineral producers, a significant number of companies, expecting an economic recovery, announced plans to construct new or expand existing facilities. The Alabama Development Office (ADO), in its 1981 report on new and expanding industries, announced 118 expansions, totaling over $1.0 billion in mineral-related fields, as follows: mining and quarrying of nonmetallic minerals, 12 expansions, with a total investment of $8.1 million; stone, clay, glass, and concrete products, 45 expansions, with a total investment of $17.3 million; and primary metals, 61 expansions, with a total investment of $980.3 million. The number of expansions was lower than that of 1980 (164 expansions), but the total value was much greater, primarily because of the United States Steel Corp.'s seamless tube steel pipe plant ($650 million) and other expansions at its Fairfield works ($211 million).

United States Steel started construction of its $650 million seamless pipe mill at the Fairfield works. The mill, with a capacity of 600,000 tons of pipe per year, is expected to be completed in late 1983 and will have twice the capacity of any other single mill of United States Steel. Products will include tubing, drill pipe, and casing, along with standard and line pipe. Steel from Fairfield's bottom-blown basic oxygen process (Q-BOP) will be utilized. Rust Engineering, Birmingham, will handle the engineering aspects with J. M. Foster and Correct Piping Co. of Gary, Ind., and Sargent Electric Co. of Pittsburgh, Pa., handling the main construction. Continuous-casting equipment will be supplied by Concast, Inc. Construction of the facility is expected to improve the financial outlook for the Fairfield works, which reportedly has lost $378 million in the last 3 years.

During the year, United States Steel operated only one blast furnace at its Fairfield works. Early in the year, the 4,000-ton-per-day No. 8 furnace was in operation, but by yearend, the smaller No. 7 furnace came onstream with No. 8 shutting down. With reduced orders for steel, the smaller No. 7 furnace kept inventories more in line with demand. Republic Steel Corp., Gadsden, also experienced a reduction in orders and reduced output.

Dayton Malleable, Inc., Attalla, began a $1.5 million expansion program, which will include melting, molding, heat treating, and finishing equipment. Along with an expected wider range of gray iron products, the expansion, when completed in 1982, was expected to increase productivity and product quality. Dayton Malleable was reportedly the largest independent foundry operation in the Nation, with nine divisions producing rough and semifinished carload products.

Southern Ductile Casting Corp. announced a $2.4 million expansion program at its Bessemer facility. The new 30,000-square-foot addition was to include a 35-ton electric holding furnace and was to increase capacity by 60% to 14,000 tons of ductile iron castings per year. The program was expected to be financed through the Industrial Development Board.

Foseco Minsep Ltd. purchased Muscle Shoals Minerals Co., Barton, in northwest Alabama for approximately $4 million. Muscle Shoals Minerals, established in 1955, produced fused magnesia, which was used as an insulator in heating elements.

At least two companies expressed interest in the low-grade tin deposits in Coosa County in southeastern Alabama. Billiton International Metals, a subsidiary of Royal Dutch/Shell, reportedly acquired land in the area. Callahan Mining Co., Phoenix, Ariz., attempted to lease substantial acreage with little success. The mineral cassiterite, associated with pegmatite and quartz veins, occurs in an area 15 miles long and several miles wide. According to published reports, the ore is approximately 0.56% tin oxide by weight.

Legislation and Government Programs.—In fiscal year 1981, the U.S. Bu-

reau of Mines had several contracts in the State. Wyle Laboratories, Huntsville, had several involving noise control, proposed machine redesign concepts, and belt-cleaning systems. Jim Walter Resources had a contract on methane control in an advancing section of an underground coal mine. The Bureau's Tuscaloosa Research Center was involved in several mineral-related projects in Alabama. Among them were (1) subsidence determination in Graysville, (2) accessory minerals in red iron ore, (3) evaluation of saprolite samples, (4) clay testing, and (5) testing of under clays associated with coal seams. Other Bureau studies included in-seam seismic techniques testing, gas determination of coal samples, and continuation of degasification studies.

Apparent consumption of industrial explosives and blasting agents in the State in quarrying and nonmetal mining was 7.9 million pounds in 1981. Of that total, the top two types, unprocessed ammonium nitrate and water gels and slurries, accounted for 81% of the explosives used.

The Mineral Resources Institute of the University of Alabama conducted research in mineral exploration, mining, processing, utilization, and conservation. Nonfuel research was conducted on recovery of graphite, mica, vanadium, and trace elements from graphite ores from Clay County and the effects of surface mine blasting on underground mines. Reports were prepared on flotation of iron ore and phosphorus removal from iron ore. The Institute also conducted short courses on mineral-related subjects.

The Geological Survey of Alabama conducted investigations and published 16 major reports and maps. Nine open-file reports, principally on ecological topics, water use, and water resources, were released. Emphases were mainly on oil and gas development, coal mapping, and other energy-related projects, but significant activity was conducted in the nonfuel mineral area. The Geologic Div. conducted work on the subsurface Jurassic section and several projects related to energy resources. The Mineral Resources Div. continued work on the seismotectonic study of the New Madrid fault area of northwest Alabama and on the computerization of mineral resource data for the U.S. Geological Survey. Work began on assessment of the gibbsite content of selected lateritic soils and investigation of subsidence in Jefferson County. The Water Resources Div.'s major program emphases were on (1) ground water investigations including an evaluation of aquifers along the Tennessee-Tombigbee corridor, (2) completion of a statewide aquifer mapping study in accordance with the underground injection control program, and (3) a study of ground water quality in potential lignite mining areas.

The U.S. Geological Survey (USGS) conducted field work to locate, study, and sample deposits of nonswelling bentonite. Studies were also underway on the Upper Cretaceous Geology of the Tennessee-Tombigbee Waterway in the State. A USGS program with the Geological Survey of Alabama continued to collect and computerize basic data on mineral resources in the State.

During the year, the Secretary of Interior designated as a National Historic Landmark the Sloss blast furnaces in Birmingham. The furnaces, constructed in 1881-82, symbolize post-Civil War efforts to industrialize the South and bring Alabama to preeminence in pig iron and cast iron pipe production in the early 20th century.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Nonmetals accounted for the bulk of the value of Alabama's total nonfuel mineral production. ADO reported that 57 operations involved with the nonmetallic minerals industries expanded to some degree in 1981 at an estimated expenditure of $25.4 million.

Asphalt (Native).—Alabama was one of three States producing native asphalt. Southern Stone Co., Inc., produced asphaltic limestone at the Margerum quarry in Colbert County; production decreased. The quarry was closed in July because of decreasing demand.

Cement.—Cement accounted for about one-third of the value of nonmetallic mineral production. Nationally, Alabama ranked fifth and eighth in the production of masonry and portland cement, respectively. Production and value of both cement types decreased.

Portland cement was produced at six plants in the State, two in Mobile County and one each in Jefferson, Marengo, St.

Clair, and Shelby Counties. Major end uses for portland cement were ready-mix concrete, concrete products, building materials, and highway construction.

Raw materials used in making cement included cement rock, limestone, chalk, clays, sand, shale, iron ore, oyster shell, and other materials.

Three cement facility expansions were announced through ADO totaling $5.6 million. The expansions involved Citadel Cement Corp., Demopolis; Lehigh Portland Cement Co., Leeds; and Martin Marietta Corp., Calera. Lehigh's announced $5 million expansion at its Leeds plant included a new grinding mill with a capacity of 75 tons of clinker per hour.

Alpha Portland Industries, Inc., Birmingham, ceased operations on April 30 and was offered for sale. The rising cost of fuel made the plant uneconomical under present market conditions. The plant used the wet process, and the estimated cost of $5 million to convert from natural gas to coal was considered excessive.

Table 4.—Alabama: Portland cement salient statistics

(Short tons unless otherwise specified)

	1980	1981
Number of active plants	7	6
Production	2,520,029	2,218,312
Shipments from mills:		
Quantity	2,491,306	2,269,844
Value	$108,437,688	$89,216,474
Stocks at mills, Dec. 31	278,888	287,025

Table 5.—Alabama: Masonry cement salient statistics

(Short tons unless otherwise specified)

	1980	1981
Number of active plants	6	5
Production	246,216	194,540
Shipments from mills:		
Quantity	241,573	192,539
Value	$13,011,656	$10,721,342
Stocks at mills, Dec. 31	34,990	24,777

The new Ideal Basic Industries, Inc., cement plant at Theodore started clinker production late in September. The $175 million plant was expected to be fully operational by yearend. The 1.5- million-ton-per-year plant utilizes the dry process and replaces an older plant in Mobile that closed in August. Limestone was barged down the Alabama River from the company's new quarry at Perdue Hill, about 90 miles north of Theodore; the quarry started operations in February. Clays and sand were received from company operations at Axis, approximately 30 miles north of Theodore. The cement plant requires about 3 million tons per year of limestone, sand, and clays. The market area to be served includes the gulf coast area from Houston to Tampa.

Clays.—In 1981, Alabama's clay industry produced common clay, fire clay, kaolin, and bentonite. The State ranked third nationally in the production of kaolin, fourth in bentonite and fire clay, and sixth in common clay. Clay ranked fourth in mineral value in Alabama in 1981. During the year, 25 companies mined clay at 42 pits in 20 counties. Ninety percent of all clay production came from the top 26 producing pits.

Common clay was mined by 15 companies at 22 pits in 15 counties; leading counties were Sumter, Jefferson, and Shelby. Production and value increased. Major uses were construction related: brick, cement, and concrete block.

Fire clay was mined by four companies at six pits in Calhoun, St. Clair, and Shelby Counties. Production and value increased. Major uses were in the foundry industry.

Kaolin was mined by 5 companies at 13 pits in Barbour, Henry, and Marion Counties in southeastern Alabama. Production and value decreased. Major uses were in firebrick and other refractories.

American Colloid Co. mined bentonite at one pit in Lowndes County for use in the foundry industry and in drilling muds. Production and value increased. The majority of the material (80%) was ground to 200 mesh, with the balance to 150 mesh.

Six clay operations announced expansions through ADO totaling nearly $750,000. Companies involved in expansions were American Colloid (Letohatchee), American Olean Tile (Fayette), Donoho Clay Co. (Anniston), Riverside Clay Co. (Pell City), Tombigbee Lightweight Aggregate Corp. (Livingston), and Vulcan Materials Co. (Bessemer).

Lime.—Alabama ranked sixth nationally in the production of lime. Production from five plants in Shelby County increased 8.1%. Major uses were in steelmaking, paper manufacture, and water purification. Lime ranked third in terms of mineral value in Alabama in 1981.

Mica.—Mining of scrap mica by Western Mica Co., in Randolph County, ceased in 1980. The facility in Heflin continued to grind ore from out of State. The fine-ground mica was used primarily as an additive in paints.

Table 6.—Alabama: Lime sold or used by producers, by use

Use	1980		1981	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Paper and pulp	327,353	$15,539	334,375	$16,481
Water purification	169,365	8,284	157,721	7,486
Aluminum and bauxite	36,601	1,791	W	W
Mason's lime	16,075	795	18,990	1,126
Steel, open-hearth	47,073	2,354	W	W
Sugar refining	5,675	274	5,395	290
Other[1]	525,958	24,648	702,790	34,070
Total	1,128,100	53,685	1,219,271	[2]59,454

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes acid mine water; agriculture; alkalies (1980); calcium carbide (1980); food, animal and human; insecticides (1980); oil and grease; oil well drilling; other chemical uses; other construction lime; other metallurgy; other ore concentration (1980); road stabilization; sewage treatment; soil stabilization; steel, basic oxygen furnace; steel, electric; tanning, wire drawing (1980); and uses indicated by symbol W.
[2]Data do not add to total shown because of independent rounding.

Perlite.—Two plants, W. R. Grace & Co., Birmingham, and National Gypsum Co., Mobile, produced perlite from ore shipped in from out of State. Production decreased, while value increased from that of 1980. The material was used for formed products, horticultural purposes, and concrete aggregate.

Phosphate Rock.—Alabama was one of seven States producing phosphate rock. Farmers Construction Co. mined phosphate rock from the Gilbert pit in Limestone County for Monsanto Co. The ore was shipped by rail to Monsanto's operations in Tennessee for further processing. Production and value increased over 47%. Mining of phosphate rock may cease in 1982 because of depletion of readily accessible material.

Salt.—Alabama ranked 10th nationally in the production of salt. Olin Corp., in Washington County, produced salt from brine wells by solution mining a near-surface salt dome for use in chemical manufacture. Production increased 6.5%, while value decreased 11.1%.

Sand and Gravel.—To reduce reporting burden and costs, the Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but contains complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Table 7.—Alabama: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	r5,582	r$10,143	r$1.82	NA	NA	NA
Gravel	r5,133	r13,541	r2.64	NA	NA	NA
Total[1] or average	r10,714	r23,683	r2.21	p10,200	p$22,200	p$2.18
Industrial:						
Sand	W	W	W	182	864	4.75
Gravel	W	W	W	--	--	--
Total or average	361	1,821	5.04	182	864	4.75
Grand total[1] or average	r11,076	r25,504	r2.30	p10,382	p23,064	p2.22

pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Total or average."
[1]Data may not add to totals shown because of independent rounding.

Sand and gravel ranked fifth in terms of mineral value in Alabama in 1981. The major use was for construction purposes, with minor amounts for industrial use. Industrial sand and gravel production decreased to about one-half of that in 1980. Although demand in both sectors decreased, five sand and gravel operations announced expansions through ADO, totaling nearly $400,000. Companies involved in expansion programs were Alabama Silica Co. (Montgomery), Calhoun Products, Inc. (Phenix City), Dirt, Inc. (Wilmer), Donnel Sand Co. (Daleville), and F & W, Inc. (Oneonta).

Stone.—Stone ranked second in mineral value in Alabama in 1981. Although production of both crushed and dimension stone decreased, unit value increased. Nationally, Alabama led in output of crushed marble, ranked third in production of oyster shell, and fourth in dimension marble. Crushed stone was produced at 51 operations in 22 counties. Material mined included limestone, marble, granite, sandstone, and oyster shell. The stone was used primarily in cement manufacture, in concrete, and as a road base. Principal production was from Shelby, Jefferson, and Colbert Counties. Seven quarries each produced in excess of 900,000 tons per year and accounted for nearly 41% of all crushed stone. Four companies quarried dimension blocks to produce primarily cut stone, rough block, and sawed stone. Shipments were mainly by truck, with minor tonnages shipped by rail or waterway.

Although stone production decreased, some producers in northwestern Alabama benefited from construction of the Tennessee-Tombigbee Waterway and Yellow Creek nuclear plant in northern Mississippi. By yearend, demand by these construction projects decreased.

The annual report of ADO reported expansion plans for eight stone operations, totaling about $10 million. Major expansion programs involved Dolcito Quarry Co. (Birmingham), Ideal (Monroeville), Moretti Harrah Marble Co. (Sylacauga), Wade Sand and Gravel Co. (Birmingham), and Vulcan (Calera, Helena, Glencoe, and Huntsville).

Ideal opened its Perdue Hill crushed stone quarry near Monroeville in February. Limestone was shipped to Ideal's new cement facility in Theodore, near Mobile, by barge. Lone Star closed its St. Stephen quarry early in the year. The quarry was closed, reportedly because the material was not compatible with other plant feed at Lone Star's cement plant in New Orleans.

Table 8.—Alabama: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	991	3,993	1,150	6,153
Concrete aggregate	3,137	9,891	3,413	12,472
Bituminous aggregate	2,061	6,903	1,904	7,732
Dense-graded road base stone	1,392	4,041	1,674	5,958
Surface treatment aggregate	80	226	75	335
Other construction aggregate and road stone	5,169	14,446	3,960	14,796
Riprap and jetty stone	584	1,914	993	3,959
Railroad ballast	200	574	W	W
Filter stone	317	1,041	51	195
Manufactured fine aggregate (stone sand)	307	962	307	1,171
Terrazzo and exposed aggregate	20	692	W	W
Cement	4,311	10,832	3,787	10,704
Lime	2,606	10,293	1,694	7,626
Dead-burned dolomite	164	W	168	508
Flux stone	468	1,248	360	1,100
Whiting or whiting substitute	W	W	233	5,753
Other fillers or extenders	455	9,353	291	5,601
Sulfur removal from stack gases	1	W	--	--
Other[2]	1,171	5,859	646	4,314
Total[3]	23,433	82,270	20,706	88,377

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

[1]Includes limestone, granite (1980), marble, sandstone (1980), and shell.

[2]Includes stone used for agricultural marl and other soil conditioners (1980), poultry grit and mineral food, macadam aggregates, mine dusting, bedding materials (1980), roofing granules (1980), other uses not specified, and uses indicated by symbol W.

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

Sulfur.—Alabama ranked fourth nationally in output of recovered sulfur. Four companies recovered sulfur from six high-sulfur crude oil processing plants in Escambia, Mobile, Tuscaloosa, and Washington Counties. Exxon Co., Hunt Oil Co., Phillips Petroleum, and Union Oil Co. sold 404,000 metric tons valued at $41.2 million, an increase of 8.0% in quantity and 28.8% in value over that of 1980.

Talc.—Cyprus Industrial Minerals Co. ground talc from Italy and Montana at its plant in Talladega County, near Alpine. The product was used primarily in ceramics and various cosmetic preparations.

Vermiculite.—W. R. Grace, Jefferson County, exfoliated vermiculite at its plant in Irondale from crude ore shipped into the State. The material was used in concrete aggregate, block, loose insulation, and as a sand conditioner.

METALS

Primary metal production was among the most important industries in the State. The four leading counties were Colbert, Jefferson, Madison, and Etowah.

Aluminum.—Alabama ranked ninth nationally in the production of primary aluminum; output and sales decreased because of the recession nationally. Primary aluminum was produced by Revere Copper & Brass Inc., Scottsboro; and Reynolds Metals Co., Sheffield, from alumina shipped in from several out-of-State sources. Aluminum Co. of America, Mobile, continued to produce alumina from imported bauxite.

Reduced demand for aluminum adversely affected both primary aluminum plants. By yearend, Revere was operating at about 90% of capacity, with inventories increasing, while Reynolds had only one out of seven lines in operation. The energy-intensive operations of both Revere and Reynolds faced an added problem of high and increasing electric rates. The relatively high cost of electricity, along with decreased demand, adversely affected operating conditions at both aluminum plants. Ford Motor Co. also announced the shutdown of its aluminum-casting plant, adjacent to Reynolds, because of excessive operating costs.

Reynolds completed a $5 million expansion of its aluminum recycling plant in Sheffield. The company installed a scrap shredder, heavy-media separator, direct-chill ingot casting operation, and a chip dryer for borings and turnings. The new separator can recover 30,000 tons per year of nonferrous metals from shredded auto hulks. Of the metals recovered, 35% was expected to be aluminum, 45% zinc, 10% copper, and the balance, other metals.

Other expansions, as announced by ADO, were for improvements at both Revere and Reynolds and totaled $24 million. Improvements were made at primary, wire, and sheet facilities at both operations.

Bauxite.—Alabama ranked second in the Nation in bauxite production. Four companies mined bauxite in Barbour and Henry Counties for use in refractories and chemical manufacture. Production and value increased over that of 1980; unit value increased about 30%.

Ferroalloys.—Alabama ranked sixth in the Nation in the production of ferroalloys. Production and value decreased 40.7% and 23.5%, respectively. Products included ferromanganese, ferrosilicon, and silicon metal. ADO announced four expansions in the ferroalloy industry, totaling over $20 million.

Iron and Steel.—Alabama ranked seventh in the Nation in the production of pig iron. United States Steel, Fairfield, and Republic Steel, Gadsden, were the major producers. Production and sales were up slightly. ADO announced four expansions in the steel industry totaling over $200 million. Companies involved in expansion or modification programs included Connors Steel Co. (Birmingham), O'Neal Steel Co. (Birmingham), Republic Steel (Gadsden), and United States Steel (Fairfield). Iron oxides were recovered at Republic Steel's Gadsden operation; production and value decreased. Alabama was one of five States reporting iron oxide recovery from steel plant wastes.

Rutile (Synthetic).—Kerr-McGee Corp. continued to operate its 100,000-ton-per-year synthetic rutile plant in Mobile. Production increased during the year, with design production levels reached by yearend. Ilmenite, imported from Australia, was processed into synthetic rutile and shipped to the company's Hamilton, Miss., plant for processing to titanium dioxide pigment for use in paints, plastics, and other products.

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[1]State Liaison Officer, Bureau of Mines, Tuscaloosa, Ala.
[2]State geologist, Geological Survey of Alabama, Tuscaloosa, Ala.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
Alumina:			
Aluminum Co. of America	1501 Alcoa Bldg. Pittsburgh, PA 15219	Plant	Mobile.
Aluminum smelters:			
Revere Copper & Brass, Inc	Box 191 Rome, NY 13440	do	Jackson.
Reynolds Metals Co	Reynolds Metals Bldg. Richmond, VA 23218	do	Colbert.
Bauxite:			
Didier-Taylor Refractories Corp	Box 568 Eufaula, AL 36027	Mine and plant	Barbour and Henry.
Eufaula Minerals Co	Box 556 Eufaula, AL 36027	do	Barbour.
A. P. Green Refractories Co., a subsidiary of United States Gypsum Co.	Mexico, MO 65265	do	Do.
Harbison-Walker Refractories Co., Inc., a division of Dresser Industries, Inc.	Dale Rd. Route 1, Box 58 Eufaula, AL 36027	do	Do.
Cement:			
Citadel Cement Corp	2625 Cumberland Pkwy., NW. Atlanta, GA 30339	Plant	Marengo.
Ideal Basic Industries, Inc.[1]	821 17th St. Denver, CO 80202	Plants	Mobile.
Lehigh Portland Cement Co	800 2d Ave., South Leeds, AL 35094	Plant	Jefferson.
Martin Marietta Corp.[2]	6901 Rockledge Dr. Bethesda, MD 20034	do	Shelby.
National Cement Co. Inc	Drawer A Ragland, AL 35131	do	St. Clair.
Clays:			
Bickerstaff Clay Products Co., Inc	Box 517 Bessemer, AL 35020	Mines	Jefferson and Russell.
Jenkins Brick Co	Box 91 Montgomery, AL 36101	do	Chilton, Elmore, Montgomery.
Martin Marietta Corp	18th Floor, Daniel Bldg. Birmingham, AL 25233	Mine	Shelby.
Tombigbee Lightweight Aggregate Corp., a division of Breeko Industries, Inc.	Box V Livingston, AL 35470	do	Sumter.
Ferroalloys:			
Alabama Alloy Co., Inc	Box 31195 Birmingham, AL 35222	Electric furnace	Jefferson.
Autlan Manganese Corp	Box 2703 Mobile, AL 36601	do	Mobile.
Interlake Inc., Globe Metallurgical Div.	Box 348 Selma, AL 36701	do	Dallas.
International Minerals & Chemical Corp., TAC Alloys Div.	Garner Rd. Bridgeport, AL 35740	do	Jackson.
Ohio Ferro-Alloys Corp	Box 68 Montgomery, AL 36057	do	Montgomery.
Reynolds Metals Co	Box 191 Sheffield, AL 35660	do	Colbert.
Lime:			
Allied Products Co	Box 268 Montevallo, AL 35115	Plant	Shelby.
Cheney Lime & Cement Co	Allgood, AL 35013	do	Do.
Martin Marietta Corp.[3]	15 20th St., South Birmingham, AL 35223	do	Do.
S. I. Lime Co	Suite 204 Three Riverchase Office Plaza Birmingham, AL 35244	do	Do.
Phosphate:			
Monsanto Co	Columbia, TN 38401	Pit	Limestone.
Pig iron:			
Republic Steel Corp	1629 Republic Bldg. Cleveland, OH 44115	Furnaces and mills.	Etowah and Jefferson.
U.S. Pipe and Foundry Co	3300 1st Ave., North Birmingham, AL 35202	Furnaces	Jefferson.
United States Steel Corp	Box 599 Fairfield, AL 35064	Furnaces and mills.	Do.
Salt:			
Olin Corp	120 Long Ridge Rd. Stamford, CT 06904	Brine wells	Washington.
Sand and gravel:			
Holland and Woodward Co., Inc	Box 1947 Decatur, AL 35601	Surface mine and plant.	Franklin.
R & S Materials, Inc	Box 3547 Montgomery, AL 36109	do	Autauga, Elmore, Macon, Montgomery.
South Ready Mix, Inc	Route 11, Box 120 Birmingham, AL 35210	do	Elmore.
Southern Industries, Radcliff Materials.	Drawer 2068 Mobile, AL 36601	do	Mobile and Montgomery.
Thackston, C.T	Box 3211 Montgomery, AL 36109	do	Montgomery.

See footnotes at end of table.

Table 9.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone:			
Allied Products Co	Box 628 Alabaster, Al 35007	Quarries	Shelby.
Citadel Cement Corp	2625 Cumberland Pkwy., NW. Atlanta, GA 30339	Quarry	Marengo.
Hoover, Inc	Box 155 Hollywood, AL 35752	Quarries	Colbert and Jackson.
Southern Stone Co., Inc.[4]	2111 8th Ave., South Birmingham, AL 35233	____do____	Bibb, Colbert, Lee, Shelby.
Vulcan Materials Co.[5]	Box 7324-A Birmingham, AL 35223	____do____	Calhoun, Colbert, Etowah, Franklin, Jackson, Madison, Shelby.
Talc:			
Cyprus Industrial Minerals Co	Alpine, AL 35014	Plant	Talladega.

[1]Also clays and stone.
[2]Also lime, stone, and clays.
[3]Also cement, clays, and stone.
[4]Also sand and gravel.
[5]Also clays and sand and gravel.

The Mineral Industry of Alaska

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

By Tom L. Pittman[1]

The value of nonfuel mineral production reported in Alaska in 1981 was $127.5 million. In 1980, the value was $115.3 million. The increase in the 1981 value was due to increases in the values reported for crushed stone, gold, sand and gravel, and gem stones. Reported values and quantities of platinum-group metals and tin increased. Tungsten and silver decreased, and there was no production of barite.

Expenditures for exploration were estimated to be at least $76 million according to a State canvass of major operators. Other estimates place the total in excess of $100 million. Exploration expenditures in 1980 were estimated at $65 million. There were major exploration expenditures in the search for precious metals, base metals, and molybdenum. Exploration efforts increased for chromite, cobalt, nickel, platinum-group metals, tin, tungsten, and other strategic and critical mineral commodities. There are about 100,000 mining claims active in Alaska. New claim recordings were 27,400 for the calendar year 1981, versus 19,359 new claims in 1980. There were 10,209 new claims recorded in the last 3 months of 1981, a substantial increase over the 7,768 new claims in the last quarter of 1980.

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

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Gem stones		NA	$50	NA	$60
Gold (recoverable content of ores, etc.)	troy ounces	r12,881	r7,890	25,316	11,636
Lead	metric tons	31	29	W	W
Sand and gravel	thousand short tons	44,911	85,214	p46,400	p87,500
Silver (recoverable content of ores, etc.)	thousand troy ounces	8	172	2	25
Stone (crushed)	thousand short tons	3,990	19,978	5,359	26,855
Tin	metric tons	W	W	136	1,200
Combined value of barite (1980), platinum-group metals, tungsten, and values indicated by symbol W		XX	1,983	XX	265
Total		XX	r115,316	XX	127,541

pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of nonfuel mineral production in Alaska, by region[1]

(Thousands)

Region	1979	1980	Minerals produced in 1980 in order of value
Cook Inlet-Susitna	$5,466	$3,702	Sand and gravel, stone, gold, silver, lead.
Copper River	600	317	Sand and gravel, gold, silver.
Kenai Peninsula	1,206	578	Do.
Kodiak	W	W	Sand and gravel, stone.
Kuskokwim	--	W	Platinum, gold.
Northern Alaska	13	13	Sand and gravel.
Seward Peninsula	W	W	Gold, silver, sand and gravel, tin.
Southeastern Alaska	W	12,874	Stone, sand and gravel, barite, gold, silver.
Yukon River	2,175	6,736	Gold, sand and gravel, stone, silver, tungsten.
Undistributed[2]	114,406	91,097	
Total[3]	123,865	115,316	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]No nonfuel mineral production was reported in Alaska Peninsula, Aleutian Islands, Bering Sea, Bristol Bay, and Northwestern Alaska Regions.

[2]Includes gem stones, some sand and gravel, some stone that cannot be assigned to specific regions, and values indicated by symbol W.

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

Table 3.—Indicators of Alaska business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	182.0	194.2	+6.7
Unemployment	do	18.1	19.0	+5.0
Employment (nonagricultural):				
Mining[1]	do	6.5	7.7	+18.5
Manufacturing	do	13.4	12.0	-10.4
Contract construction	do	10.3	12.1	+17.5
Transportation and public utilities	do	17.0	17.9	+5.3
Wholesale and retail trade	do	29.1	30.9	+6.2
Finance, insurance, real estate	do	8.2	8.5	+3.6
Services	do	30.0	31.1	+3.7
Government	do	55.0	57.2	+4.0
Total nonagricultural employment[1 2]	do	169.4	177.3	+4.7
Personal income:				
Total	millions	$5,139	$5,842	+13.7
Per capita		$12,759	$14,090	+10.4
Construction activity:				
Number of private and public residential units authorized		2,230	4,440	+99.1
Value of nonresidential construction	millions	$64.1	$204.2	+218.6
Value of State road contract awards	do	$85.0	$120.0	+41.2
Shipments of portland cement to and within the State	thousand short tons	94	137	+45.7
Nonfuel mineral production value:				
Total crude mineral value	millions	$115.3	$127.5	+10.6
Value per capita, resident population		$284	$319	+12.3
Value per square mile		$193	$217	+12.4

[p]Preliminary.

[1]Includes bituminous coal and oil and gas extraction.

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

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

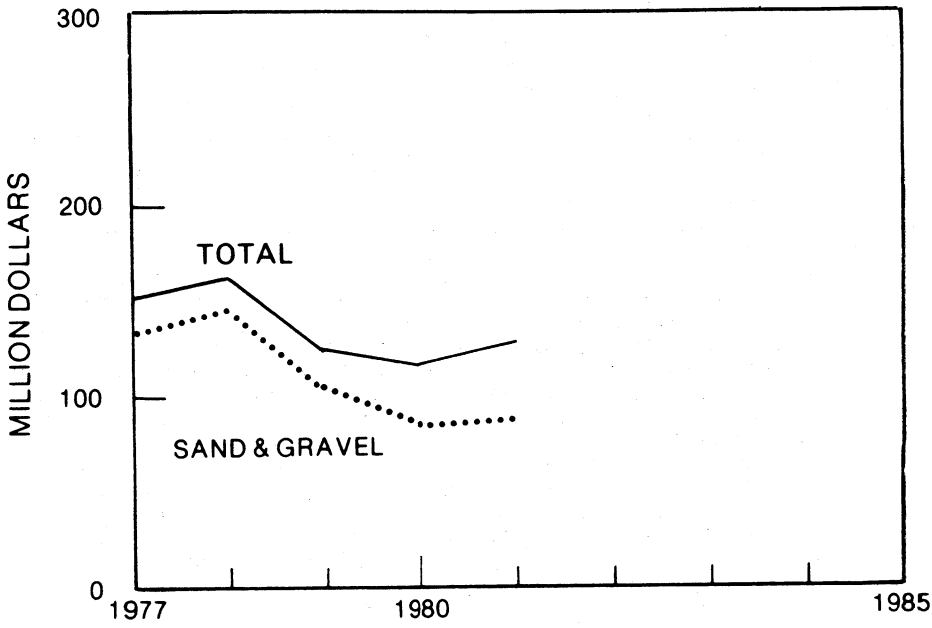

Figure 1.—Value of sand and gravel and total value of nonfuel mineral production in Alaska.

The location of large blocks of mining claims by the larger companies at the start of an exploration project has become a usual procedure. These blocks may run from less than 100 claims to more than 1,000 claims. Small companies and individuals are paying increased attention to exploring, developing, and producing precious metal deposits believed to contain limited reserves of relatively high-grade ores.

Several of the 12 Native regional corporations in the State are placing increasing emphasis on known and possible mineral resources in developing criteria for selection of their remaining land entitlements. Some of these corporations have acquired prospects and partly explored deposits that should become potential major producers. The corporations succeeded in this by retaining or contracting with exploration consultants and mining companies, forming joint ventures, and setting up various leasing and operating entities with companies they believe have the resources to bring major deposits to the production stage and successfully operate the mines.

The level of exploration activity indicated by the mining claim recordings in 1981 does not include the activity on Native lands. The regional corporation administers the subsurface rights and resources on corporation and village lands. All mineral-related activity is arranged by negotiation with the corporation. These lands are closed to mineral entry, and to any entry not authorized by an easement in the title documents transferring the land from the Federal Government to Native ownership.

Enactment of Public Law 96-487, the Alaska National Interest Lands Conservation Act (ANILCA), in December 1980, has helped clarify and define land management and minerals access on large blocks of Federal land. Federal land management agencies published most of their regulations and their management philosophies became apparent during 1981. Some of the problems and uncertainties that have slowed the minerals industries became definable, specific, and capable of solution or partial alleviation. These factors helped encourage exploration and production investments and activities. Permitting problems are decreasing for some activities but increasing for others. A practical and realistic definition of wetlands is needed. It must be acceptable to State and Federal regulatory and permitting agencies. Clarification of

the wetlands classification is especially important in Alaska because a large part of the land surface suitable for construction of surface facilities and for transportation corridors is muskeg or tundra that now technically is subject to stringent control and permitting by the Corps of Engineers. Mining people believe most of the muskeg and tundra areas do not have the ecological and environmental characteristics that the wetlands land classification was defined to protect in the more southern part of the United States.

Coastal Management Programs for the city of Cordova, the city of Yakutat, and the city and borough of Sitka were accepted by the Coastal Policy Council. Programs for Anchorage, Haines, and Annette Island Indian Reserve were approved in 1980, bringing the total approved programs to six, covering a very small part of the coast. All mining, processing, and transportation facilities within the coastal zone must eventually meet the test of consistency with the Coastal Management Programs within which they are sited. Mining developments in coastal areas not covered by accepted programs may face unpredictable future problems and expenses.

Mineral rights have been acquired on State lands by locating mining claims according to provisions of the State mining laws and doing the required annual work on the claims. An opinion by the State attorney general's office states this is an erroneous procedure. Section 6(i) of the Statehood Act mandates "mineral lands" can only be disposed of by leasing. A legal question must be answered: What were the "mineral lands" referred to in the act? Hopefully the problem of acquiring mineral rights on State lands will be solved by the Alaska State Legislature early in 1982. The Bureau of Land Management (BLM) announced that during fiscal year 1981 it had issued 1 mineral patent for 240 acres, involving 16 lode claims in the Ambler area, to the Kennecott Corp. Also, an increase in program support has enabled BLM to schedule 12 mineral examinations for the 1982 field season, triple the 1981 number.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Asbestos.—Alaska Asbestos Co. continued exploration drilling and also conducted bulk sampling on the Slate Creek deposit, using 12-inch-diameter diamond drills to extract core samples for beneficiation and other testing and evaluation procedures. Exploration on the Champion Creek deposit, about 15 miles northeast of Slate Creek, indicated the probability of another major asbestos discovery. These deposits will be recovered by surface mining. They will be accessible by roads connecting to the Taylor Highway. This highway runs north from Tetlin Junction on the Alaska Highway to Eagle on the Yukon River. The deposits are on land belonging to Doyon Ltd., a Native regional corporation. WGM Inc. is the operator.

Barite.—No barite was produced in Alaska in 1981. Chromalloy American Corp. operated their offshore mine at Castle Island, west of Petersburg, through the 1980 season. In mid-January 1981, they had sold the mining and milling plant to a salvage company. All equipment and buildings were removed from the operations site.

Large tonnages of barite are associated with some of the major stratabound massive sulfide deposits in the Delong Mountains in northwestern Alaska, in southeastern Alaska, and in several other areas in the State. Barite has been considered as a possible coproduct in the mining plans for some of these deposits. The Marmot deposit, about 40 miles northwest of Haines, is probably the most accessible of the major deposits. Current development plans include the production of barite concentrate as a major coproduct with lesser amounts of base metal-precious metal concentrates containing lead, zinc, copper, and silver.

Gem Stones.—Jade is produced in the Jade Mountain area east of Kotzebue. The NANA Regional Corp., Inc., produced jade and Native industries manufactured most of it into arts, crafts, and jewelry products. Smaller amounts of jade were recovered from privately owned claims and used by rock hounds and jewelers. Soapstone was produced from the Talkeetna Mountains, near Palmer. Most of the soapstone is used as carving material for arts and crafts items for the tourist trade and individual hobbyists. Some outstanding epidote and other mineral specimens were recovered from the Green Monster Mountain area on Prince of Wales Island. Most of these specimens went to private collections. Coral, obtained off-

shore along the Alaska Peninsula and other localities, is a popular and rather expensive jewelry material. Clays used by Alaskan ceramics manufacturers and hobbyists were obtained from the Healy Coalfield and many other areas. The materials used ranged from true clays to selected materials of glacial rock flour origin.

Sand and Gravel.—To reduce reporting burdens and costs, the Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production. The preliminary estimates for construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Preliminary estimates of sand and gravel production in 1981 indicated a total of 46 million short tons, somewhat greater than 1980 production. The value in 1981 was slightly greater than the value reported in 1980. The entire production was classified as construction sand and gravel. A gradual decrease in local reserves and anticipated zoning restrictions and other problems are causing some of the major producers in the Anchorage area to develop sources of supply near Palmer and other more distant areas. Alaska Aggregate Corp. (ALAGCO) completed a $2.5 million capital improvement project at its C Street plant in Anchorage and its quarry in the Matanuska Valley. The Palmer pit capacity was increased 100%. ALAGCO is one of the Alaska Brick Group of companies owned by Sealaska Corp., the southeastern Alaska Native regional corporation. Increasing production more distant from Anchorage is improving revenues earned by the Alaska Railroad. Two major sand and gravel producers are studying the feasibility of building cement plants to produce several grades of cement by blending and grinding clinker and gypsum imported from the west coast of the United States or from foreign sources. One of these cement plants will probably be built in 1982. Most of the initial production will be used in company-owned ready-mix concrete operations.

Table 4.—Alaska: Construction sand and gravel sold or used by producers

	1980			1981[P]		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Sand	40,062	$75,778	$1.89	NA	NA	NA
Gravel	4,849	9,436	1.95	NA	NA	NA
Total or average	44,911	85,214	1.90	46,400	$87,500	$1.89

[P]Preliminary. NA Not available.

Stone.—Crushed stone reported in 1981 was 5.4 million tons, valued at $26.9 million. The quantity and value of 1981 production each were about 34% greater than the 1980 production and value. Principal uses for 1981 crushed stone were construction aggregate and road stone 83%, dense-graded road base stone 9%, and riprap and jetty stone 7%. The rest of the crushed stone was utilized for surface-treatment aggregate, railroad ballast, manufactured fine aggregate (stone sand), and other uses. Production reported by regions, in thousands of short tons, was Southeast 4,317, Cook Inlet 377, Yukon River 358, Alaska Peninsula 270, and Copper River 36.

Table 5.—Alaska: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Dense-graded road base stone	344	1,808	487	1,670
Surface-treatment aggregate	39	165	5	W
Other construction aggregate and road stone	3,581	17,744	4,461	23,206
Riprap and jetty stone	1	2	369	W
Railroad ballast	2	14	33	220
Manufactured fine aggregrate (stone sand)	--	--	4	20
Other[2]	22	247	--	1,739
Total[3]	3,990	19,978	5,359	26,855

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, granite, traprock, and miscellaneous stone.
[2]Includes stone used for concrete aggregate, bituminous aggregate, and terrazzo and exposed aggregate (1979).
[3]Data may not add to totals shown because of independent rounding.

METALS

Chromium.—Anaconda Minerals Co. completed its exploration program and investigations at the Red Mountain chromite deposits near the south end of the Kenai Peninsula. A large resource of low-grade chromite mineralization was identified but no reserves were developed with the grade and tonnage necessary for economic exploitation. There was no work reported in 1981 at the Claim Point deposit by the company that investigated it in 1980.

Copper.—Expenditures on the major known copper-zinc-silver deposits from the Ambler to the Picnic Creek areas in the Brooks Range covered annual assessment and maintenance, with minor additional exploration. Bear Creek Mining Co., an exploration subsidiary of Kennecott Minerals Co., opened an office in Anchorage to handle their Alaska exploration projects and anticipated development plans for the Arctic Camp deposit in the Ambler area. Kennecott received a patent for 16 lode mining claims in the Ambler area and has additional patent applications pending. Anaconda did required work on claims jointly owned by Anaconda and Sunshine Mining Co. east of the Ambler district. Several other companies also maintained their claims in the Brooks Range copper belt.

Bear Creek maintained its copper claims in the Bond Creek area. The Orange Hill copper-molybdenum deposit and several other claims in this area, north of the Wrangell Mountains and east of Nabesna to the Canadian border, are now within the Wrangell-St. Elias National Park and Preserve. Owners of most of the other more promising copper and copper-molybdenum properties in Alaska are covering their assessment work requirements. Copper deposits containing economic silver and gold values are being actively sought and explored. Geneva Pacific Corp. continued exploration for Kennecott-type copper-silver deposits east of McCarthy in the Wrangell Mountains. They announced exploration activities with the Ahtna Joint Venture, a minerals development group of Ahtna Inc., a Native regional corporation. Several companies explored copper deposits and occurrences in the Denali Highway-Talkeetna Mountains area. There was some exploration activity on large, low-grade copper deposits on the Alaska Peninsula, southeast and southwest of Port Moller, and southeast of Ugashik Bay.

In the southeast region, there was exploration by Placid Oil Co. at the Sumdum Chief, Magic-Tracy, and Sulfide deposits. Noranda Exploration, Inc., and Cominco American Inc. explored deposits in the Niblack area, and similar activity was reported in the Cholomondely Sound and Hetta Inlet areas, on Prince of Wales Island. Exxon Minerals Co. recorded a large group of claims late in 1981 south and east of Twelve Mile Arm, Prince of Wales Island.

Gold.—Estimated gold production was over 134,000 troy ounces. The Division of Geological and Geophysical Surveys (DG&GS) (Alaska Department of Natural Resources) and the Mineral Industries Research Laboratory (University of Alaska) estimated total State mineral production by several canvass surveys of mine operators. Gold production was also estimated by contacting at least 2 operators in each of 23 major mining districts for district estimates. These surveys indicated about 134,400 ounces of gold were produced by 207 operators. Placer mines produced 97% of

this amount. There are over 400 placer mines, with 207 classed as major operations. An estimated 1,500 people engaged in recreational placer mining using small suction dredges and hand methods.

The Seward Peninsula had at least 35 mechanized gold placer operations. Alaska Gold Co. operated Dredge No. 5 on the Third Beach northeast of Nome and Dredge No. 6 on the Submarine Beach, near the airport. One of the dredges was shut down for some time because of a power shortage. The dredge mining season ended the last week in October. The company is drilling thaw fields. Small bucketline dredges were operated on Basin Creek by Engstrom and Sons, on the Niukluk River by Steve Pederson, at the mouth of Henry Creek by the Tweets, and on the Ungalik River by Bliss and Sons. Greatland Exploration Ltd. mined on the Second Beach, about 2 miles east of Nome, using bulldozers, draglines, and Ross sluicebox equipment. Thirty other gold placers were reported on 26 creeks. Two of the regular operators were moving to new locations and plan to mine again in 1982. Up to 100 people per day worked the Nome Beach. Most of this hand-scale work was from the Nome city limits east to Fort Davis, with some activity west of the city.

Alaska Gold and Greatland Exploration explored onshore beach ground. Several operators explored ahead of their mining areas and other companies and individuals were using drills and test-pit sampling methods searching for sites for new operations. Placid Oil was reported drilling on Quartz Creek, in the Kougarok River area, and Noranda Mining Inc. was examining ground it may drill in the winter of 1981-82. Goldwinn Resources Ltd. brought in equipment and was testing a large area of offshore leases in Golovin Lagoon, about 65 miles east of Nome. A Utah operator has leased patented claims on Cripple Creek and patented ground near Bluff. Anaconda continued exploration drilling and other work at the Big Hurrah lode mine. The airstrip at Candle was lengthened to 5,500 feet last year and has been used in 1981 by heavy aircraft to bring in fuel, supplies, equipment, and people for operators in the Candle, Deering, and Buckland areas and for the north side of the peninsula.

Silverado Mines, Ltd., acquired placer claims near Nolan, in the Koyukuk district. They reported recovering 728 ounces of gold from 21,000 cubic yards of mixed overburden and gravel, and exploring and evaluating similarly good ground for 1982 operations. They also conducted explorations for lode gold deposits and located 70 lode claims. Nolan is about 5 miles northwest of Wiseman and west of the North Slope haul road. Tri-Con Mining Inc. is the operator for Silverado. Jan Drew Holdings Ltd. leased placer claims from Little Squaw Gold Mining Co. in the Chandalar district about 80 miles north-northeast of Wiseman. They mined on Tobin Creek and explored and evaluated ground on some neighboring creeks.

There were 8 or 10 other operators in these northern areas at various places including Crevice Creek and Tramway Bar. Alaska Gold reconditioned its 7-cubic-foot dredge in the Hogatza River area, mined, and did some exploration. This dredge had been idle since 1975. This locality, often referred to as Hog River, is about 45 miles westerly from Hughes and 110 miles northerly from Galena.

Tuluksak Dredging Ltd. has operated one or two 4-cubic-foot dredges on the Tuluksak River in the Kuskokwim Basin, near Nyac. Nyac is about 65 miles easterly from Bethel and 40 miles southerly from Aniak. Northland Gold Dredging Ltd. operated the 6-cubic-foot dredge they rebuilt last year near Nyac. Northland is a joint venture formed by Tuluksak and Noranda Mining to rebuild this old New York Alaska Co. dredge and operate it. There are over 20 operating placer mines in the area between Nyac and Tolstoi, about 80 miles west-northwest of McGrath. The Crooked Creek, Iditarod-Flat, Innoko, and Tolstoi mining districts are in this area. Several companies had placer and lode exploration projects in these districts.

There were three placers working in the newly recognized Bitzshtini Mountain area, about 50 miles south of Tanana. About 15 major and several smaller placers operated in the Manly-Tofty-Eureka area between Tanana and Fairbanks. There were 28 placers reported in the Fairbanks area. There were over 40 major operations in the Miller Creek to Circle areas and many smaller mines. The Forty Mile district, including Chicken, Eagle, and the Seventy Mile areas, reported 18 main operations and many smaller ones.

Canadian Natural Resources Inc. was the operator of the Livengood placer, largest of several mines in the Tolovana area, northwest of Fairbanks. The operation was described at the Third Annual Conference on

Alaskan Placer Mining, April 1-2, 1981, at the University of Alaska, Fairbanks. The pay horizon is 5.5 miles long, 300 to 2,000 feet wide and 10 to 40 feet thick. It is covered with muck averaging 47 feet deep. Everything is frozen to a depth of about 60 feet. Frozen overburden was stripped during the winter. A dike was built to contain and settle the clay and slime tailings and runoff from the mine area. The dike is 300 feet wide at the bottom and 100 feet wide at the top and will have about 25 million cubic feet of impound volume. It was built with 300,000 cubic yards of gravel in the core and 800,000 cubic yards of frozen muck. Winter stripping moved 1.2 million cubic yards of material, ripping and removing an average of 15,000 cubic yards each 10-hour day. Plans call for three Muller sluice units, each 20 feet wide and 150 feet long, with a 150-foot conveyor stacker for tailings gravel. The circuit will be log washer to shaking screen to sluices to 36-inch spiral classifiers. The rated capacity will be 500 cubic yards per hour.

Fifteen placer operators were reported in the Kantishna area north of Denali National Park. DG&GS reported 34 placer mines in the Chistochina, Valdez Creek, Nizina, Cache Creek, Nelchina, Willow Creek, and Kenai Peninsula areas. Hall-Yentna Mining Co. operated again in the Cache Creek area, using backhoes and bulldozers to feed gravel and move tailings at two floating washing plants. These washers are equipped with trommels and sophisticated sluices with mechanical slope controls, riffle lifters, and concentrate holding tanks. Cleanups are made during the half-hour periods needed to service the powerplants and equipment. Plant capacity is rated at 10,000 cubic yards daily. Territorial Corp., a subsidiary of Rancher's Exploration and Development Corp., reported their placer operation in the upper Chistochina River area recovered 4,500 ounces of gold from 275,000 cubic meters of gravel in the 4-month season ending September 30.

Cook Inlet Exploration and Development Inc. announced finding what they described as a large "workable deposit" of placer gold offshore from the Anchorage International Airport. Aspen Exploration Corp. of Denver is also investigating offshore placer potential in this part of Cook Inlet. There were placer prospecting projects and test runs with pilot recovery units by at least two mining companies on Cape Yakataga beach sand deposits and river gravels. Several private operators were also active. Two mechanized operations were reported in the Porcupine district northwest of Haines, in southeastern Alaska.

Table 6.—Alaska: Placer production of gold

Year	Mines producing	Material[1] treated (thousand cubic yards)	Gold recovered		
			Troy ounces	Value (thousands)	Average value per cubic yard
1977	22	1,800	18,924	$2,807	$1.559
1978	21	1,455	18,599	3,600	2.474
1979	14	778	6,675	2,053	2.639
1980[r]	21	973	11,386	6,975	7.169
1981	20	3,101	25,217	11,591	3.738

[r]Revised.
[1]Excludes material treated primarily for the recovery of platinum.

Opinions vary on the success rate of placer mines in Alaska. DG&GS estimates up to 40% of all mines statewide failed owing to economic or production problems.

Little Squaw reported the production of almost 5,000 ounces of gold by the placer and lode lessees on its mining property in the Chandalar district. The mill treated ore mined chiefly from the Mikado lode. They also mined and milled some ore from the Summit lode under an agreement with owners of that property. Lode mining stopped in July because of underground thawing and other problems. Plans have been made to equip for surface mining of ore bodies above the 100-foot level next season. Several hundred feet of underground exploration and development work were reported.

The Grant Mine produced and milled ore from underground exploration and development workings. Tri-Con, the operator, also accomplished a large amount of drilling and surface exploration on other property on Ester Dome controlled by Silverado. Ester Dome is a few miles west of Fairbanks.

There were shipments of small lots of high-grade gold and silver ores from the Fairbanks area and the Kenai Peninsula. There were reported mining activities producing several lots of shipping-grade ore in the Kaiyhu Mountains, Nixon Fork area, and the Wrangell Mountains but no confirmation of shipments in 1981. Bedrock Mining Co. produced gold in a cleanup operation at the old Alaska Juneau mill, and Taku Joint Venture reworked a carefully selected lot of sand tailings near the mill.

There was increased effort by many companies to find and explore hard-rock gold deposits. The Independence Mine, in the Willow Creek district west of Palmer, is scheduled for operation in 1982. Underground exploration and development continued through 1981. A new access decline was nearing completion and preparations at camp and mill sites were in advanced stages. St. Joe American Corp. continued exploration at the old Ryan Lode Mine on Ester Dome. A new decline was driven to gain underground access for bulk sampling and other work but was abandoned because of bad ground conditions. In the Cleary area, north of Fairbanks, Placid Oil drove an adit to a vein system they have been exploring and are doing underground sampling. Resource Associates of Alaska (RAA), Houston International Minerals Corp., and Getty Oil Co. are also active in gold lode exploration in the interior. Beaver Creek Gold Mines Ltd. announced favorable results from a diamond drill program near the Canadian boundary and north of the Alaska Highway. Catalina Resources and Energy Ltd. continued work at the Apollo and Sitka Mines of Alaska Apollo Gold Mines Ltd. on Unga Island. RAA did additional work on their previous discoveries and prospected on other islands and the Alaska Peninsula. There was some work on the Nelchina Glacier gold prospect, south of Eureka on the Glenn Highway. The Nabesna Mine, north of the Wrangell Mountains, was examined and some of the underground workings were sampled by Eastern Leaseholds. The company plans to do some diamond drilling in 1982.

In southeastern Alaska, Placid Oil continued underground and surface exploration drilling and sampling at the Kensington-Comet-Sherman Creek area east of Lynn Canal and north of Juneau. Placid acquired a large group of claims from Whelans Mining and Exploration Inc. in the Eagle River Mine area north of Juneau and started geologic mapping and other work on them. Hyak Mining Co. worked at the Jualin Mine, on Johnson Creek north of Berners Bay. Noranda Exploration, Houston International Minerals, and Aspen Exploration were active in Juneau area exploration. Mapco Inc. did some drilling on their Sweetheart Ridge gold-copper-zinc property near Gilbert Bay and were active at their prospect in the Hollis area on Prince of Wales Island. Orell Resources Ltd. explored underground workings and planned a fall drilling project at the Flagstaff Mine on Prince of Wales Island. Enserch Exploration Inc. is examining the Hirst-Chichagof Mine, north of Sitka.

Oxford Assaying and Refining and Engelhard Industries West each opened gold assaying, melting, and buying plants in Anchorage. With the facilities of Delta Smelting and Refining Co., Ltd., in Fairbanks and at least two smaller companies, Alaskan gold producers now have previously unavailable conveniences and options for evaluating and marketing their raw gold, amalgam, cleanup concentrates, and gold-bearing high-grade black sands. Alaskan-based precious metals refiners indicated to DG&GS that about 160,000 ounces of gold were processed during 1981. Some of this gold may have been carried over from the previous season or seasons but it indicates that the gold production estimated for 1981 is probably quite conservative.

Lead and Zinc.—The most important development was the exploration of the Red Dog zinc-lead-silver deposit by Cominco and NANA. Preliminary information available in 1981 indicated it was a very large, relatively high-grade deposit. A Cominco news release in February 1982, stated that drilled reserves through 1981 were 85 million tons averaging 17.1% zinc, 5% lead, and 2.4 ounces of silver per ton. The Red Dog deposit is in the DeLong Mountains, north of Kotzebue. The deposit will be recoverable by surface mining. Cominco also continued work on its Sue deposit. Additional work was done on the Lik deposit, on the Wulik River west of the Red Dog, by its owners, GCO Minerals Co., Houston International Minerals, and WGM Inc. An airstrip 4,200 feet long was completed at the property, a major goal of the owners.

Greatland Exploration and other companies explored lead, zinc, and silver deposits on the Seward Peninsula. The Delta area contains over 30 known massive sulfide deposits carrying zinc, lead, copper, silver, and gold. Exploration was done by Anacon-

da, RAA, Union Carbide Corp., and several other companies. RAA and Getty Oil worked on prospects in the Bonnifield area, east of Healy. In southeastern Alaska, the intensive lead and zinc exploration activity of 1980 was not duplicated in 1981. There was some work done by Mapco and by Cominco on their respective claim groups on Kuiu Island. There was relatively little activity on Kupreanof and Etolin Islands, southerly along the Admiralty Island-to-Etolin Island mineral trend.

Molybdenum.—U.S. Borax and Chemical Corp., a subsidiary of the United Kingdom-based Borax Holdings, continued active development of the Quartz Hill molybdenum deposit 45 miles east of Ketchikan. U.S. Borax estimated proven and probable minable ore reserves to be more than 1.5 billion tons with an average grade of 0.136% molybdenite, using a cutoff grade of 0.07% molybdenite. This includes 200 million tons of at-surface ore grading better than 0.2% molybdenite. Since its discovery in 1974, U.S. Borax has spent $41 million on the Quartz Hill Project. Diamond drilling has produced 231,214 feet of cores from 420 holes drilled to explore the deposit. The only access to the camp and deposit is by helicopter. The exploratory and development phase of the project has included geologic mapping, core drilling, surface sampling, surveying, aerial and topographic mapping, investigation of facility sites, small-scale metallurgical testing, environmental baseline data collection, bathymetric surveys, market investigations, and project evaluations.

In 1981, the U.S. Forest Service published a Draft Mining Development Concepts Analysis Document (CAD), followed by a Final CAD, and on December 3 a Draft Environmental Impact Statement (EIS): Road Access and Bulk Sampling at the U.S. Borax Quartz Hill Molybdenum Claims, Tongass National Forest, Alaska. These three documents, with the scheduled release dates, were specified by ANILCA. Following publication of the Final EIS in 1982 the Forest Service may determine the route for a 10-mile access road to the deposit from either Boca de Quadra Fiord or Wilson Arm and issue a permit for the road. Construction will probably start in 1982 and the removal of a 5,000-ton bulk sample required for metallurgical testing and mill design may be completed in 1983.

AMAX Exploration, Inc., continued exploration diamond drilling at the Groundhog Basin molybdenum deposit east of Wrangell. No activity was reported at the Burroughs Bay deposit of AMAX and Duval Corp. The 1981 assessment work was done in September 1980. This deposit is in the Misty Fiords National Monument wilderness.

Nickel and Cobalt.—Inspiration Development Co. did assessment work drilling at their nickel-copper-cobalt claims on Yakobi Island and on the Mirror Harbor deposit on Chichagof Island, about 15 miles south of the Yakobi Island deposits. Several companies conducted exploratory investigations for nickel and cobalt in a number of ultramafic rock bodies and prospected for cobalt in other types of deposits. No reports of worthwhile discoveries are known. The identification of a cobalt resource in the Ruby Creek copper-zinc deposit was the only announced discovery. The grade or amount of contained cobalt at Ruby Creek was not specified.

Platinum-Group Metals.—The Goodnews Bay district produced the only platinum-group metals reported in Alaska. The bucketline dredge of Hanson Properties Inc. worked part of the 1981 season at the Salmon River placer platinum deposit. The 8-cubic-foot dredge was installed on the property in 1937 by Goodnews Bay Mining Co. It was operated by them until 1975, when Goodnews stopped mining. Hanson purchased the property with all equipment and facilities and has been getting the equipment into operating condition, training personnel, learning the intricacies and problems of a unique and highly specialized operation, and preparing to move the dredge to richer ground.

Several companies that own or control deposits with nickel, copper, cobalt, or magnetite values in mafic host rocks are reassessing the deposits for possible platinum-group metals content. In southeastern Alaska, renewed investigations and research on samples from the Brady Glacier nickel-copper-cobalt deposit by Newmont Mining Corp. and the U.S. Geological Survey has identified a resource of over 0.5 million ounces of platinum-group metals in the drill-explored, 80-million-ton portion of the deposit. Additional metallurgical research will be required to determine the economics and efficiencies of recovery. Inspiration Development Co. has supplied samples from their Yakobi Island deposits to research laboratories for similar analyses. The old Salt Chuck Mine, a former producer of cop-

per, gold, palladium, and a small amount of platinum, was relocated by Fox Consultants. Exploration in 1981 included diamond drilling, geologic mapping, and sampling on the surface and in underground workings.

Finnbear Mining and Exploration Co. is exploring a gold-platinum lode deposit near Rainy Pass, northwest of Anchorage. Several companies are assessing the platinum-group metals potential of gold placer deposits reported to have produced some platinum. Placers in the eastern Seward Peninsula, upper Chistochina River area, and on Cache Creek in the Yentna area are among these deposits.

Silver.—Management of the Greens Creek Joint Venture silver-gold-zinc-lead property has been transferred to Noranda Mining from Noranda Exploration. Field activities in 1981 included excavation of a crosscut from the diamond drill adit to the mineral horizon, some drifting along the horizon, obtaining a mineral sample suitable for metallurgical testing, seismic surveys, and shallow diamond drilling to evaluate proposed alternative tailings disposal sites. The bulk sample was shipped to a metallurgical laboratory for detailed testing. The joint venture has invested more than $9 million for claim staking, metallurgical test work, geophysical surveying, excavation of the 4,200-foot drill station adit, 48,000 feet of diamond core drilling, and environmental studies. All access to the deposit area has been by helicopter. Nearly 4,100 hours of flying time have been used in support of all exploration and predevelopment activities, moving in drilling and mining equipment, surface facilities, camp, supplies, and personnel.

Diamond drill core intercepts have indicated geologic reserves above the 1,100-foot elevation estimated at 3 million short tons containing over 10 ounces of silver per ton, 0.1 ounce of gold per ton, 8% to 10% zinc, 2.5% lead, and 0.5% copper. Additional exploration along the vertical and horizontal extent of the ore horizon could add several million tons to the indicated reserves. The U.S. Forest Service is preparing a Greens Creek Draft EIS scheduled for release late in the summer of 1982.

Anaconda did some drilling on the Pyrola silver-zinc-lead-barite property on Admiralty Island. Alaska Silveinia Mines explored for silver, gold, and lead at their vein deposits in the Bishop Creek area of the Kaiyuh Mountains. Some ore was reported mined and hand sorted.

Silverstar Mining Co. continued developing the Silverstar and Pandora properties in the Granite Mountain area, on the upper Kotsina River, in the Wrangell Mountains.

Tin.—Lost River Mining Co. produced and marketed cassiterite concentrates from its Cape Creek placer property. The mine is east of Wales on the western part of the Seward Peninsula. This was the only tin production reported to the U.S. Bureau of Mines in 1981. Lee Mine on lower Cape Creek was apparently inactive. Tin concentrates are produced as a coproduct at some gold placer operations. Delta Smelting and Refining obtained cassiterite concentrates from a gold placer operation in the Manley area for tin smelting tests and feasibility studies.

Lost River Mining explored for placer tin. Anaconda continued work on their Kougarok Mountain greisen-type deposit, a few miles west of Taylor. Hawk Mining prospected for lode tin in the Dorothy Creek and Christian Creek areas. Several other companies have been prospecting and exploring for tin on the Seward Peninsula. Patino Inc. explored for tin and tungsten on lands of Doyon, Ltd. Interesting lode and placer results have been obtained in the Kanuti-Kilolitna-Sithylemenkat area. Land, designated the Steese National Conservation Areas, was created by ANILCA and closed to mineral entry. Several companies have mining claims in the Steese areas predating the restrictive act. The area has tungsten and tin resources that, with more exploration, might be developed as economic sources of several metals. Assessment work was done on the Purkeypile silver-tin-beryllium deposit southwest of Mount McKinley. A tin discovery was reported south of the Golden Zone Mine and west of the Alaska Railroad. A massive sulfide deposit near Sheep Creek, east of Healy, contains tin-bearing zones similar to those at the Sullivan Mine in Canada. Bear Creek is working on this copper-zinc-lead-silver deposit.

Tungsten.—The Yellow Pup Mine produced the only tungsten concentrates reported in Alaska. Vince Manzulla has operated this mine and its gravity mill for several years. The mine is on Gilmore Dome, about 15 miles northeast of Fairbanks. There is some renewed interest in tungsten exploration at Gilmore Dome and in the Steele Creek-First Chance area, closer to Fairbanks. Houston International Minerals is exploring tungsten-bearing skarns north of the Salcha River and south-

east of Chena Hot Springs. Several companies staked claims for tungsten and tin on lands designated in ANILCA as the 1.22-million-acre Steese National Conservation Areas. One area is north of the Steese Highway and 55 to 100 miles northeast of Fairbanks. The other area is south of the highway and 55 to 120 miles east-northeast of Fairbanks. Birch Creek traverses the northern part of this area. Mining companies have been working with BLM to develop mutually acceptable regulations providing access to claims and the exploration and development of mineral deposits.

[1]State Liaison Officer, Bureau of Mines, Juneau, Alaska.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	Region
Gold:			
Alaska Gold Co	Box 64 Nome, AK 99762	Placer-dredge	Seward Peninsula, Yukon River.
Canadian Natural Resources Inc	Box 467 Fairbanks, AK 99707	Placer	Do.
Little Squaw Gold Mining Co	Box 184 Spokane, WA 99210	Lode, placer	Do.
Northland Gold Dredging Ltd	8740 Hartzell Rd. Anchorage, AK 99507	Placer-dredge	Kuskokwim River.
Territorial Corp	Box 6217 Albuquerque, NM 87197	Placer	Copper River.
Sand and gravel:			
Anchorage Sand and Gravel Co	1813 East 1st Ave. Anchorage, AK 99501	Pit	Cook Inlet-Susitna.
Brechan Enterprises Inc	Box 1275 Kodiak, AK 99615	Pit	Kodiak.
Energy Co. of Alaska	4607 East Tudor Rd. Anchorage, AK 99507	Pit	Cook Inlet-Susitna.
Fairbanks Sand and Gravel Inc	Box 686 Fairbanks, AK 99701	Pit	Yukon River.
Herndon and Neal Gravel Co	Box 393 Homer, AK 99603	Pit	Kenai Peninsula.
Red Samm Construction Inc	Route 6, Box 6800 Juneau, AK 99803	Pit	Southeastern Alaska.
Stephans and Sons	6957 Old Seward Highway Anchorage, AK 99502	Pit	Cook Inlet-Susitna.
U.S. Bureau of Land Management	Box 13, 701 C Street Anchorage, AK 99513	Pit	Various.
Stone:			
Aleutian Constructors	Box 4D Anchorage, AK 99509	Quarry	Do.
Moore Construction Co	Box 8100 Ketchikan, AK 99901	do	Southeastern Alaska.
Morrison Knudsen Co. Inc	813 D St. Anchorage, AK 99501	do	Various.
City of Sitka	Box 79 Sitka, Ak 99835	do	Southeastern Alaska.
U.S. Forest Service, Region 10	Box 1628 Juneau, AK 99802	do	Southeastern Alaska, various.
Yutan Construction Co	Box 1775 Fairbanks, AK 99707	do	Yukon River.
Tin:			
Lost River Mining Co	Box 411 Nome, AK 99762	Placer	Seward Peninsula.

The Mineral Industry of Arizona

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Arizona Bureau of Geology and Mineral Technology for collecting information on all nonfuel minerals.

By Lorraine B. Burgin[1]

The value of Arizona nonfuel mineral production increased from $2.5 billion in 1980 to a record $2.6 billion in 1981. Copper output surpassed the high achieved in 1979, and Arizona again ranked first in national production of nonfuel minerals and copper. Arizona produced almost 68% of the Nation's copper in 1981. Arizona once more ranked second in molybdenum produced, with 30% of the national total; second in silver, with nearly 20% of domestic production; and fourth in gold, with about 7% of that production. All of these metals were recovered principally as byproducts or coproducts of copper production.

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

Mineral	1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	151	$1,151	148	$1,105
Copper (recoverable content of ores, etc.) metric tons	r770,118	r1,738,908	1,040,813	1,953,142
Gem stones	NA	3,100	NA	3,250
Gold (recoverable content of ores, etc.) troy ounces	r79,631	r48,779	100,339	46,120
Gypsum thousand short tons	209	2,017	213	2,594
Lead (recoverable content of ores, etc.) metric tons	r162	r152	993	800
Lime thousand short tons	514	23,904	538	29,913
Molybdenum (content of concentrate) thousand pounds	35,668	341,965	35,808	254,345
Pumice thousand short tons	r9	r13	1	3
Sand and gravel do	24,399	73,773	p22,679	p69,855
Silver (recoverable content of ores, etc.) thousand troy ounces	r6,268	r129,363	8,055	84,728
Stone:				
Crushed thousand short tons	r6,205	r24,780	6,315	26,263
Dimension do	W	45	W	578
Zinc metric tons	W	W	138	135
Combined value of asbestos, barite (1981), cement, perlite, pyrites, salt, tungsten, vanadium, and values indicated by symbol W	XX	r83,037	XX	93,009
Total	XX	r2,470,987	XX	2,565,840

pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of nonfuel mineral production in Arizona, by county

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Apache	$1,900	$2,560	Sand and gravel, stone, clays.
Cochise	29,479	30,651	Copper, lime, stone, sand and gravel.
Coconino	2,521	W	Stone, sand and gravel, pumice.
Gila	253,024	236,730	Copper, silver, molybdenum, gold, sand and gravel, lime, asbestos, stone, clays.
Graham	496	483	Sand and gravel, stone, pumice.
Greenlee	385,755	321,206	Copper, gold, silver, lime, stone, sand and gravel.
Maricopa	r47,526	48,164	Sand and gravel, stone, salt, lime, clays, silver, lead.
Mohave	52,813	74,908	Molybdenum, copper, silver, stone, sand and gravel, gold, vanadium.
Navajo	2,942	1,298	Sand and gravel.
Pima	914,846	1,043,374	Copper, molybdenum, silver, cement, gold, sand and gravel, stone, clays, lead, zinc, tungsten.
Pinal	589,683	484,290	Copper, molybdenum, silver, gold, stone, sand and gravel, gypsum, lime, perlite, lead, pyrites, zinc, clays.
Santa Cruz	W	264	Sand and gravel.
Yavapai	199,699	214,803	Copper, cement, molybdenum, silver, lime, stone, sand and gravel, gold, clays, gypsum.
Yuma	W	W	Sand and gravel, stone, lead, silver, copper, gold.
Undistributed[1]	r9,797	12,259	
Total	2,490,481	[2]2,470,987	

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Includes gem stones and values indicated by symbol W.
[2]Data do not add to total shown because of independent rounding.

Table 3.—Indicators of Arizona business activity

		1980	1981p	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	1,149.3	1,200.7	+4.5
Unemployment	do	75.4	78.9	+4.6
Employment (nonagricultural):				
Mining[1]	do	21.0	25.0	+19.0
Manufacturing	do	154.4	159.6	+3.4
Contract construction	do	76.5	70.0	-8.5
Transportation and public utilities	do	51.3	53.8	+4.9
Wholesale and retail trade	do	243.0	254.1	+4.6
Finance, insurance, real estate	do	58.2	61.1	+5.0
Services	do	207.7	216.0	+4.0
Government	do	201.8	199.7	-1.0
Total nonagricultural employment[1]	do	[2]1,014.0	1,039.3	+2.5
Personal income:				
Total	millions	$24,013	$27,087	+12.8
Per capita		$8,814	$9,693	+10.0
Construction activity:				
Number of private and public residential units authorized		36,803	33,664	-8.5
Value of nonresidential construction	millions	$759.9	$702.9	-7.5
Value of State road contract awards	do	$117.0	$115.0	-1.7
Shipments of portland cement to and within the State	thousand short tons	1,457	1,479	+1.5
Nonfuel mineral production value:				
Total crude mineral value	millions	$2,471.0	$2,565.8	+3.8
Value per capita, resident population		$892	$944	+5.8
Value per square mile		$21,295	$22,525	+5.8

pPreliminary.
[1]Includes bituminous coal and oil and gas extraction.
[2]Data do not add to total shown because of independent rounding.

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

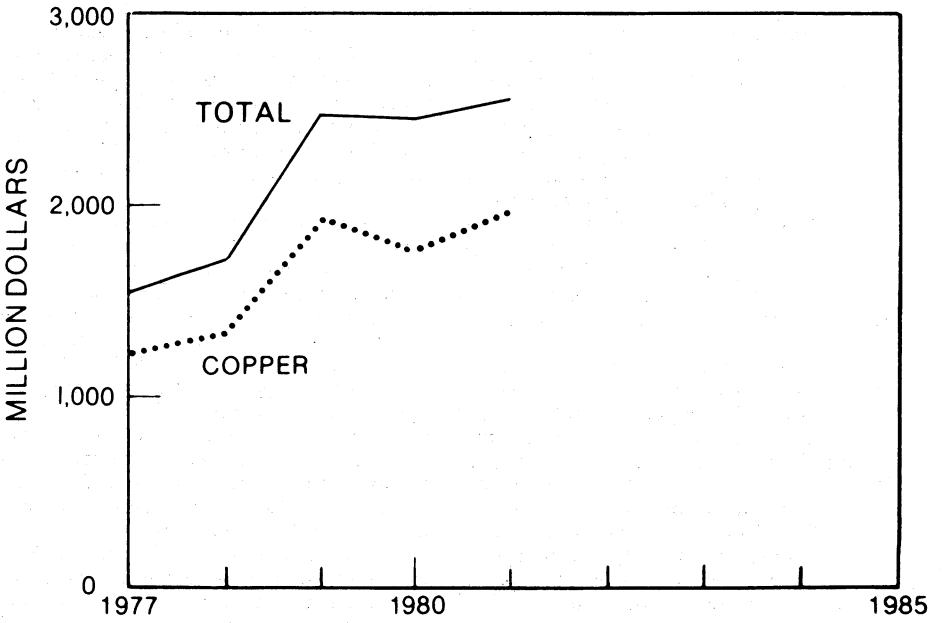

Figure 1.—Value of mine production of copper and total value of nonfuel mineral production in Arizona.

Metal production increased to $2.34 billion in 1981, compared with $2.26 billion in 1980; however, as a percent of the total value of nonfuel mineral production in the State, the metals group dipped slightly to 91.2% in 1981 from the 91.4% in 1980. The drop is attributed to the decrease in price of every metal except zinc. Recovering from the copper strike of 1980, copper and its coproduct or byproduct metals all increased in output; however, because of the drop in metal prices, molybdenum, silver, and gold all decreased in value of production.

Portland cement, sand and gravel, lime, and crushed stone were the leading commodities in the nonmetals group in terms of value. Asbestos, clays, pumice, and pyrites each declined in value of output.

Trends and Developments.—Arizona had a record production of copper in 1981, in both quantity and value, despite the fall of copper prices to the lowest point since January 1979. High interest rates and inflation induced cutbacks in the automotive, construction, and other industries that used copper and its byproduct metals. Weakening prices and markets for the metals resulted in efforts to reduce output of some Arizona operations early in the year. The expected rally in the markets by fall did not materialize, and companies curtailed production through shutdowns, furloughs, and extended holiday vacations during the fourth quarter of the year. Higher costs and the plummeting prices of the byproduct metals, which had sustained the Arizona copper companies during the strike-ridden year of 1980, led to lower profits for the metal mining divisions of many of these firms.

The Kennecott Corp. and Standard Oil Co. of Ohio (Sohio) merger on June 4, 1981, continued the trend of oil companies acquiring Arizona copper operations. Arizona operations that survived the takeover-rush through 1981 included AMAX Inc., ASARCO Incorporated, Newmont Mining Corp., and Phelps Dodge Corp.

Exploration and prospecting for gold and silver continued throughout the year, even though prices of the metals declined. Ranchers Exploration and Development Corp. carried on its geologic mapping and surface-sampling program at the Mystic gold property in the Hieroglyphic Mountains near Phoenix, Maricopa County. Hecla Mining

Co., a 50% partner with Fischer-Watt Mining Co. and Canadian Natural Resources, Ltd., of Calgary, Alberta, had an exploration project in the Oatman (San Francisco, Gold Road) gold mining district, Mohave County. Other companies with projects in the area included Meridian Land and Mineral Co., a subsidiary of the Burlington Northern Railroad Co., which together with Crown Resources Corp. staked claims for gold in the Union Pass (San Francisco) district. In another venture with Houston Oil and Minerals Corp., Crown Resources acquired additional claims in the same area.[2]

Stan West Mining Corp. acquired mining properties at five sites in the Prescott-Jerome area of Yavapai County, including the Stan-McCabe properties in the Big Bug mining district. The Grubstake Mine and Development Co. explored for gold and silver at the old Grubstake Mine and the Sorrell Top Mine in the Oro Blanco mining district, Santa Cruz County. Houston Mining and Resources, Inc., leased claims and prospected for silver in the Tombstone and Courtland-Gleeson region, Cochise County. Tombstone Exploration, Inc., and State of Maine Mining Co. continued mining and treating silver ores near Tombstone. Arizona Silver Corp. of Vancouver, British Columbia, reopened the old G.A.R. and Hulda shafts on its White Hills property, near Chloride, Mohave County, and cyanide vat-leached waste dumps and tailings in the area.

In other developments, Canadian Natural Resources and Fischer-Watt mined and milled silver-lead ore from the old McCracken Mine properties, Mohave County, from September 1980 to April 1981. At another old mine, the Congress, Yavapai County, Congress Consolidated Gold Mining Co. recovered gold using a cyanide-leach process. Yuma Metals, Inc., explored the old Red Cloud Mine in the Silver mining district in the Trigo Mountains, Yuma County.

The Bureau of Land Management (BLM), in late June 1981, reopened 32,000 acres of Federal land near Yuma for mineral exploration. Located in the Muggins Mountains east of Yuma, the 50-square-mile area was withdrawn from public use in 1952 when it was made part of the U.S. Army Yuma Test Station.

Legislation and Government Programs.—On November 30, 1981, the Arizona Supreme Court unanimously upheld the constitutionality of the 1980 Groundwater Management Act. The decision affirmed the authority of the Arizona Department of Water Resources to regulate the State's groundwater supplies in the interest of the "public good." Overdraft of groundwater is a serious problem in the State, and beginning in 1985, as authorized by the act, a conservation program will be enforced on municipal, industrial (including mining), and agricultural water users.

The Arizona Mining Association (AMA) estimated the Arizona copper mining industry paid nearly $120 million in taxes and royalties to the State in 1981, compared with about $118 million in 1980. Salaries, wages, and fringe benefits paid by the copper companies exceeded $794 million in 1981 and over $610 million in 1980. Expenditures for environmental control facilities in this industry were more than $472 million in 1981 and over $450 million in 1980. AMA reported that 25,446 workers were employed in Arizona copper mining operations in 1981, compared with 26,280 in 1980. These mines and related facilities used 214,977 acres in the State in 1981.[3] Federal and State areas restricted from mineral entry totaled 34,316,465 acres, 47.2% of the State land area.[4]

The Bureau of Mines awarded contracts and grants totaling $753,000 to organizations in the State of Arizona during fiscal year 1981.

REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Copper.—Surpassing the high achieved in 1979, copper set a new record in both quantity and value of production in 1981, recovering from the 1980 strike-induced slump in output. Output increased 35%; however, because of the drop in copper price from an average $1.02 in 1980 to an average $0.85 per pound in 1981, the value of copper production gained only 12%.

Of total copper production, 849,972 metric tons was recovered from processing 184,366,575 metric tons of ore treated by concentration; 61,982 metric tons from electrowinning 7,332,848 metric tons of copper ore; 55,328 metric tons from heap or vat leaching 4,859,345 metric tons of ore; 209 metric tons from 109,716 metric tons of direct-smelting copper ore; 63,650 metric tons from precipitates from "waste dump" or in-place leaching; and 4,975 metric tons of precipitates from leaching ore.

Copper was produced from 44 operations in Cochise, Gila, Greenlee, Maricopa, Mohave, Pima, Pinal, Yavapai, and Yuma Counties. Of these, 22 were large-scale operations producing over 100,000 tons of copper ore and/or precipitates per year. The larger operations are discussed in the following section where all quantities noted are in terms of short tons unless otherwise identified.

Amoco Minerals Co., a subsidiary of Standard Oil Co. (Indiana), acquired Cyprus Mines Corp. in June 1980. During 1981, Cyprus Mines Corp., the operating subsidiary of Amoco, continued to manage Cyprus Bagdad Copper Co., Cyprus Pima Mining Co. (now owned 75.01% by Amoco and 24.99% by Utah International Corp., a division of General Electric Co.), and Cyprus Johnson Copper Co.

The Cyprus Bagdad installation, 120 miles northwest of Phoenix, Yavapai County, comprised the Cyprus Bagdad open pit mine, a 54,000-ton-per-day (tpd) concentrator, and a solvent extraction-electrowinning plant (SX-EW). In 1981, the company's ongoing $95 million construction project included purchasing seven dump trucks and two power shovels for the mine, completing the concentrator expansion from 40,000 to 54,000 tpd, and adding 198 residences for a total of 783 at the Bagdad townsite.

At Tucson, the Cyprus Metallurgical Process Corp. completed testing its Cymet hydrometallurgical process for producing high-purity copper from concentrates. Ores from Cyprus Bagdad were tested at the pilot plant, and a decision on the commercial use of the process will be reached after a review of the engineering data. Bagdad had no smelter; its concentrates were shipped to the Phelps Dodge smelter at Hidalgo, N. Mex.

Cyprus Pima operated an open pit copper mine and a 32,500-tpd concentrator about 16 miles south of Tucson. Plans for increasing the capacity to 45,500 tpd were deferred until the price of copper improves. The company extended its Christmas shutdown from 4 to 9 days, cutting its December copper production approximately 33%. Normal employment was about 737 workers.

Cyprus Johnson exchanged, with the BLM, two parcels of land in Graham and Cochise Counties for 769.96 acres adjacent to the Cyprus Johnson Mine near Benson, Cochise County.

According to the Standard Oil Co. (Indiana) 1981 annual report, copper production for all its Amoco mineral operations was more than 234 million pounds, a 21% increase over that of 1980. Standard's copper ore reserves, including all of its Arizona properties, were 554 million tons at an average grade of 0.475% in 1981, compared with 444 million tons at an average grade of 0.493% in 1980.

The Anamax Mining Co., owned equally by AMAX and Anaconda Minerals Co. (formerly Anaconda Copper Co.), a wholly owned subsidiary of the Atlantic Richfield Co., operated the Twin Buttes Mine 25 miles south of Tucson, Pima County. The Twin Buttes complex comprised an open pit mine, a 40,000-tpd sulfide ore concentrator, a 10,000-tpd ion-exchange electrowinning plant for processing solutions from leached oxide ores, and a uranium oxide extraction plant.

In response to declining markets, Anamax, early in November, terminated about 172 employees indefinitely. As many as 1,532 production workers were employed at the operation early in 1981.

The Eisenhower Mining Co., under an Anamax and Asarco general partnership, mined the Palo Verde copper deposit north of the Twin Buttes Mine between Asarco's Mission and San Xavier Mines. Asarco operated the mine; ores from each partner's interest in the Eisenhower property were crushed and then treated either at Asarco's Mission concentrator or transported over a 6.5-mile conveyor system for treatment at the Anamax Twin Buttes concentrator. In 1981, Anamax estimated its share of reserves at Eisenhower (Palo Verde deposit) to be 112 million tons, averaging 0.55% copper; Asarco estimated its share of reserves to be 35 million tons of 0.74% copper and 0.14% silver.

Asarco owned and operated the Mission and San Xavier open pit mines and the Mission 22,500-tpd concentrator near Sahuarita, Pima County, about 15 miles south of Tucson; the Sacaton open pit mine and 11,000-tpd concentrator about 5 miles north of Casa Grande, Pinal County; and the Silver Bell open pit mine and 11,400-tpd concentrator at Silver Bell, Pima County, 38 miles northwest of Tucson. Concentrates were processed through the Asarco-owned Hayden smelter at Hayden, Pinal County.

The 1981 Asarco annual report listed production as follows at its Arizona properties: Mission treated 4,779,000 tons of ore in 1981 and recovered 33,600 tons of copper, 555,000 ounces of silver, and 537,000 pounds

of molybdenum, compared with 1,118,000 tons of ore treated and 7,300 tons of copper, 89,000 ounces of silver, and 71,000 pounds of molybdenum recovered in 1980.

Sacaton treated 4,103,000 tons of ore and recovered 21,000 tons of copper, 172,000 ounces of silver, and 3,334 ounces of gold in 1981, compared with 3,819,000 tons of ore treated and 16,100 tons of copper, 124,000 ounces of silver, and 2,504 ounces of gold recovered in 1980.

Silver Bell treated 3,689,000 tons of ore and recovered 23,300 tons of copper, 221,000 ounces of silver, and 236,000 pounds of molybdenum in 1981, compared with 2,205,000 tons of ore treated and 12,900 tons of copper, 88,000 ounces of silver, and 195,000 pounds of molybdenum recovered in 1980.

San Xavier treated 1,740,000 tons of ore and recovered 8,600 tons of copper, 81,000 ounces of silver, and 32,000 pounds of molybdenum in 1981, compared with 502,000 tons of ore treated and 2,100 tons of copper, 19,000 ounces of silver, and 28,000 pounds of molybdenum recovered in 1980.

In its 1981 Form 10K Annual Report (10K Report) submitted to the Securities and Exchange Commission, Asarco estimated mineral reserves at its Arizona properties, as of December 31, 1981, as follows: San Xavier, 163.7 million tons of 0.52% copper and 0.06 ounce of silver per ton; Mission, 89.6 million tons of 0.76% copper and 0.14 ounce of silver per ton; Silver Bell, 22.7 million tons of 0.68% copper and 0.07 ounce of silver per ton; and Sacaton, 22.5 million tons of 1.06% copper.

At the Mission Mine, the company neared completion of a 2-year $32 million capital investment project that included purchasing twenty 170-ton trucks, constructing five shop bays for truck maintenance, installing larger copper flotation cells, modifying the molybdenum flotation circuit, and adding solar water heat and women's facilities to the employee change house.[5]

Table 4.—Arizona: Production and value of copper in Arizona and the United States

Year	Arizona copper production		U.S. copper production		Arizona
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Percent of U.S. copper production
1977	838,038	$1,234,168	1,364,374	$2,009,297	61.4
1978	891,405	1,306,866	1,357,586	1,990,323	65.7
1979	946,002	1,940,211	1,443,556	2,960,676	65.5
1980[r]	770,118	1,738,908	1,181,116	2,666,931	65.2
1981	1,040,813	1,953,142	1,538,160	2,886,440	67.7

[r]Revised.

Table 5.—Arizona: 15 leading copper-producing mines in 1981, in order of output

Rank in 1981	Rank in 1980	Mine	County	Operator	Source of copper in 1981
1	1	Morenci	Greenlee	Phelps Dodge Corp	Copper ore and precipitates.
2	5	San Manuel	Pinal	Magma Copper Co	Copper ore.
3	4	Ray Pit	do	Kennecott Copper Corp	Copper ore and precipitates.
4	3	Twin Buttes	Pima	Anamax Mining Co	Copper ore.
5	7	Pinto Valley	Gila	Cities Service Co	Copper ore and precipitates.
6	2	Sierrita	Pima	Duval Corp	Copper ore.
7	6	Bagdad	Yavapai	Cyprus Bagdad Copper Co	Do.
8	8	Inspiration	Gila	Inspiration Consolidated Copper Co.	Copper ore and precipitates.
9	9	Eisenhower	Pima	Eisenhower Mining Co	Copper ore.
10	13	Magma (Superior).	Pinal	Magma Copper Co	Do.
11	10	Pima	Pima	Cyprus Pima Mining Co	Do.
12	11	New Cornelia	do	Phelps Dodge Corp	Do.
13		Mission	do	ASARCO Incorporated	Do.
14		Silver Bell	do	do	Copper ore and precipitates.
15	15	Sacaton Unit	Pinal	do	Copper ore.

Table 6.—Arizona: Material handled and copper produced at 16 leading copper open pit and underground mines

Mine	Ore mined (thousand metric tons)		Waste material removed (excluding material placed in leach dumps) (thousand metric tons)		Material placed in leach dumps (thousand metric tons)		Total copper produced[1] (metric tons)	
	1980	1981	1980	1981	1980	1981	1980	1981
OPEN PIT								
Morenci	16,051	26,073	11,832	15,735	14,983	26,873	120,659	175,931
Ray	10,142	13,441	--	--	29,946	25,294	76,360	104,887
Twin Buttes	10,006	[2]11,362	29,209	[2]35,942	2,020	[2]1,162	84,283	93,455
Pinto Valley	10,037	17,278	--	--	16,299	29,417	42,416	80,457
Sierrita	32,086	32,986	35,612	25,205	--	7,219	93,666	79,531
Bagdad	13,771	13,421	19,712	23,416	863	588	58,024	64,869
Inspiration	3,795	6,088	NA	9,349	NA	6,740	32,779	50,427
Eisenhower	6,602	7,305	17,109	14,452	--	--	30,867	40,777
Pima	6,630	10,356	47,343	31,659	--	--	26,821	38,607
New Cornelia	6,388	8,809	8,126	4,295	--	--	26,224	34,135
Mission	[r]1,013	4,335	[r]3,548	8,713	--	--	[r]6,646	30,487
Silver Bell	2,000	3,351	2,019	3,400	1,071	1,323	11,698	21,104
Sacaton	3,465	3,722	7,668	4,844	--	--	14,603	19,064
Esperanza	5,504	5,687	1,470	4,225	2,715	6,875	21,782	19,531
UNDERGROUND								
San Manuel	12,522	20,138	20	64	--	--	72,696	115,739
Magma (Superior)	505	927	93	160	--	--	21,886	40,082

[r]Revised. NA Not available.
[1]Gross metal content.
[2]Wet weight.

Table 7.—Arizona: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Lode mines producing[1]	Material sold or treated (metric tons)	Gold		Silver	
			Troy ounces	Value	Troy ounces	Value
1979, total	42	185,485,876	101,840	$31,315,805	7,478,942	$82,941,467
1980, total[r]	33	155,244,137	79,631	48,778,766	6,267,588	129,363,016
1981:						
Gila	7	25,933,646	(2)	(2)	422,376	4,442,707
Pima	15	84,246,956	(2)	(2)	4,094,673	43,069,286
Pinal	9	39,946,963	(2)	(2)	1,672,223	17,589,062
Yuma	2	15,232	194	89,170	771	8,109
Undistributed[3]	16	46,926,244	100,145	46,030,650	1,865,188	19,618,738
Total	49	197,069,041	100,339	46,119,820	8,055,231	84,727,902

	Copper		Lead		Zinc		Total value
	Metric tons	Value	Metric tons	Value	Metric tons	Value	
1979, total	946,002	$1,940,211,347	354	$410,996	W	W	W
1980, total[r]	770,118	1,738,907,764	162	151,849	W	W	W
1981:							
Gila	147,404	276,612,250	(2)	(2)	(2)	(2)	$284,068,184
Pima	354,675	665,566,173	(2)	(2)	(2)	(2)	716,836,201
Pinal	278,753	523,095,165	(2)	(2)	(2)	(2)	562,884,238
Yuma	(2)	(2)	18	14,878	(2)	(2)	113,000
Undistributed[3]	259,981	487,867,946	975	784,959	138	$135,270	521,022,740
Total	1,040,813	1,953,141,534	993	799,837	138	135,270	2,084,924,363

[r]Revised. W Withheld to avoid disclosing company proprietary data.
[1]Operations at which metals were recovered from tailings are not counted as mines.
[2]Included in "Undistributed."
[3]Includes Cochise, Greenlee, Maricopa, Mohave, and Yavapai Counties and items indicated by footnote 2 combined to avoid disclosing company proprietary data.

Table 8.—Arizona: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1981, by class of ore or other source material

Source	Number of mines[1]	Material sold or treated (metric tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode ore:							
Gold[2]	7	1,527	204	W	W	W	--
Gold-silver	3	13,473	1,850	[3]110,848	--	--	--
Silver	10	111,218	367	203,601	W	W	W
Total	19	126,218	2,421	314,449	W	W	W
Copper	28	196,668,266	95,496	7,565,368	[4]972,466	[3]993	[3]138
Lead	2	3,572	9	1,907	W	W	W
Total	30	196,671,838	95,505	7,567,275	[5]972,466	[3]993	[3]138
Other lode material:							
Gold-silver tailings[6]	1	158,257	2,413	173,507	[3]62	W	--
Copper precipitates	6	112,730	--	--	68,284	--	--
Total[7]	7	270,986	2,413	173,507	68,347	W	--
Grand total[7]	49	197,069,041	100,339	8,055,231	1,040,813	993	138

W Withheld to avoid disclosing company proprietary data.
[1]Detail will not add to total shown because some mines produce more than one class of material. Operations from which metals are recovered only from tailings or precipitates are not counted as producing mines.
[2]Includes material that was leached.
[3]Includes columnar data indicated by symbol W to avoid disclosing company proprietary data.
[4]Includes copper recovered from precipitates of ore leached.
[5]Does not include copper from lead ore.
[6]Combined to avoid disclosing company proprietary data.
[7]Data may not add to totals shown because of independent rounding.

Table 9.—Arizona: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1981, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode:					
Cyanidation	[1]913	[1]1,592	--	--	--
Acid leaching (vat, tank, heap)	--	--	[2]122,286	--	--
Smelting of concentrates	95,481	7,694,911	849,972	895	137
Direct smelting of:					
Ore	2,432	185,521	[3]271	[3]98	1
Precipitates	--	--	[2]68,284	--	--
Tailings	[4]1,513	[4]173,207	([5])	([5])	--
Total	3,945	358,728	[6]68,556	98	1
Grand total	100,339	8,055,231	[6]1,040,813	993	138

[1]Includes metal recovered by cyanidation process.
[2]Includes copper recovered by electrowinning process.
[3]Includes metal recovered from tailings.
[4]Does not include metal recovered from tailings by cyanidation process.
[5]Combined with metal recovered by direct smelting of ore to avoid disclosing company proprietary data.
[6]Data do not add to total shown because of independent rounding.

The company shut down its Sacaton underground project in September 1981; however, the surface mine and mill at Sacaton remained in operation. High construction costs and excess water halted Sacaton's underground exploration and development program for the third time since its inception. Fifty to sixty contract workers on the building program were terminated.

Asarco, on December 23, 1981, closed its Silver Bell Mine. About 240 workers were affected by the cutback. Asarco reported 16% of the unit's total production continued to be recovered from leach dumps. On the same day, workers at the Mission and Sacaton open pit operations were given extended holidays until January 4, 1982.

On June 22, 1981, a judge in the U.S. District Court for Arizona signed a consent decree between Asarco and the Environmental Protection Agency (EPA) setting forth emission limitations for sulfur dioxide and particulates for the Hayden smelter. At a cost of $132.6 million, a new furnace and

related equipment will be constructed at the Hayden smelter site, in addition to a new acid plant, water-treatment plant, and upgrading of the present acid plant. Environmental restrictions and resultant intermittent curtailment of smelter operations have prevented the smelter from reaching its rated annual capacity of 175,000 tons of blister copper; during the year, the company recovered 110,200 tons.

In October, Asarco secured $30 million in tax-exempt bonds from the Industrial Development Authority of Gila County; part of the $80 million to $88 million needed to construct the pollution-control facilities.

The Miami operations of Cities Service Co. included the Pinto Valley open pit mine, a 50,000-tpd concentrator, and a new 33,000-pound-per-day SX-EW plant about 6 miles west of Miami, Gila County; and at Miami, another SX-EW plant that treated leach solutions from the company's old underground Miami copper mine. Leaching operations were also continued through the year at the old Copper Cities property in the Miami area.

According to the Cities Service 1981 annual report, the company recovered 165,100,000 pounds of copper from its milling facilities at its Miami operations, 19,522,000 pounds of copper from its leaching plants, and a record 1,393,000 pounds of molybdenum in concentrate. In 1981, copper production was up substantially over that of 1980 when the copper strike shut down the Pinto Valley Mine and mill for 18 weeks. The company estimated proven and probable reserves at its Miami properties on September 30, 1981, at 404.6 million tons of ore of 0.447% copper, 398.6 million tons at the Pinto Valley open pit mine, and 6 million tons at its Miami East underground mine scheduled to begin production the third quarter of 1982.

During the year, the company completed constructing the new $26 million SX-EW plant on an 8-acre site just west of the Pinto Valley No. 2 tailings pond. The plant is scheduled to produce about 11 million pounds of copper cathode per year.

Development work at the Miami East underground mine continued with production expected in the fall of 1982. Reserves are an estimated 6 million tons of sulfide ore averaging 3.14% copper.[6]

On May 19, 1981, Cities Service announced plans to sell its Miami Copper operations in Arizona and its Industrial Chemical Div. at Copperhill, Tenn. The company reported that copper production from its Arizona mining operations in 1981 was a record 184.6 million pounds because of higher average ore quality and improvements in recovery.

Duval Corp., a subsidiary of Pennzoil Corp., operated the Sierrita and adjacent Esperanza open pit copper-molybdenum mines about 30 miles south of Tucson, Pima County, and the Mineral Park surface copper-molybdenum mine, 15 miles northwest of Kingman. Ores were processed through concentrators at each mine; Sierrita had a design capacity of 82,500 tpd, Esperanza, 15,000 tpd; and Mineral Park, 19,000 tpd.

The company's concentrates and precipitates were sold as such, processed at the Duval Copper Leach Electrolysis and Regeneration (CLEAR) process hydrometallurgical plant near the Sierrita property, or toll smelted and refined by others for redelivery and marketing by Duval. Operated at 99% of its 40,000-ton-per-year (tpy) capacity in 1981, the CLEAR plant manufactured copper crystals electrolytically from concentrates produced at the Sierrita and Esperanza Mines and from precipitates recovered at the Esperanza and Mineral Park Mines.

According to the Pennzoil 1981 annual report, copper production at Duval's Arizona and Nevada operations dropped from 275,003,000 pounds in 1980 to 246,770,000 pounds in 1981; the molybdenum coproduct production fell from 23,509,000 pounds to 21,855,000 pounds in 1981; and byproduct silver output increased in 1981.

As of December 31, 1981, the company estimated reserves at Sierrita were 366 million tons of ore containing 0.3% copper and 0.035% molybdenum; at Esperanza 49 million tons of ore of 0.27% copper and 0.034% molybdenum; and at Mineral Park 36 million tons of 0.17% copper and 0.054% molybdenum.

Beginning December 14, 1981, Duval curtailed operations at all of its copper-molybdenum facilities in Arizona. The CLEAR plant, however, remained open to treat the inventory of copper concentrates. Production was expected to resume in 3 months. Of the 2,505 workers at the Sierrita and Esperanza operations, about 1,335 were laid off. At the Mineral Park Mine, Mohave County's largest employer, 283 of the 434 workers normally employed were laid off.

Inspiration Consolidated Copper Co. operated the Thornton, Live Oak, Red Hill, and Joe Bush open pit copper mines at Inspiration; a heap leach at the upper and lower Ox Hide Mines about 8 miles west of Inspiration; and the Christmas open pit

mine about 35 miles southeast of Inspiration, Gila County. Inspiration Consolidated is a subsidiary of Plateau Holdings, Inc., which is jointly owned by Hudson Bay Mining and Smelting Co., Ltd., and Minerals and Resources Corp., Ltd. Principal plants of Inspiration in the Miami area include crushing facilities, a 20,000-tpd concentrator, a 20,000-tpd vat leaching plant, precipitation and solvent extraction plants, an electrowinning plant, a smelter with an annual capacity of 150,000 tons of blister copper, a sulfuric acid plant, a 72,000-ton-annual capacity electrolytic refinery, and a rod-fabricating plant. In 1981, besides treating its own material, the smelter and electrorefinery processed approximately 76,000 tons of copper for toll customers.

Productivity at the Inspiration Mine was improved by (1) the use of six leased 170-ton haulage trucks, (2) upgrading concentrator performance, (3) the smelter modification project begun April 1, (4) installation of a $3 million instrumentation monitoring system, and (5) operating the rod plant at 47.3% above its original design capacity.

The modernization, expansion, and environmental control project at Inspiration was financed in part by $90 million of Gila County Industrial Development Authority 20-year pollution control revenue bonds. In the 10 years ending December 31, 1981, the company had made capital expenditures of more than $97 million for pollution-control facilities at its smelter.

The Inspiration Consolidated 1981 annual report estimated reserves at the Inspiration area mines, as of December 31, 1981, were 221 million tons of 0.51% copper; at the Christmas open pit mine, 8 million tons of 0.63% copper, and at the inactive Christmas underground mine, 20 million tons of 1.78% copper; at the inactive Ox Hide Mine, 29 million tons of 0.3% copper; and at the inactive Sanchez Mine, 79 million tons of 0.36% copper.

In mid-December, the company announced plans to suspend operations at its Christmas Mine in Gila County and at its Sanchez project near Safford, Graham County, and to cut back 10% of its hourly employees at Miami early in 1982. At yearend, the company employed 2,181.

On June 4, 1981, at a cost of $1.77 billion, Kennecott was acquired by Standard Oil Co. of Ohio (Sohio), which is in turn 53% owned by British Petroleum Co. In Arizona, Kennecott Minerals Co., a subsidiary of Kennecott Corp., operated the Ray Mines Div. The facilities included an open pit copper mine; a 15,000-tpd silicate ore vat leach, an electrowinning copper refinery, and a solvent extraction plant near Ray, Pinal County; and 22 miles to the southeast, a 27,000-tpd concentrator, a smelter with an annual capacity of 80,000 tons of copper anodes, and a sulfuric acid plant at Hayden, Gila County.

The Sohio 1981 10K Report stated the Ray Mines Div. mined, milled, and treated 14,816,000 tons of ore in 1981 compared with 11,180,000 tons in 1980. The average grade of ore mined in 1981 was 0.969% copper compared with 0.916% in 1980. Copper recovered from all sources in 1981 was 111,267 tons compared with 84,269 tons in 1980. In 1981, reserves at the Ray pit were an estimated 606 million tons of ore of 0.7% copper and 0.010% MoS_2; Ray silicate copper reserves were 226 million tons of ore of 0.68% copper.[7]

Normally employing about 2,050 workers at its mine, mill, and smelter, the company cut back about 250 workers on March 1, 1981. In late December 1981, plans were announced to shut down production 3 to 8 weeks for maintenance in July 1982; about 600 workers would be affected in the action.

During the year, Kennecott began studying a modernization project at Ray, to expand the mill capacity to 80,000 tpd.[8]

Magma Copper Co., a subsidiary of Newmont Mining Corp., had two major operations in Pinal County, one at San Manuel, 43 miles northeast of Tucson, the other at Superior, 60 miles east of Phoenix. The San Manuel Div. included an underground mine, a 64,000-tpd concentrator, a smelter with 200,000 tons annual capacity of anode copper, a 200,000-ton-annual-capacity refinery, and a 125,000-tpy continuous cast-rod mill.

San Manuel production returned to normal levels in 1981, following a labor strike and a mine fire in 1980. Mine ore production, according to the Newmont 1981 annual report, reached 22,198,000 tons of 0.635% copper in 1981, compared with 13,803,000 tons of 0.65% copper in 1980. Smelter operations were curtailed periodically to comply with air-quality standards resulting in an 11.8% reduction of throughput in 1981 versus 9.5% in 1980. Development work on the Kalamazoo project, scheduled for production in 1983, was halted at yearend.

Magma Copper estimated ore reserves at San Manuel, including the Kalamazoo Mine, were 704 million tons averaging

0.707% copper at the end of 1981, compared with 653 million tons averaging 0.716% copper in 1980.

Following the copper industry pattern in 1981, Magma Copper shut down its operation from December 24, 1981, to January 2, 1982, for a Christmas maintenance program at the San Manuel and Superior Mines.

The company annual report showed the Superior Div. mined and milled 1,022,000 tons of ore averaging 4.48% copper in 1981, compared with 556,800 tons of 4.32% copper in 1980. Approximately 42,460 tons of copper, 610,800 ounces of silver, and 19,300 ounces of gold were recovered. Estimated reserves in 1981 at Superior were 5 million tons averaging 5.52% copper, compared with 6 million tons of 5.5% copper in 1980.

Noranda Lakeshore Mines, Inc., subsidiary of Noranda Mines, Ltd., of Toronto, Canada, operated the Noranda Lakeshore Mine 28 miles southwest of Casa Grande, on the Papago Indian Reservation, in Pinal County. The company continued developing its underground block-cave operation. According to the Noranda 1981 annual report, severe ground conditions required steel supports in virtually every heading. The resulting ore-draw scheduling in the mine caused difficulties that reduced ore production to 82% of that planned. Ores mined from the oxide ore body were vat leached, and after problems with excessive fines were solved, copper recovery exceeded forecasts for the last 5 months of the year. An $8 million solvent-extraction plant, which was brought onstream in June, contributed to improved copper recovery rates and treatment costs.

In 1981, Noranda reported treating 1,767,000 tons of ore and recovering 13,035 tons of copper in cathodes. Reclassification of oxide ore at the Lakeshore Mine reduced its reserves estimate from 22 million tons of 1.21% copper in 1980, to 17 million tons of 1.17% copper in 1981; sulfide tactite ores in 1981 were estimated to be 9 million tons of 1.35% copper, and sulfide porphyry ores were estimated to be 41 million tons of 0.65% copper. Production from the sulfide ore body will not begin until economically feasible.

Phelps Dodge Corp. ranked first in the State in total copper production. During the year, Phelps Dodge operated the Morenci open pit mine 169 miles northeast of Tucson, Greenlee County; the New Cornelia open pit mine at Ajo, Pima County, 106 miles southeast of Phoenix; and the Copper Queen Branch, which recovered copper precipitates by leaching low-grade material at the permanently closed Lavender Pit Mine at Bisbee, Cochise County.

At Morenci, the installations included the Morenci Mine and a 60,000-tpd concentrator, the adjacent Metcalf Mine with a 40,000-tpd concentrator, and a smelter with an annual capacity of 160,000 tons of product. Low-grade material was usually leached at both Morenci and Metcalf, and precipitates were processed at the Morenci smelter. The Metcalf Mine was shut down at the end of 1980, and beginning in 1981, the Morenci Mine supplied both the Morenci and Metcalf concentrators. The arrangement lowered the overall waste-to-ore ratio and temporarily increased the grade of ore delivered to the concentrators. Morenci installed two additional banks of 1,000-cubic-foot flotation cells in the mill. The tailings leach plant at Morenci was not operated during 1981.

The New Cornelia operation at Ajo included the mine, a 34,000-tpd concentrator, and a smelter that has an annual capacity of more than 50,000 tons of product. Expansion of the New Cornelia pit continued. The first product from the molybdenite recovery plant, completed in November 1980, was shipped January 26, 1981.

The Phelps Dodge 1981 annual report showed production of recoverable copper at the Morenci, Ajo, and Bisbee properties reached 233,800 tons of copper in 1981, compared with the 165,100 tons of copper produced in strike-affected 1980. Production in 1981 was lower than that of 1979 because of the Metcalf Mine shutdown, operating schedules were reduced at Morenci beginning March 1981, and summer vacations and December holiday shutdowns were extended at Morenci and Ajo.

In other developments, Phelps Dodge purchased the Western Copper Property from the Hanna Mining Co. on April 1, 1981. The $10 million purchase included 81 patented claims covering 1,862 acres east of the Morenci Mine and adjacent to the Metcalf. Phelps Dodge had leased the property from Hanna since 1961.

At midyear, Phelps Dodge established the Small Mines and Development Div. to develop and explore small mines. Shamrock Enterprises' Ash Peak Mine east of Safford was leased by the company, and the siliceous silver-bearing ore was shipped for use as flux at the Morenci smelter. The old Campbell and Shattuck Mines at Bisbee were under an exploration and mining pro-

gram during 1981.[9] The company reached an agreement with Verde Exploration, Ltd., to reopen the Edith shaft of the United Verde Extension Mine (Daisy Mine) at Jerome, Yavapai County, which had been closed since 1938. During the year, Phelps Dodge expended an additional $8 million developing its low-grade sulfide copper deposit near Safford.

A consent decree negotiated with the EPA on the Morenci and Ajo smelters' air-quality compliance programs was approved by the Federal District Court in Arizona on October 15, 1981. Deferred compliance orders required Phelps Dodge to bring sulfur dioxide and particulate emissions into compliance with certain regulations under the Clean Air Act by January 1, 1985, at Morenci and by December 31, 1985, at Ajo. Construction of a 500-tpd smelter using the new oxygen sprinkle process began at Morenci in May 1981. By yearend, Phelps Dodge had spent $17.4 million on compliance programs at Morenci; total cost is expected to be about $185 million.

No major expenditures on the compliance program at Ajo are necessary until early 1983, and the company was evaluating the possibility of closing that smelter instead of spending the estimated $45 million dollars required to complete the program.

Phelps Dodge asked for a variance at the Douglas smelter to allow the same sulfur dioxide emissions limitation requirements until yearend 1982. If a second nonferrous smelter order were granted at Douglas, the smelter could be operated under current Federal law until December 31, 1987. The company said that costs of bringing this smelter into compliance with 1981 air-quality standards would inevitably force the company to close the operation.

Sulfuric acid was a byproduct of smelter output at the Ajo and Morenci plants in Arizona and the plant at Hidalgo in New Mexico. Approximately 901,000 tons of sulfuric acid was produced at these facilities in 1981, and 882,100 tons was sold at prices below the cost of production.

Ranchers Exploration and Development Corp. owned and operated the Bluebird Mine, Gila County. Low-grade ore was open pit mined, leached with sulfuric acid, and the resulting copper-bearing solutions were processed through a SX-EW plant. Mining and construction of leaching heaps were halted in July 1981; copper, however, continued to be recovered throughout the year from previously built heaps.

According to the company annual report for the fiscal year ending June 30, 1981, copper production at the Bluebird Mine increased from 12,189,249 pounds of copper cathodes in 1980 to 13,598,470 pounds in 1981. Reserves were estimated to be 65 million tons of ore averaging 0.53% copper.

The Old Reliable Mine near Mammoth, Pinal County, was closed in 1981 after producing 424,603 pounds of cement copper during Ranchers' fiscal year; in the 1980 fiscal year, 1,850,057 pounds of copper was produced. The mine was the first copper deposit in the United States to be blasted on a large scale and leached entirely in place.

Gold.—Gold continued to be recovered principally as a byproduct of Arizona copper production. After the 1980 copper strike, the quantity of gold produced in 1981 increased 26%, almost recovering to its 1979 level. The value of gold production, however, declined over 5% because of the drop in the price of gold from an average unit price of $612.56 per troy ounce in 1980 to $459.64 per troy ounce in 1981. Listed, in order of production, copper operations at San Manuel, Morenci, Magma (Superior), New Cornelia, Pinto Valley, Sacaton, Christmas, Bagdad, Twin Buttes, Sierrita, Pima, Inspiration, Ray, and Mineral Park collectively recovered 95% of the gold produced in the State.

The higher gold and silver prices in 1980 stimulated the exploration and development of small mines (under 100,000 tons of material treated) during 1981. Twenty-two small operations recovered gold. Noteworthy was Congress Consolidated Gold Mining Co.'s recovery of gold by leaching dumps near the old Congress Mine, Yavapai County.

Lead.—Arizona output of lead in 1981 increased 513% over that of 1980, and the value of lead produced rose 426% even though the average unit price of lead dropped from $0.4246 per pound in 1980 to $0.3653 per pound in 1981. The increase in lead production was attributed to resumption of operations after the 1980 copper strike; a brief rally in the price of lead after 7 major lead mines in Missouri were shut down by a midyear, 12-week strike; the reopening of 13 precious and base metal mines; and a shortage of lead scrap. Large copper producers accounted for more than 51% of lead produced in the State. Listed, in order of output, major lead producers were the McCracken, Silver Bell, Sierrita, Tiger, Mission, Mineral Park, Pinto Valley,

Eisenhower, Hull, Sacaton, and San Xavier mines. Thirteen small mines and eight large copper mines recovered lead in the State.

Molybdenum.—Ranked second in production after Colorado, Arizona shipped 30% of the Nation's molybdenum in 1981. All molybdenum was recovered as a byproduct or coproduct of copper production. Copper operations shipping molybdenum ore and concentrates were, in descending order of production, Sierrita, San Manuel, Mineral Park, Twin Buttes, Esperanza, Bagdad, Pima, Pinto Valley, Ray, Mission, Inspiration, Eisenhower (Palo Verde), and Silver Bell. Sixty-six percent of the State's molybdenum production came from Pima County. Stimulated by high prices and demand for molybdenum the past several years, many copper operations in Arizona had installed new molybdenum circuits or reactivated old ones. In 1981, the nationwide oversupply of molybdenum and resultant lower prices were reflected in Arizona's insignificant 0.39% increase in the amount of molybdenum ore and concentrates shipped, and a 25% decrease in the value of those shipments. The average producer's price per pound of molybdenum contained in technical-grade molybdic oxide dropped from $9.70 in 1980 to $6.85 in 1981.

Rhenium.—A rhenium product was scheduled to be recovered for the first time in Arizona at Duval's Sierrita Mine. Ammonium perrhenate, a compound of rhenium, was to be obtained as a byproduct of roasting molybdenum concentrates. Production of about 8 pounds of ammonium perrhenate per day was expected from the new facility that was to come online in October of 1981 and, if operated daily, would produce 2,600 pounds of the rhenium compound per year.[10] By yearend, however, the plant had not yet attained marketable ammonium perrhenate production. In 1980, the average price per pound of metal powder (99% pure perrhenic acid) was $1,500; however, in 1981, the price dropped to $675. More than 92% of rhenium production in the Nation was used in platinum-rhenium catalysts for low-lead and lead-free high-octane gasoline.

Silver.—Arizona achieved a record output of silver in 1981; not since the depression years of 1936 and 1937 was as much silver produced. The value of silver production, however, decreased about 34% from the record high set in 1980, as the average annual price of silver plunged from $20.63 per troy ounce in 1980 to $10.52 per troy ounce in 1981.

Ranking second in output after Idaho, the State produced 20% of the Nation's silver. The following large open pit operations recovered 94% of the precious metal as a byproduct of their 1981 copper production: Twin Buttes, Sierrita, Morenci, Eisenhower (Palo Verde), Magma (Superior), San Manuel, Mission, Bagdad, Pima, Ray, Pinto Valley, Silver Bell, Mineral Park, New Cornelia, Sacaton, San Xavier, Christmas, and Inspiration. Thirty small operations also produced silver, about one-half as precious metal mines and the rest as precious and base metal operations. In 1980, only nine small mines had recovered silver.

Tungsten.—Tungsten shipments in the State decreased in quantity but increased slightly in value in 1981. A small amount of tungsten was shipped by Joseph Parent from his mine in Pima County, and by Bell Associates from its property in Pinal County. Tungsten concentrates were shipped to Union Carbide Corp. and Kennametal, Inc.

Vanadium.—Arizona vanadium production increased slightly during 1981 when a small amount was shipped from Mohave County to the Energy Fuels Nuclear, Inc., plant at Blanding, Utah.

Zinc.—Zinc production in the State increased substantially during 1981. Listed in decreasing order of output, the following large copper operations recovered zinc as a byproduct of copper production: Mission, Mineral Park, Eisenhower, San Xavier, Sierrita, Pinto Valley, and Sacaton. Three small operators recovered zinc at their precious and base metal operations in Mohave, Pima, and Yuma Counties. In 1980, only two large copper mines recovered zinc. The average unit price of the metal rose from $0.374 per pound in 1980 to $0.446 per pound in 1981.

NONMETALS

Asbestos.—The State's asbestos production and shipments continued to decline in quantity and value. Arizona was third among three States producing and shipping asbestos fiber; as in the other States, the quantity of shipments and sales declined in 1981. Jaquays Mining Corp., the only active asbestos operation in the State, mined a low-iron, chrysotile fiber at the El Dorado underground mine in Ash Creek Canyon, Gila County. The ore was treated at the company's Globe mill for shipment to markets out of State.

In recent years, State agencies have designated the sites of several asbestos milling operations at Globe as hazardous areas, and

during 1981, all were closed except the Jaquays operation. Residents of a mobile home park were temporarily evacuated from a land development on abandoned tailings while a 6-inch soil base was placed over the site. Reportedly, erosion allowed some of the tailings to work through the cover, and in 1981, the State requested funds from the EPA to clean up the development.

Cement.—Gray portland cement production increased almost 2% in 1981; however, the value of that output increased more than 12%. Masonry cement decreased 11% in output, but the value of that production also increased.

Phoenix Cement Co., a division of Gifford-Hill & Co., Inc., produced cement at its 550,000-ton-per-year plant near Clarkdale, and the Arizona Portland Cement Co., a division of California Portland Cement Co., produced cement at its 1,150,000-tpy plant at Rillito. Both installations mainly use natural gas and coal for their dry-process kilns; in addition, both companies purchase electrical energy. Leading consumers of finished portland cement were ready-mix concrete companies, concrete-product manufacturers, highway contractors, building material dealers, and others.

About 250 employees of the Rillito plant of Arizona Portland Cement and about 150 workers from the Clarkdale plant of Phoenix Cement Co. were involved in a strike that lasted from May 8 to June 8, 1981.

Clays.—Total production of clays declined slightly in amount and value in 1981. Although common clay output was the same in 1981 as in 1980, bentonite production dropped about 9%, and no ball clay was mined. Clay producers, listed in order of quantity mined, included Phoenix Brick Yard, Maricopa and Pima Counties; Phoenix Cement, Yavapai County; Filtrol Corp., Apache County; United Catalysts, Inc., Yavapai County; Superior Companies' Arizona Gypsum Corp., Yavapai County; McKusick Mosaic Co., Gila County; and Magma Copper, Pinal County.

Filtrol, United Catalysts, and Superior Companies mined nonswelling bentonite; McKusick Mosaic mined swelling bentonite; and Phoenix Brick Yard, Phoenix Cement, and Magma Copper mined common clay and shale. Common clay and shale were used principally for portland cement and face brick, and nonswelling bentonite was used primarily for filtering, clarifying, and decolorizing animal oils, mineral oils and greases, and vegetable oils.

Gem Stones.—Arizona continued to lead the Nation with more than 42% of its gem stone production. Turquoise found in the oxidized parts of the State's copper deposits is one of the most abundant gem stones; others include agate, amethyst, chalcedony, chrysocolla, jasper, malachite, marekanite (Apache tears), onyx marble, peridot, pyrope garnet, and shattuckite. The Black Bear Corp. was formed in 1981 to develop a newly discovered deposit of black (nephrite) jade south of the Mogollon Rim.

Gypsum.—Production of crude gypsum increased in amount and value in 1981, despite the decline in the construction industry. The major producer of crude and calcined gypsum, National Gypsum Co., had a quarry and crushing plant at Feldman near Winkelman, Pinal County, and its calcining and wallboard plant in Phoenix, Maricopa County. Superior Companies obtained crude gypsum from a quarry 4 miles southeast of Camp Verde in Yavapai County and from another quarry and plant near Winkelman, Pinal County. At both localities, gypsum was mined for use as a cement additive. Pinal Mammoth Gypsum Co. quarried gypsum for agricultural use at the Thunderbird Mine 6 miles north of Mammoth.

Lime.—In 1981, the slight rise in production of lime and substantial gain in value of output were attributed to resumption of operations after the 5-month copper strike in 1980 and a sizable increase in the price of lime. Most lime in Arizona was used at copper operations as pH-adjusting reagent of beneficiating ores in the flotation concentrating process; however, lesser amounts are used in smelters as a flux and for absorbing SO_2 from stack gases and in the construction industry. Genstar Cement & Lime Co. in Yavapai County was the leading producer in 1981, followed by Paul Lime Div. of Can-Am Corp., Cochise County; Magma Copper (San Manuel) and Kennecott Minerals Co. (Ray Mines Div.), Pinal County; Amstar Corp., Maricopa County; and Phelps Dodge, Greenlee County. Arizona ranked 12th in the Nation in lime production.

Perlite.—The quantity of crude perlite mined by Arizona's two perlite producers decreased in 1981; however, the amount and value of the processed ore sold or used increased over that of 1980. Harborlite, Inc., processed perlite at its plant 2 miles west of Superior. Perlite was shipped to expanding plants in California and Michigan. Filters International, Inc., operated the Chicago Pit

southwest of Superior and marketed its product in Illinois, Louisiana, Texas, and Wyoming. Although only a small quantity of perlite was mined in Arizona, the State ranked second in the Nation after New Mexico. Perlite was used as a filtering aid in the beverage, chemical, pharmaceutical, and sugar industries; as an agriculture fertilizer carrier; and in the building construction industry.

Pumice and Pumicite (Volcanic Ash).—The Gila Valley Block Co. P-B-T operation near Safford was the only producer of pumice in the State in 1981. The material was processed and used in concrete aggregate, insulation, and landscaping.

Pyrites.—Magma Copper, Superior Div., sold pyrites from its Magma Mine in 1981.

Salt.—Salt output in the State remained the same as in 1980; its value, however, rose. Southwest Salt Co., Arizona's only salt producer, solution mined the Luke Salt deposit west of Glendale, Maricopa County. Recovered by solar evaporation, the product was marketed for water softeners and for domestic and industrial purposes.[11]

Sand and Gravel.—This chapter contains only preliminary estimates for construction sand and gravel production, but contains complete data on industrial sand and gravel. To reduce reporting burdens and costs, the Bureau of Mines implemented new canvassing procedures for its 1981 surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and completed the following year.

Preliminary estimates indicated that construction sand and gravel production declined in 1981; industrial sand, however, increased in both quantity and value. Principal producers of industrial sand included Arizona Silica Sand Co., Apache County; A. J. Gilbert Construction Co., Cochise County; Little Hill Mines, Inc., Pinal County; and Don Kelland Materials, Yuma County. Most industrial sands were used as silica flux for the copper industry, and the remainder for hydrofracture treatment of oil wells, blasting, and filtration; a small amount of industrial gravel was used for filtration. One operation quarried more than 50% of the industrial sand and gravel produced.

Table 10.—Arizona: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	6,712	$20,781	$3.10	NA	NA	NA
Gravel	17,517	51,057	2.91	NA	NA	NA
Total or average	24,229	71,838	2.96	ᵖ22,500	ᵖ$67,400	ᵖ$3.00
Industrial:						
Sand	W	W	11.41	W	W	13.75
Gravel	W	W	8.67	W	W	W
Total or average	170	1,936	11.39	179	2,455	13.71
Grand total or average	24,399	[1]73,773	3.02	ᵖ22,679	ᵖ69,855	ᵖ3.04

ᵖPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included in "Total."
[1]Data do not add to total shown because of independent rounding.

Stone.—Total stone production increased in quantity and value in 1981; in percent, the most dramatic increase was in output of dimension stone. Crushed stone, however, continued to comprise most of the total stone production. In 1981, the Bureau of Mines included volcanic cinder and scoria data under stone, which accounts for the rise in value and amount of stone production.

Two companies continued to quarry limestone for cement: Arizona Portland Cement, Pima County; and Phoenix Cement, Yavapai County.

Lime used in copper operations was manufactured from limestone by Paul Lime Div. of Can-Am, Cochise County; by Ray Mines Div. of Kennecott Minerals, and San Manuel Div. of Magma Copper, Pinal County; and by Genstar Cement & Lime (for-

merly Flintkote Lime Co.), a subsidiary of Genstar Corp. (Canada), Yavapai County. Limestone used as flux in copper smelters was mined by Paul Lime Div., Cochise County; Pattullo Lime plant, Gila County; Phelps Dodge, Greenlee County; and McFarland-Hullinger and Ray Mines, Pinal County. Sandstone or siliceous ores used as flux in copper smelters was mined by Charlie Nichols, Gila County; Phelps Dodge, Greenlee County; and Little Hills Mines, Inc., Magma Copper, and McFarland-Hullinger in Pinal County.

In other applications, Superior Companies in Apache County crushed limestone for treating sulfur dioxide stack gases. Paul Lime Div. also crushed limestone in Cochise County for sugar refining, for treating sulfur dioxide stack gases, and for terrazzo and exposed aggregate. The Pattullo Lime plant produced dead-burned dolomite in Gila County. Robert E. McKee, Inc., Mohave County, mined and crushed dolomite for use as dense-graded road base stone. Crushed marble was produced for use as fine aggregate, poultry grit, roofing granules, and terrazzo and exposed aggregate by Andrada Marble Co. and Catalina Marble Co. in Pima County. Granite Construction Co. mined and crushed limestone for riprap and jetty stone in Pima County. Ray Mines also used limestone as a filter stone. J & A Mining Corp. produced a fine aggregate and filler material from stone in Pinal County.

Crushed granite was produced in Maricopa County for use as unspecified aggregate by Choctaw Materials, Inc.; Deer Valley Granite, Sand and Stonetown of Arizona, Inc.; and Sanner Contracting Co. Also in Maricopa County, Tall Stone and Supply Co., Inc., crushed granite for use as dense road base stone; and Madison Granite Co. crushed granite for use as terrazzo and exposed aggregate. A & A Materials, Inc., also crushed granite in Pinal County.

The Flagstaff Cinder Sales Co., Coconino County, and various governmental agencies mined and used volcanic cinder for dense-graded road base stone. The Gila Valley Block Co. mined cinder in Graham County for use in concrete aggregate, and Superlite Builders Supply obtained scoria in Coconino County for concrete aggregate.

Hazel Bowman quarried dimension sandstone for flagging in Coconino County; Catalina Marble cut irregular-shaped dimension marble in Pima County; and Apache Stone and Supply quarried a dimension sandstone for rubble in Yavapai County.

Including volcanic cinder and scoria, crushed and dimension stone was obtained from 53 quarries in the State; the average unit value of all stone was $4.24 per ton.

Sulfuric Acid.—Arizona ranked first in the Nation in production of sulfuric acid. Of the total domestic output, 34% was recovered as a byproduct from the State's copper smelters. In 1981, the 1.3 million tons of sulfuric acid produced in the State was valued at $22,372,000.

Table 11.—Arizona: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Poultry grit and mineral food	14	142	13	177
Bituminous aggregate	W	W	(2)	1
Dense-graded road base stone	r882	W	W	4,970
Other construction aggregate and road stone	209	365	178	273
Riprap and jettystone	W	W	17	83
Railroad ballast	W	2,813	--	--
Manufactured fine aggregate	80	762	118	1,119
Terrazzo and exposed aggregate	151	718	76	379
Lime manufacture	950	4,851	1,088	4,910
Dead-burned dolomite	--	--	11	W
Flux stone	465	2,052	411	2,149
Other fillers or extenders	36	W	59	W
Fill	11	16	--	--
Roofing granules	7	93	4	90
Other[3]	r3,401	r12,968	4,340	12,111
Total[3]	r6,205	r24,780	6,315	26,263

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Other."

[1]Includes limestone, granite, marble, sandstone, miscellaneous stone (1981), and volcanic cinder and scoria.

[2]Includes concrete aggregate, filter stone, cement manufacture, refractory stone (1980), sugar refining, sulfur removal from stack gases, and other uses not specified.

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

Vermiculite.—W. R. Grace & Co. continued to bring crude vermiculite into Maricopa County for processing. Output of exfoliated vermiculite decreased in 1981; value, however, rose. Leading uses of the product included fireproofing, concrete aggregate, block insulation, and as soil conditioners.

Zeolites.—The natural zeolite chabazite was shipped from a deposit near Bowie, Cochise County. Union Carbide reportedly shipped chabazite from Bowie; however, production remained about the same as the much depressed 1980 rate.[12]

[1]State Liaison Officer, Bureau of Mines, Denver, Colo.
[2]Western Prospector & Miner. May 1982, p. 1.
[3]Arizona Pay Dirt. 1981 Was Banner Production, Tax Year for Arizona Copper Mines. No. 517, July 1982, p. 5.
[4]Arizona Today's Business (Special Mining Issue). An Editorial: How Much Arizona Land for Mining? V. 7, No. 11, Dec. 24, 1981, pp. M8, M11, M14, M17.
[5]Builder Architect/Contractor Engineer. $32 Million Capital Investment at ASARCO Mission Mine. November 1981, pp. 34-35.
[6]Mining Record (Denver, Colo.). Oct. 14, 1981, p. 1.
[7]Argall, G. O. (senior ed.). Takeovers Shake USA Mining Companies. World Min., v. 34, No. 5, May 1981, pp. 56-59.
[8]Arizona Pay Dirt. Kennecott Starts Moving on Copper Projects. No. 507, September 1981, pp. 1, 4, 5.
[9]Phelps Dodge Today. Small Mines and Mine Development. V. 3, No. 3, September 1981.
[10]Arizona Pay Dirt. Duval Is Squeezing One More Squeal Out of Pig-Rhenium. No. 507, September 1981, pp. 1, 8.
[11]Pierce, H. W. Major Salt Deposits. Arizona Bureau of Geology and Mineral Technology, Fieldnotes, v. 11, No. 4, December 1981, pp. 1-5.
[12]Eyde, T. H. Zeolites. Min. Eng., v. 34, No. 1, May 1982, p. 583.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
Asbestos:			
Jaquays Mining Corp	1219 South 19th Ave. Phoenix, AZ 85009	Underground mine crushing, screening, air-separation plant.	Gila.
Cement:			
Arizona Portland Cement Co.,[1] a division of California Portland Cement Co.	Box 338 Rillito, AZ 85246	Quarry and dry-process, 4-rotary-kiln plant.	Pima.
Phoenix Cement Co.,[2] a division of Gifford-Hill, Inc.	2505 West Beryl Box 35395 Phoenix, AZ 85069	Quarry and dry-process, 3-rotary-kiln plant.	Yavapai.
Cinder:			
Flagstaff Cinder Sales, Inc	Old Highway 66 Box 2796 Flagstaff, AZ 86003	Quarry	Coconino.
Superlite Builders Supply	4150 West Turney Box 23163 Phoenix, AZ 85063	Open pit mine	Do.
Clays:			
Filtrol Corp	Box 155 Sanders, AZ 86512	____do	Apache.
Phoenix Brick Yard	1814 South 7th Ave. Phoenix, AZ 85007	____do	Maricopa.
Copper:			
Amoco Minerals Co., a subsidiary of Standard Oil Co. (Indiana)			
Cyprus Mines Corp., a subsidiary of Amoco:			
Cyprus Bagdad Copper Co.[3 4 5]	Box 245 Bagdad, AZ 86321	Open pit mine, mill, dump leach, solvent extraction-electrowinning plant.	Yavapai.
Cyprus Johnson Copper Co	Drawer R Benson, AZ 85602	Open pit mine, heap leach, solvent extraction-electrowinning plant.	Cochise.
Cyprus Pima Mining Co.[3 4 5]	Box 7187 Tucson, AZ 85725	Open pit mine and mill	Pima.
Anamax Mining Co.,[3 4 5] Twin Buttes Mine.	Box 127 Sahuarita, AZ 85629	Open pit and underground mines and mill.	Do.
ASARCO Incorporated:			
Hayden Unit	Box 98 Hayden, AZ 85235	Smelter and acid plant	Gila.
Mission Unit[3 4 6 7]	Box 111 Sahuarita, AZ 85629	Open pit mine and mill	Pima.
Sacaton Unit[4 5 6 7]	Box V Casa Grande, AZ 85222	____do	Pinal.
San Xavier Unit[4 6 7]	Box 111 Sahuarita, AZ 85629	Open pit mine	Pima.
Silver Bell Unit[3 4 6]	Silver Bell, AZ 85270	Open pit mine, mill, leach dumps, precipitation plant.	Do.
Cities Service Co., Miami Operations: Pinto Valley Mine.[3 4 5 6 7]	Box 100 Miami, AZ 85539	Open pit mine, mill, leach dumps, in-place leaching precipitation plants, solvent extraction-electrowinning plants.	Gila.

See footnotes at end of table.

Table 12.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Copper—Continued			
Duval Corp., a subsidiary of Pennzoil Co.:			
Esperanza Mine[3] and Sierrita Mine [3 4 5 6 7]	Box 125 Sahaurita, AZ 85629	Open pit mines, mills, leach dumps, precitation plant.	Pima.
Mineral Park Mine [3 4 5 6 7]	Box 3009 Kingman, AZ 86401	Open pit mine, mill, leach dumps, precipitation plant.	Mohave.
Eisenhower Mining Co., Palo Verde Mine. [3 4 6 7]	Box 39 Sahuarita, AZ 85629	Open pit mine	Pima.
Inspiration Consolidated Copper Co. [3 4 5]	Box 4444 Claypool, AZ 85532	Open pit mines, mill, vat leaching plant, solvent extraction-electrowinning plant, in-place leaching, heap leaching, precipitation plant, rod plant, custom smelter, electrolytic refinery.	Gila.
Christmas Mine [4 5]	Box 4444 Claypool, AZ 85532	Open pit mine and mill	Do.
Ox Hide Mine	Box 4444 Claypool, AZ 85532	Open pit mine and heap leach	Do.
Kennecott Minerals Co., a subsidiary of Kennecott Corp., a subsidiary of Standard Oil Co. (Ohio), Ray Mines. [3 4 6]	Hayden, AZ 85235	Open pit mine, precipitation, vat leaching, solvent extraction-electrowinning plants, smelter.	Gila and Pinal.
Magma Copper Co., a subsidiary of Newmont Mining Corp.:			
San Manuel Div.[1 3 4 5]	Box M San Manuel, AZ 85631	Underground mine, mill, smelter, refinery, continuous rod casting plant.	Pinal.
Superior Div.[4 5]	Box 37 Superior AZ 85273	Underground mine and mill	Do.
Noranda Lakeshore Mines, Inc., a subsidiary of Noranda Mines, Ltd.	Box C6 Casa Grande, AZ 85222	Underground mine, mill, vat leach, and solvent extraction-electrowinning plant.	Do.
Phelps Dodge Corp.:			
Copper Queen Branch[4 5]	Highway 92 Bisbee, AZ 85603	Underground mine, leach dumps, in-place leaching, precipitation plant.	Cochise.
Douglas Reduction Works	Drawer E Douglas, AZ 85607	Smelter	Do.
Morenci Branch[3 4 5]	Morenci, AZ 85540	Open pit mines, mills, tailings leach plant, leach dumps, precipitation plant, smelter.	Greenlee.
New Cornelia Branch[3 4 5]	Drawer 9 Ajo, AZ 85321	Open pit mine, mill, smelter.	Pima.
Ranchers Exploration and Development Co., Bluebird Mine.	Box 880 Miami, AZ 85539	Open pit mine, dump leach, solvent extraction-electrowinning plant.	Gila.
Dolomite:			
Robert E. McKee Inc	Box 107 Peach Springs, AZ 86434	Quarry	Mohave.
Gypsum:			
National Gypsum Co.:			
Winkelman Gypsum Pit	Star Route, Box 3990 Winkelman, AZ 85292	Open pit mine	Pinal.
Gold Bond Building Products Div.	Box 20863 Phoenix, AZ 85036	Plant	Maricopa.
Pinal-Mammoth Gypsum	Box 1208 Coolidge, AZ 85228	Open pit mine	Pinal.
Superior Companies[8]	2402 South 19th Ave. Phoenix, AZ 85005	Quarries and plant	Apache, Pinal, Yavapai.
Lead:			
Canadian National Resources, Ltd., Fischer-Watt Mining Co., McCracken Mine.[4 5 7 9]	300 5th Ave. SW. Calgary, Alberta G2P 3C4	Open pit mine and mill	Mohave.
Lime:			
Paul Lime Div. of Can-Am Corp	Drawer T Douglas, AZ 85607	Quarry and 3 lime kilns	Cochise.
Kennecott Corp., Ray Mines Div	Hayden, AZ 85235	Kiln	Gila.
Phelps Dodge Corp., Morenci Branch.	Morenci, AZ 85540	Rotary kiln, fluidized-bed-kiln plant.	Greenlee.
Amstar Corp	11800 East Riggs Rd. Chandler, AZ 85224	Kiln	Maricopa.
Genstar Cement & Lime Co., a division of Genstar Corp.	Box 197 Peach Springs, AZ 86434	Quarries and plant	Yavapai.

See footnotes at end of table.

Table 12.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Perlite:			
Filters International, Inc	Box Z Superior, AZ 85273	Open pit mine and plant	Pinal.
Harborlite Corp	Box 960 Superior, AZ 85273	do	Do.
Salt:			
Southwest Salt Co	Box 1237 Litchfield Park, AZ 85340	Solar evaporation of brine from wells.	Maricopa.
Sand and gravel:			
Arizona Sand and Rock Co., a division of California Portland Cement Co.	1801 East University Box 20067 Phoenix, AZ 85036	Plants	Do.
Tanner Co., United Metro Div	3640 South 19th Ave. Box 20128 Phoenix, AZ 85036	Open pits and plant	Maricopa and Pima.
Union Rock and Materials Corp	2800 South Central Ave. Box 8007 Phoenix, AZ 85066	Plant	Do.
Silica flux:			
Little Hill Mines, Inc	Box 332 Oracle, AZ 85623	Open pit mine and plant	Pinal.
McFarland-Hullinger	Box 811 Tucson, AZ 85702	Quarry and plant, tailings	Do.
Stone:			
Andrada Marble Co	4901 East Drexel Tucson, AZ 85706	Quarry	Pima.
Vanadium:			
Energy Fuels Nuclear, Inc.[10]	Box 1320 Kanab, UT 84741	Underground mine	Mohave.
Vermiculite (exfoliated):			
W. R. Grace & Co., Construction Products Div.	4220 West Glenrosa Phoenix, AZ 85019	Plant	Maricopa.

[1]Also lime.
[2]Also clays.
[3]Also molybdenum.
[4]Also silver.
[5]Also gold.
[6]Also lead.
[7]Also zinc.
[8]Also clays and limestone.
[9]Also copper.
[10]Also uranium.

The Mineral Industry of Arkansas

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Arkansas Geological Commission, for collecting information on all nonfuel minerals.

By Jane P. Ohl[1]

Arkansas' nonfuel mineral production in 1981, comprising 2 metallic and 12 nonmetallic minerals, was valued at $281.5 million, a 3.8% decrease from the value for the previous year. The State continued as a major producer of several nonfuel minerals, ranking first in production of bauxite and bromine, and was one of the main suppliers of whetstones and abrasive materials. Eleven of the minerals produced during 1981 decreased in production, reflecting the general national downturn in demand for metallic and industrial minerals by the manufacturing and construction industries. Soapstone and vanadium producers, however, reported significant increases in quantity: 20% and 34%, respectively.

The nonmetallic sector contributed more than 8 out of every 10 dollars of the State's total nonfuel mineral value. Leading the nonmetallic commodities in value was bromine, followed by portland cement, crushed stone, and sand and gravel. In the metallic sector, bauxite led in value followed by vanadium.

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

Mineral	1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Abrasives ---- short tons	280	$1,686	W	W
Bauxite ---- thousand metric tons	1,299	19,252	1,242	$22,185
Clays ---- thousand short tons	1,150	14,402	880	9,333
Gem stones	NA	140	NA	200
Lime ---- thousand short tons	175	7,785	149	8,102
Sand and gravel ---- do	13,017	r34,562	p12,742	p40,336
Stone:				
Crushed ---- do	20,666	61,399	13,834	47,260
Dimension ---- do	8	355	7	411
Combined value of barite, bromine, cement, gypsum, talc (soapstone), tripoli, vanadium, and value indicated by symbol W	XX	r153,061	XX	153,721
Total	XX	r292,642	XX	281,548

pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Ashley	$176	$134	Sand and gravel.
Baxter	1,269	W	Stone, sand and gravel.
Benton	3,991	W	Do.
Boone	W	W	Do.
Bradley	172	167	Sand and gravel.
Calhoun	2,848	2,799	Do.
Carroll	208	W	Stone, sand and gravel.
Chicot	W	W	Sand and gravel.
Clark	W	W	Stone, sand and gravel, clays.
Clay	166	145	Sand and gravel.
Cleburne	473	W	Stone, sand and gravel.
Cleveland	W	325	Sand and gravel.
Columbia	W	W	Bromine.
Conway	W	282	Stone.
Craighead	W	1,130	Sand and gravel, clays.
Crawford	3,615	W	Sand and gravel, stone.
Crittenden	W	W	Clays.
Cross	529	286	Sand and gravel.
Dallas	10	24	Do.
Drew	123	12	Do.
Faulkner	W	W	Stone, sand and gravel.
Franklin	W	W	Sand and gravel.
Fulton	197	989	Stone, sand and gravel.
Garland	W	W	Vanadium, abrasives, stone, sand and gravel, tripoli.
Grant	278	351	Sand and gravel.
Greene	260	170	Do.
Hempstead	W	W	Sand and gravel, clays.
Hot Spring	W	3,201	Barite, stone, sand and gravel, clays, abrasives.
Howard	24,742	25,707	Cement, gypsum, stone, sand and gravel.
Independence	8,407	W	Stone, lime, sand and gravel.
Izard	4,427	W	Stone, sand and gravel.
Jackson	W	--	
Jefferson	W	W	Sand and gravel.
Johnson	W	W	Sand and gravel, clays.
Lafayette	291	210	Sand and gravel.
Lawrence	W	W	Stone, sand and gravel.
Lincoln	298	279	Sand and gravel.
Little River	44,411	41,744	Cement, stone, sand and gravel.
Logan	W	W	Stone, sand and gravel.
Lonoke	W	W	Stone, clays.
Madison	W	W	Sand and gravel.
Marion	610	1,075	Do.
Miller	2,202	W	Sand and gravel, clays.
Mississippi	19	10	Sand and gravel.
Monroe	W	--	
Montgomery	W	W	Stone, barite, sand and gravel.
Nevada	366	29	Sand and gravel.
Ouachita	W	W	Sand and gravel, clays.
Perry	1,269	1,505	Stone.
Pike	W	W	Sand and gravel, gypsum, stone.
Poinsett	666	737	Sand and gravel.
Polk	707	862	Sand and gravel, stone.
Pope	W	1,080	Do.
Pulaski	W	34,611	Stone, clays, sand and gravel, bauxite.
Randolph	57	148	Stone, sand and gravel.
St. Francis	1,072	1,218	Sand and gravel.
Saline	W	23,747	Bauxite, lime, sand and gravel, stone, tale.
Scott	8	7	Sand and gravel.
Searcy	W	--	
Sebastian	2,037	W	Stone, sand and gravel, clays.
Sevier	W	W	Stone, sand and gravel.
Sharp	W	--	
Stone	W	W	Sand and gravel.
Union	W	W	Bromine.
Van Buren	--	52	Stone.
Washington	751	W	Stone, sand and gravel.
White	W	W	Do.
Woodruff	W	W	Sand and gravel.
Yell	W	174	Do.
Undistributed[2]	198,442	149,429	
Total[3]	305,096	292,642	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]Arkansas, Desha, Lee, Newton, Phillips, and Prairie Counties are not listed because no nonfuel production was reported.

[2]Includes sand and gravel (1980) that cannot be assigned to specific counties, gem stones, and values indicated by symbol W.

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

Table 3.—Indicators of Arkansas business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	948.4	991.2	+4.5
Unemployment	do.	74.7	101.5	+35.9
Employment (nonagricultural):				
Mining[1]	do.	5.2	5.9	+13.5
Manufacturing	do.	209.1	210.3	+.6
Contract construction	do.	37.6	34.3	-8.8
Transportation and public utilities	do.	43.3	43.4	+.2
Wholesale and retail trade	do.	159.8	160.0	+.1
Finance, insurance, real estate	do.	31.3	31.9	+1.9
Services	do.	114.9	116.8	+1.6
Government	do.	141.1	137.8	-2.3
Total nonagricultural employment[1]	do.	742.3	740.4	-.3
Personal income:				
Total	millions	$16,462	$18,461	+12.1
Per capita		$7,185	$8,042	+11.9
Construction activity:				
Number of private and public residential units authorized		8,424	5,341	-36.6
Value of nonresidential construction	millions	$132.0	$120.7	-8.6
Value of State road contract awards	do.	$80.7	$82.1	+1.7
Shipments of portland and masonry cement to and within the State	thousand short tons	807	707	-12.4
Nonfuel mineral production value:				
Total crude mineral value	millions	$292.6	$281.5	-3.8
Value per capita, resident population		$125	$123	-1.6
Value per square mile		$5,398	$5,302	-1.8

[p]Preliminary.
[1]Includes bituminous coal and oil and gas extraction.

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

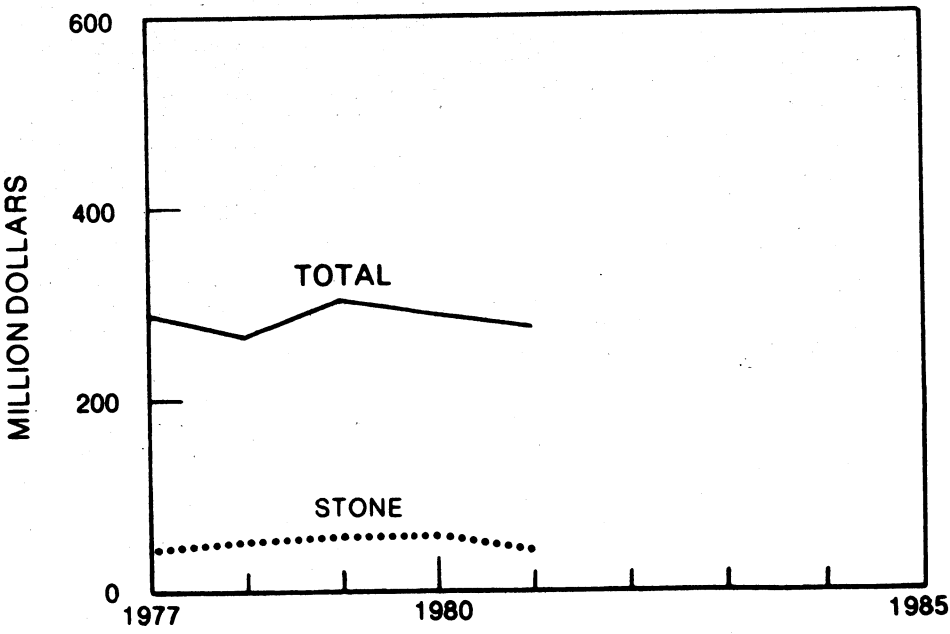

Figure 1.—Value of stone and total value of nonfuel mineral production in Arkansas.

Legislation and Government Programs.—House Bill 36 (Act 31) provided for distributing Federal revenues received from the sale of mineral leases on military reservation lands in Arkansas. The first $21.5 million was to be distributed to (1) public school fund, $7.425 million; (2) affected counties (schools, county road fund, and other local taxing units), $5.375 million; (3) State employees insurance reserve, $3.5 million; and (4) reserve, $5.2 million. Additional monies, any amount over $21.5 million, will be divided 50% to the general improvement fund and 50% to the affected counties. After April 16, 1983, all Federal monies relating to the Fort Chaffee lands will be distributed only to the affected counties, unless new legislation is enacted.

Arkansas' Natural Resources Committee decided in May 1981 to continue collecting a minimum royalty on sand and gravel mined from State lands: Companies will pay 10 cents per ton on sand and 20 cents per ton on gravel. The committee also decided to revise to 10 years (formerly 5 to 7 years) the maximum term for contracts between Arkansas and companies that are removing sand and gravel from State lands.

Reclamation.—According to a news article,[2] Reynolds Metals Co. and Aluminum Co. of America (Alcoa) achieved marked successes in growing vegetation and trees on mined surfaces. New reclamation techniques are solving the problem of coping with the highly acidic (pH 2.5) soils that were removed during the mining process and then replaced.

Employment.—Employees on mining payrolls in the State of Arkansas numbered 5,200 in January 1981 and increased to 6,000 by the end of December.[3]

Residential construction contracts were down $31.8 million (4.8%), and nonresidential construction contracts decreased $53.0 million (14.9%) from 1980 values.[4] Residential and nonresidential construction used many of the industrial minerals produced in the State: cement, clay, gypsum, and sand and gravel.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Abrasives.—During 1981, fine-grained rocks (such as novaculite) used as oilstones and whetstones were mined and finished by Hall's Arkansas Oilstones Inc., Hiram A. Smith Whetstone Co., and the Norton Pike Div. of Norton Co., all having operations in Garland County. Arkansas Whetstone Co. mined and finished novaculite from both Garland and Hot Spring Counties; and Wallis Whetstone of Magnet Cove quarried novaculite from a deposit in Horseshoe Mountain, in sec. 6, T3S, R16W and sec. 1 T3S, R17W, Hot Spring County. The Hot Springs Mine of Malvern Minerals Co., Inc., in Garland County, was the only producer of tripoli. Several other firms finished small quantities of abrasive materials but did not mine the rock: Arkansas Abrasives, Inc.; Natural Hones, Inc.; Pioneer Whetstone; and Poorboy Whetstone.

Arkansas ranked first nationally in quantity of oil stones and novaculite and third in quantity of tripoli and amorphous silica-type abrasives produced during 1981.

Barite.—Arkansas produced a 13% smaller quantity of the Nation's total primary barite output during 1981, compared with that of 1980. Nevertheless, Arkansas ranked third out of eight producing States. Value of the barite produced in 1981 increased substantially over that of the preceding year.

Production came solely from NL Industries, Inc., Baroid Div.'s Magnet Cove Mine in Montgomery County. To the west, also in Montgomery County, Milchem, Inc., a wholly owned subsidiary of Baker International Corp., was developing a surface mine, about 5 miles west of the community of Fancy Hill, in sec. 24, T4S, R27W. The processing plant was to go into operation in October 1982.[5] The barite ore is not high grade and the life of the plant is estimated at 10 years; however, the facility will provide a substantial amount of the barite used in the world's supply of oil well drilling mud.

Although oil well drilling leveled off by yearend, barite demand was expected to increase by about 10% in 1982 because wells are being drilled deeper.[6] Less expensive imports, especially Chinese barite arriving at Texas ports, were undercutting domestic prices and may adversely affect the production plans of domestic firms that ship their barite to gulf coast areas.

Bromine.—Arkansas, again the largest domestic producer of bromine, accounted for about one-half of the world's production during the year; however, both quantity and value of the State's output decreased

from that of 1980 by about 2.4% and 10.9%, respectively. These decreases were much less pronounced than those of 1980 from 1979 quantity and value. Bromine and brominated compounds dominated the State's industrial mineral sector in value of production, accounting for more than one-fourth the value of all nonmetallic nonfuel mineral commodities produced during 1981.

The bromine was extracted from salt brines in the south-central part of Arkansas. Elemental bromine and brominated compounds came from six plants operated by five companies in Columbia and Union Counties. Dow Chemical U.S.A. and Ethyl Corp. operated plants at Magnolia in Columbia County. Arkansas Chemicals, Inc., Great Lakes Chemical Corp., and Velsicol Chemical Corp. operated plants in Union County near El Dorado and Marysville.

In July 1981, Great Lakes purchased Velsicol's bromine plant at El Dorado; Velsicol had no further interests in bromine from that date. Great Lakes also owns a 50% interest in the Arkansas Chemicals bromine plant.[7]

Cement.—Shipments of portland cement by the State's two producers decreased less than 5% from that of 1980; shipments of masonry cement decreased slightly more than 5%. Portland cement, which accounted for more than nine-tenths of the total cement produced in Arkansas, consisted primarily of Type I and II—general use and moderate heat cements. Only small amounts of Type III—high early strength cement were produced. All kilns used the wet process, and the pollution control equipment was the electric precipitator type. Natural gas was the predominant fuel, but a small amount of bituminous coal was used by both companies.

Ready-mix companies used two-thirds of the portland cement; other users were general contractors, concrete-product manufacturers, building-material dealers, highway contractors, and government agencies. Nearly 91% of the portland cement shipped to consumers was handled by truck in bulk form.

Clays.—Common clays and kaolin were produced from 18 mines in Clark, Craighead, Crittenden, Hempstead, Hot Spring, Johnson, Lonoke, Miller, Ouachita, Pulaski, and Sebastian Counties during 1981. Production decreased 23% from that of 1980 to 879,918 tons. Total and per ton values decreased 35% and 15%, respectively, to $9.3 million and $10.61.

The leading companies, in decreasing order of tonnage mined, were Acme Brick Co. (a division of Justin Industries, Inc.) and Arkansas Lightweight Aggregate Corp., producers of common clays and shale from seven pits; and A. P. Green Refractories Co. (a subsidiary of United States Gypsum Co.) and Stauffer Chemical Co., producers of kaolin from two pits.

The kaolin clays, mined only in Pulaski County, were used for firebrick, chemical manufacturing, pesticides and related products, and kiln furniture. Arkansas ranked fourth nationally of the 12 kaolin-producing States.

The common clays were used, in decreasing order of quantity, for common and face brick, concrete block and structural concrete, highway surfacing, and sewer pipe.

Acme Brick produced common clay from Hot Spring County and shale from Sebastian County. Production from the company's three Hot Spring County operations was valued at $589,450; the unit value for the 261,500 tons produced was $2.25. In contrast, a smaller producer, Wheeler Brick Co., whose four pits are in Craighead County, produced 35,124 tons for $64,628 (unit value, $1.84).

The average unit value for the combined common clays produced during the year rose to $1.83, 10% above the average unit value in 1980. Calcined high-temperature kaolin brought $76.23 per ton; unprocessed kaolin was valued at $34.28 per ton.

Acme Brick dedicated its third brick-manufacturing plant in Malvern (and fourth in Arkansas) in February 1981. Representing an investment of $6 million, the new Ouachita plant employed 40 people until it shut down in November 1981. Compact and efficient, the plant was designed with the latest available automatic equipment and fuel-efficient burning system. The plant design is centered on a high-capacity extrusion machine, an automatic setting machine, a top-fired tunnel kiln, and a mechanical dehacker. Annual rate of production between September 1980 and November 1981 was 43 million standard brick equivalents, mostly for the Arkansas and Southwestern U.S. markets; however, at such a rapid rate of production, and lacking demand from economically depressed users, the storage space at the Ouachita plant soon was filled. The operation was shut down until the construction business returns to normal rates of brick consumption. Earlier, in June 1981, the older Malvern

plant had been closed, owing to the economic downturn. A central mining operation served all three of the Acme plants in the Malvern area;[8] three types of clays were mined: red-burning shale, white-burning fire clay, and buff-burning alluvial material.[9]

Gem Stones.—Crater of Diamonds State Park attracted nearly 208,000 visitors during 1981; 88,638 bought tickets permitting them to search for diamonds or other gem stones in the 78-acre volcanic breccia pipe. Some searchers worked the grounds on free passes, but others paid from $1 to $3 each; ticket volume increased 18% over the 1980 ticket volume. Visitors collected nearly 1,300 diamonds; most weighed from 1 to 24 points (0.01 to 0.24 carats); however, one white diamond weighed 8.82 carats, and three other diamonds each weighed more than 5 carats.

The State Parks, Recreation, and Travel Commission refused to lease a part of the Crater of Diamonds to Anaconda Mining Co. or to two other mining companies that had proposed to explore for diamonds. Anaconda had proposed paying the State a $500,000 bonus as well as a $500,000 annual delayed rent during the exploration program on the approximately 80 acres.

Turquoise was mined until November 1981 from the Mona Lisa Mine on Little Porter Mountain in the Ouachita National Forest, 12 airmiles southeast of Mena, Polk County. The turquoise from the mine is robin's-egg blue, soft, and chalky. Although it does not contain enough copper to fit the mineralogical definition of true turquoise, the owner expected to mine it at a profit.

Graphite.—On October 13, 1981, the Great Lakes Carbon Corp. dedicated its new $45 million facility at Ozark, Franklin County. The new facility has the capacity to manufacture 35 million pounds of graphite electrodes annually. Approximately 100 people worked at the Ozark plant, earning an annual payroll of $1.5 million. The Ozark region was selected for the plant because it offered good supplies of natural gas, a central location near Midwest steel mills, and the growing steel-producing activity in the South and Southwest.

In its initial operational status, the Ozark facility received extruded "green" electrode stock from Great Lakes' other graphite plants. The green electrodes are baked in natural-gas-fired furnaces, impregnated with pitch in high-pressure autoclaves, rebaked, and finally graphitized in electric-resistance furnaces. By late 1983, the plant will be fully integrated: raw materials—calcined petroleum coke and coal tar pitch binder—will be mixed, blended, and extruded on site. When that phase of development is completed, the plant will employ approximately 150 people.

Ultra-high-power graphite electrodes, such as those manufactured at Ozark, were used in electric arc furnaces to melt scrap material for new steel production.[10]

Gypsum.—Crude gypsum was produced by firms in Howard and Pike Counties during 1981; quantity increased 8% and value increased 18% from those of 1980. In addition, Weyerhaeuser Co., Dierks Div., in Howard County, and Temple-Eastex, Inc., Temple Gypsum Div., in Crittenden County, manufactured calcined gypsum.

Weyerhaeuser's Briar Mine north of Nashville in Howard County employed 42 persons at its surface mine and 168 at its wallboard manufacturing plant in 1981. On a 16-hour-per-day, 5-day-per-week schedule, the mine produced 600,000 tons of ore. The plant usually operated around the clock 7 days a week and produced about 500 million square feet of wallboard and sheathing. Each August, the company schedules an 8-hour safety retraining course for all miners; during that time the mine is shut down. New employees are given 24 hours of safety training.[11] The company had accumulated 1.8 million accident-free working hours through December 1981.[12]

After a nearly 2-year closure, the former Arkansas Gypsum Co. mining operation north of Highland in Pike County was reopened in April 1981 by a new owner, C. W. Harrison, president of Harrison Gypsum Co., of Lindsay, Okla. Harrison's new Arkansas operation, called Highland Gypsum Co., leased 55 acres from International Paper Co. in sec. 16, T8S, R26W, and built a new haulage road to shorten the distance between the plant buildings in sec. 21 and the new mine developed on the Gypsum Trail. The mining superintendent and a crew of six men, all of whom had worked for Arkansas Gypsum before it closed in June 1979, mined 198 to 276 tons of gypsum per day. The new gypsum surface mine has 40 feet of overburden (compared with 60 feet at the closed mine). The crushed gypsum was trucked to storage sheds at Highland and then trucked to Arkansas Cement Corp. at Foreman and to Ideal Cement Co.'s plant at Okay, north of Saratoga, to be used there as a retardant to control the setting time of cement.

Perlite.—Strong-Lite Products Corp. expanded crude ore, mined outside the State, at its Pine Bluff plant in Jefferson County. The expanded perlite (986 tons) was used in horticultural aggregates (857 tons) and in concrete aggregates (129 tons).

Sand and Gravel.—To reduce the burdens and costs of reporting, the Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. This chapter, therefore, contains only preliminary estimates for construction sand and gravel production but complete data on industrial sand and gravel. The preliminary estimates of construction sand and gravel production for odd-numbered years will be revised and completed the following year.

During the year, Silica Products Co., Inc., the largest industrial sand producer in the State, quarried high-quality material near Guion, Izard County. Other producers quarried sand in Crawford and Hempstead Counties. The average unit value for industrial sand in Arkansas was $12.82. In decreasing order, industrial sand from Izard County was used for foundry molding and core, speciality glassmaking, glass containers, blasting abrasives, plate and window glass, and other.

On a winning competitive bid to mine sand and gravel from a 9-mile length of the Ouachita River north of Camden, in Ouachita County, the Standard Gravel Co. agreed to pay the State $75 for the 10-year lease, plus 31 cents for each ton of sand and gravel mined from the river.

Stone.—During 1981, Arkansas' dimension and crushed stone producers quarried 13.8 million tons of rock, valued at $47.3 million, decreases of 33% and 23%, respectively, from quantity and value of 1980. The State's 60 quarries produced limestone (44% of the total output), granite (syenite, nepheline syenite) (30% of output), sandstone (25% of output), and slate and other rock types that made up the small remainder of the total production.

Crushed limestone was produced from six counties on the State's northern boundary (Baxter, Benton, Boone, Carroll, Fulton, and Marion); from several adjacent northern counties (Independence, Izard, Lawrence, and Washington); and from two southwestern counties (Howard and Little River). In decreasing order of quantity, crushed limestone from these 12 counties was used for cement manufacture, dense-graded road base, concrete aggregate, chemicals, bituminous aggregate, and railroad ballast; these uses consumed 80% of all the crushed limestone produced during the year. Other applications included abrasives, agricultural limestone, agricultural marl and soil conditioner, asphalt filler, flux stone, glass manufacture, lime manufacture, poultry grit, riprap and jetty stone, roof aggregates and chips, surface treatment, unspecified aggregates, and other unspecified uses. A substantial amount of crushed limestone, produced at two mines near Batesville, is consumed in the alumina plants operated by Alcoa and Reynolds.

Crushed sandstone was produced from 16 counties in the northwest half of the State: Clark, Cleburne, Conway, Crawford, Faulkner, Fulton, Garland, Hot Spring, Logan, Perry, Pike, Pope, Sebastian, Sevier, Van Buren, and White. In decreasing order of quantity, it was used principally for dense-graded road base, bituminous aggregate, surface treatment, riprap and jetty stone, and concrete aggregate. Other uses were as abrasives, filler, filter stone, railroad ballast, manufactured fine aggregate, and unspecified aggregate.

Crushed slate, used as flour slate and roof aggregates or chips, was quarried in Montgomery and Saline Counties.

About 4.2 million tons of crushed granite (syenite and nepheline syenite) quarried from Pulaski County was used in roof aggregates or chips (1.1 million tons, or 27% of total granite output), dense-graded road base (0.9 million tons, 22%), unspecified aggregate (0.7 million tons, 16%), railroad ballast (0.6 million tons, 15%), and other uses.

Dimension sandstone, used as cut stone, flagging stone, rubble, and sawed stone, was quarried in Independence County by McBride Stone Quarries and in Logan County by Logan County Building Stone Co., Inc., the larger of the two producers.

Less than one-half percent of the total production of all stone was used as dimension stone, which sold for an average price of $60.73 per ton.

Average values per unit for stone, other than dimension sandstone, were crushed limestone, $3.09; crushed sandstone, $3.43; slate, $20.30; crushed granite, $3.60; other crushed stone, $4.10. The average value per unit for all stone produced in Arkansas was $3.44.

Table 4.—Arkansas: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	470	1,651	371	1,483
Poultry grit and mineral food	12	100	19	168
Concrete aggregate	1,604	4,850	1,403	4,695
Bituminous aggregate	2,595	7,736	1,390	4,843
Dense-graded road base stone	5,670	15,426	3,059	9,420
Surface-treatment aggregate	755	2,723	450	1,803
Other construction aggregate and road stone	1,851	5,229	1,018	3,568
Riprap and jetty stone	1,020	3,387	773	2,900
Railroad ballast	1,763	4,938	1,117	3,774
Filter stone	51	174	40	142
Manufacture fine aggregate (stone sand)	277	350	142	191
Cement manufacture	W	W	1,726	3,887
Abrasives	5	61	6	74
Fill	W	W	86	153
Roofing granules	1,284	5,551	1,221	5,405
Other[2]	3,309	9,223	1,013	4,756
Total	20,666	61,399	13,834	[3]47,260

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

[1]Includes limestone, granite, sandstone, slate, and miscellaneous stone.

[2]Includes stone used for agricultural marl and soil conditioners, lime manufacture, flux stone, asphalt filler, other fillers or extenders, refractory stone (1980), flour (slate), glass manufacture, paper manufacture, chemicals, and other uses not specified.

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

Talc.—The Milwhite Co., Inc., mined a small fraction of the Nation's talc from its Congo pit west of Benton and processed the ores at its mill at Bryant.

Saline County has long been a source of the impure variety of talc called soapstone used in roofing materials and as industrial fillers. Recent technological research has found new uses for talc, notably as a filler or extender in petrochemically based plastics.[13]

Vermiculite.—Crude vermiculite was imported from out-of-State and exfoliated by Strong-Lite at its Pine Bluff plant in Jefferson County and by W. R. Grace & Co. at its North Little Rock plant in Pulaski County. Strong-Lite produced 5,114 tons of exfoliated vermiculite, a 34% increase over that of 1980. About 45% of Strong-Lite's production was used in paint-texture products. The remainder was used in concrete aggregate (30%), horticultural aggregate (14%), block insulation (6%), and packing (4%).

W. R. Grace exfoliated vermiculite that was used principally as concrete aggregate, block insulation, fireproofing, loose-fill insulation, horticultural aggregate, plaster aggregate, and soil conditioner.

METALS

Bauxite.—Arkansas led the three States in the Nation that produced bauxite in 1981, accounting for more than 1.2 million metric tons (dry equivalent) or 82% of the total national production. Mine production of crude ore and shipments from mines and processing plants during the year declined from that of 1980. The quantity of crude ore mined in 1981 was nearly 2% less, although value rose slightly more than 15%. On a dry equivalent basis, ore shipments in 1981 decreased about 11%, but ore-shipment values increased nearly 8%.

According to Reynolds Metals Co.'s 10K annual report for 1981 to the Securities and Exchange Commission, Reynolds owned approximately 9,600 acres of land in the State containing bauxite deposits. These deposits were stated to be sufficient to operate the firm's Hurricane Creek alumina plant at 55% of rated capacity through at least 2000. Only when Arkansas bauxite is mixed with high-grade imported bauxite can the alumina plant be operated at greater than 55% of its rated capacity.

Reynolds' Jones Mills and Arkadelphia aluminum reduction plants use purchased electrical energy, although the Jones Mills operation has gas-engine power-generating facilities capable of generating electric power for approximately 40% of the plant's rated annual capacity (125,000 short tons). The rated capacity of the Arkadelphia plant is 68,000 short tons.[14]

Table 5.—Arkansas: Mine production of bauxite and shipments from mines and processing plants to consumers in the United States

(Thousand metric tons and thousand dollars)

Year	Mine production			Shipments from mines and processing plants to consumers		
	Crude	Dry equivalent	Value[1]	As shipped	Dry equivalent	Value[1]
1977	2,048	1,703	24,851	1,964	1,684	26,532
1978	1,778	1,446	21,103	1,734	1,483	24,230
1979	1,685	1,430	20,555	r1,783	r1,512	r25,726
1980	1,533	1,299	19,252	r1,577	r1,371	r24,405
1981	1,505	1,242	22,185	1,429	1,221	26,358

rRevised.
[1]Computed from selling prices and values assigned by producers and from estimates of the Bureau of Mines.

Reynolds' new continuous rolling plant at Jones Mills is capable of processing about 300 million pounds of aluminum annually, using eight Pechiney Ugine Kuhlmann (of France) casters. Sustaining this operation will depend, however, on a more stable economy than that of the early 1980's.

In its 1981 annual report, Reynolds described the aluminum business during the year as having been beleaguered by slumps in the transportation and housing markets, by the "disappearance of the unusually high export business" of 1980, and by escalations in operating costs, especially energy and labor costs. Reynolds had six plants in Arkansas employing 3,600 workers before the 1981 cutbacks. By yearend, none of the 814 workers laid off during the year had been recalled.

Slowdowns and shutdowns occurred in 1981 at Reynolds' cable plant, mines, and alumina plants. To balance inventories with reduced demand, potlines at Jones Mills reduction plant were suspended, decreasing the annual rate of production to 75,000 short tons by yearend.

The Hurricane Creek plant has an annual production capacity of 650,000 metric tons of alumina. The annual payroll at the plant was $33 million; the operations customarily injected about $51 million per year into the local economy.[15]

Launching an intensive effort to cut costs and expenses, Reynolds continued to expand its system for recycling aluminum, which added substantially to the firm's total metal capacity. Requiring a relatively small capital investment, recycling aluminum may save 95% of the energy needed to produce aluminum from ore.

Vanadium.—In both quantity and value of recoverable (contained) vanadium, Arkansas ranked fourth of the six producing States in the Nation. During 1981, Garland County vanadium production increased nearly 34% over that of 1980 and nearly equaled the quantity and value of 1979. Union Carbide Corp. was again the State's sole producer of the metal. By April 1981, production had been resumed at Union Carbide's Wilson Springs surface mine and mill complex; both had been closed during most of the second half of 1980. In December, the firm was doing development work at two new areas northwest of its plant and at a third area north of Magnet. The company expected to begin removing waste from the developing surface mines in mid-1982, unless the economy turns downward.

[1]State Liaison Officer, Bureau of Mines, Denver, Colo.
[2]Ellis, R. Companies Proud of Reclamation. Arkansas Gazette (Little Rock), Oct. 18, 1981, pp. 1E-2E.
[3]Bureau of Labor Statistics. Employment and Earnings, March 1982, Table B-8 Employees on Nonagricultural Payrolls for States and Selected Areas by Industry Division, pp. 66-77.
[4]Arkansas Business and Economic Review. V. 15, No. 1, Summer 1982, pp. 36-37.
[5]Paul Peppers, Milchem, Inc., oral communication, July 12, 1982.
[6]Castelli, A. V. Barite: U.S. Production Continues Strong, Sets Record at 2.4 Million ST. E&MJ, March 1982, pp. 135, 137.
[7]Clayton Carter, Great Lakes Chemical Corp., El Dorado, Ark., oral communication, July 21, 1982.
[8]Jeffers, P. E., ed. Acme's New Ouachita Plant. Brick & Clay Record, March 1981, pp. 28-31.
[9]Ron Gallagher, Plant Manager, Acme Brick Co., Malvern, oral communication, July 13, 1982.
[10]Arkansas Economic Report. Great Lakes Carbon Dedicates Ozark Plant. V. 2, No. 4, 1981, p. 3.
[11]U.S. Department of Labor, Mine Safety and Health Administration. Brair Gypsum Operation is Safe, Efficient, and on the Informal Side. Mine Safety & Health, v. 6, No. 4, August 1981, pp. 14-17.
[12]Larry Renard, Brair Plant General Manager, oral communication, July 2, 1982.
[13]Clifton, R. A. Talc and Pyrophyllite. Bureau of Mines Minerals Yearbook 1978-79, v. 1, Metals and Minerals, p. 905.
[14]Reynolds Metals Co. 10K Report for 1981 to the Securities and Exchange Commission.
[15]Campbell, R. P. Reynolds Metals Co. Reynolds Cutbacks to Force 148 Layoffs at Plant, Mines. Arkansas Gazette, Apr. 30, 1981, p. 6A.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasives (tripoli):			
Malvern Minerals Co., Inc	Box 1246 Hot Springs, AR 71901	Mine	Garland.
Barite:			
NL Industries, Inc., Baroid Div.:	Box 1675 Houston, TX 77001		
McKnight Mine		Open pit	Montgomery.
Magnet Cove plant		Plant	Hot Spring.
Bauxite:			
Aluminum Co. of America	1501 Alcoa Bldg. Pittsburgh, PA 15219	Mine and plant	Saline.
American Cyanamid Co	Berdan Ave. Wayne, NJ 07470	do	Do.
Reynolds Metals Co	Box 97 Bauxite, AR 72011	Mines and plant	Pulaski and Saline.
Bromine:			
Arkansas Chemicals, Inc	Route 6, Box 98 El Dorado, AR 71730	Brine wells and plant.	Union.
Dow Chemical U.S.A., Magnolia plant	2030 Dow Center Midland, MI 48640	do	Columbia.
Ethyl Corp., Arkansas Div	Box 729 Magnolia, AR 71753	do	Do.
Great Lakes Chemical Corp	Box 2200 West Lafayette, IN 47906	do	Union.
Velsicol Chemical Corp	351 East Ohio St. Chicago, IL 60611	do	Do.
Cement:			
Arkansas Cement Corp., a subsidiary of Arkla, Inc.	Box 130 Foreman, AR 71836	Plant	Little River.
Ideal Cement Co., a subsidiary of Ideal Basic Industries, Inc.	Box 8789 Denver, CO 80201	do	Howard.
Clays:			
Acme Brick Co., a division of Justin Industries, Inc.	Box 425 Fort Worth, TX 76101	Pits and plants	Hot Spring and Sebastian.
A. P. Green Refractories Co., a subsidiary of United States Gypsum Co.	Box 6057 Little Rock, AR 72216	Pit and plant	Pulaski.
Arkansas Lightweight Aggregate Corp	El Dorado, AR 71730	Pits and plant	Crittenden and Lonoke.
Stauffer Chemical Co	Box 9509 Industrial Station Little Rock, AR 72209	Pit and plant	Pulaski.
Gypsum:			
Highland Gypsum Co	Box 336 Lindsay, OK 73052	Mine	Pike.
Weyerhaeuser Co, Dierks Div	Route 4, Box 78 Nashville, AR 71852	Mine and plant	Howard.
Lime:			
Aluminum Co. of America	1501 Alcoa Bldg. Pittsburgh, PA 15219	Plant	Saline.
Arkansas Lime Co., a subsidiary of Rangaire Corp.	Box 2356 Batesville, AR 72501	Quarry and plant	Independence.
Reynolds Metals Co	6603 West Broad St. Richmond, VA 23226	do	Saline.
Perlite (expanded):			
Strong-Lite Products Corp	Box 8029 Pine Bluff, AR 71611	Plant	Jefferson.
Sand and gravel (industrial):			
Silica Products Co., Inc	Box 248 Guion, AR 72540	Pit	Izard.
Stone:			
Granite:			
Freshour Construction Co., Inc.[1]	Box 77 Sweet Home, AR 72164	Quarry	Pulaski.
McGeorge Contracting Co., Inc	Box 7008 Pine Bluff, AR 71611	Quarries	Do.
Minnesota Mining & Manufacturing Co	3M Center, 224 6SW St. Paul, MN 55101	Quarry	Do.
Limestone:			
Arkansas Cement Corp., a subsidiary of Arkla, Inc.	Box 130 Foreman, AR 71836	do	Little River.
Arkansas Lime Co., a subsidiary of Rangaire Corp.	Box 2356 Batesville, AR 72501	Quarries	Independence and Izard.
Ideal Cement Co., a subsidiary of Ideal Basic Industries, Inc.	Box 8789 Denver, CO 80201	Quarry	Howard.
McClinton-Anchor Co., a subsidiary of Ashland Oil, Inc.	Box 756 Fayetteville, AR 72701	do	Benton and Washington.
Midwest Lime Co	Box 2608 Batesville, AR 72501	do	Independence.
Sandstone:			
Arkhola Sand & Gravel Co., a subsidiary of Ashland Oil, Inc.	Box 1627 Fort Smith, AR 72901	Quarries	Crawford and Sebastian.
Ben M. Hogan Co., Inc.[2]	Box 2860 Little Rock, AR 72203	do	Fulton, Garland, Pike, White.

See footnotes at end of table.

Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone —Continued			
Sandstone —Continued			
H M B Construction Co	Box 5606 Texarkana, TX 75501	Quarry	Sevier.
M & M Rock Co., Inc	Box 1190 Conway, AR 72032	Quarries	Faulkner, Perry, White.
Slate:			
Bird & Son, Inc	Box C Glenwood, AR 71943	Quarry	Montgomery.
Sulfur (recovered elemental):			
Ethyl Corp., Arkansas Div	Box 729 Magnolia, AR 71753	Sulfur recovered in bromine extraction.	Columbia.
Phillips Petroleum Co	724 Adams Bldg. Bartlesville, OK 74004	Sulfur recovered as a byproduct of petroleum refining.	Lafayette.
Talc:			
The Milwhite Co., Inc	Box 15038 Houston, TX 77020	Mine and plant	Saline.
Vanadium:			
Union Carbide Corp., Metals Div	Route 6, Box 943 Hot Springs, AR 71901	Mine and mill	Garland.
Vermiculite (exfoliated):			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plant	Pulaski.
Strong-Lite Products Corp	Box 8029 Pine Bluff, AR 71611	do	Jefferson.

[1]Also produced limestone in Fulton County.
[2]Also produced limestone in Lawrence County.

The Mineral Industry of California

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

By F. V. Carrillo,[1] J. F. Davis,[2] and J. L. Burnett[3]

California's nonfuel mineral production value in 1981 increased nearly 6%, to a total of $1.98 billion. This resulted primarily from a rise in value of boron and sand and gravel products. Thirty-two mineral commodities, including 10 metallic minerals, were produced in California during the year. Nonmetallics accounted for over 92% of the State's mineral production value. California ranked third nationally in total nonfuel mineral production and led in the production of asbestos, boron minerals, diatomite, and rare earths.

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

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
Boron minerals thousand short tons	1,545	$366,760	1,481	$435,387
Cement: Portland do	8,797	542,487	7,896	518,966
Clays do	2,558	17,766	2,309	19,118
Gem stones	NA	200	NA	300
Gold (recoverable content of ores, etc.) troy ounces	r4,078	r2,498	6,271	2,882
Gypsum thousand short tons	1,644	12,763	1,456	13,948
Lead (recoverable content of ores, etc.) metric tons	W	W	W	W
Lime thousand short tons	554	29,444	472	26,834
Mercury 76-pound flasks	226	88	85	35
Perlite thousand short tons	W	W	36	1,044
Pumice do	r58	r1,340	98	1,501
Sand and gravel do	r114,663	r363,904	p112,050	p381,669
Silver (recoverable content of ores, etc.) thousand troy ounces	49	1,017	53	560
Stone:				
Crushed thousand short tons	r37,760	r118,140	34,560	118,698
Dimension do	36	1,967	29	1,909
Talc do	100	1,863	2111	25,855
Zinc (recoverable content of ores, etc.) metric tons	--	--	W	W
Combined value of asbestos, calcium chloride, carbon dioxide, copper, diatomite, feldspar, iron ore, magnesium compounds, molybdenum, peat, potassium salts, rare-earth concentrates, salt, sodium carbonates, sodium sulfate, tungsten, wollastonite (1981), and values indicated by symbol W	XX	r411,619	XX	446,310
Total	XX	r1,871,856	XX	1,975,016

pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes pyrophyllite; value included with "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Alameda	W	W	Sand and gravel, salt, stone, clays.
Alpine	$262	$591	Silver, gold.
Amador	11,007	13,654	Sand and gravel, stone, clays.
Butte	4,688	4,823	Sand and gravel.
Calaveras	56,305	56,179	Cement, asbestos, stone, gold, silver, clays, sand and gravel.
Colusa	W	W	Sand and gravel, stone.
Contra Costa	14,455	W	Stone, sand and gravel, lime, clays.
Del Norte	W	W	Sand and gravel, stone, gold.
El Dorado	W	W	Stone, sand and gravel, talc.
Fresno	17,410	15,466	Sand and gravel, gold, stone, clays, silver.
Glenn	W	W	Sand and gravel, lime.
Humboldt	2,874	3,406	Sand and gravel, stone.
Imperial	W	W	Gypsum, sand and gravel, lime.
Inyo	45,322	35,174	Tungsten, boron minerals, molybdenum, talc, stone, perlite, sand and gravel, silver, copper, pumice, gold, clays, lead.
Kern	389,730	433,458	Boron minerals, cement, stone, sand and gravel, gypsum, clays, carbon dioxide, tungsten.
Kings	--	W	Gypsum.
Lake	W	W	Sand and gravel, stone, mercury.
Lassen	1,065	2,384	Sand and gravel, stone.
Los Angeles	58,320	64,781	Sand and gravel, lime, stone, clays, tungsten.
Madera	6,357	9,440	Tungsten, sand and gravel, stone, pumice.
Marin	W	W	Stone, clays, sand and gravel.
Mariposa	262	W	Sand and gravel, stone.
Mendocino	1,547	1,546	Sand and gravel.
Merced	1,913	1,825	Do.
Modoc	W	W	Peat, stone, sand and gravel.
Mono	1,104	1,019	Pumice, clays, sand and gravel.
Monterey	44,325	61,058	Magnesium compounds, lime, asbestos, sand and gravel, stone.
Napa	W	W	Salt, sand and gravel, stone.
Nevada	W	W	Sand and gravel, clays, stone.
Orange	W	22,166	Sand and gravel, feldspar, stone, clays.
Placer	W	W	Sand and gravel, clays, stone.
Plumas	1,190	W	Stone, sand and gravel.
Riverside	W	W	Iron ore, cement, sand and gravel, stone, clays.
Sacramento	r23,475	19,069	Sand and gravel, clays, gold, silver.
San Benito	W	W	Stone, sand and gravel, clays.
San Bernardino	421,613	488,269	Cement, boron minerals, sodium carbonate, rare-earth minerals, stone, potash, sodium sulfate, sand and gravel, lime, clays, calcium chloride, salt, feldspar, talc, iron ore, gold, silver.
San Diego	44,880	51,867	Sand and gravel, stone, salt, gypsum, magnesium compounds, clays, feldspar, tungsten.
San Joaquin	12,662	12,764	Sand and gravel, lime, gold, peat, silver.
San Luis Obispo	4,724	W	Stone, sand and gravel, gypsum.
San Mateo	W	W	Magnesium compounds, stone, salt.
Santa Barbara	64,409	W	Diatomite, sand and gravel, lime, stone.
Santa Clara	W	W	Cement, stone, sand and gravel.
Santa Cruz	W	W	Cement, sand and gravel, stone, clays.
Shasta	28,796	W	Do.
Sierra	W	W	Gold, silver.
Siskiyou	W	1,353	Stone, sand and gravel, pumice, gold.
Solano	W	1,646	Stone.
Sonoma	11,831	11,493	Sand and gravel, stone, mercury.
Stanislaus	W	W	Sand and gravel, gold, clays, silver.
Sutter	696	W	Sand and gravel, clays.
Tehama	818	1,192	Sand and gravel, stone.
Trinity	W	W	Stone, sand and gravel.
Tulare	3,938	W	Sand and gravel, stone, tungsten.
Tuolumne	W	W	Lime, stone, gold, silver, lead.
Ventura	15,881	W	Sand and gravel, clays, stone, gypsum.
Yolo	W	W	Sand and gravel, lime.
Yuba	W	W	Sand and gravel, stone, clays.
Undistributed[2]	r475,001	557,226	
Total[3]	r1,766,855	1,871,856	

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]No nonfuel mineral production was reported for San Francisco County.

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

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

Table 3.—Indicators of California business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	11,243.0	11,489.1	+2.2
Unemployment	do	701.0	983.9	+40.4
Employment (nonagricultural):				
Mining[1]	do	43.5	48.0	+10.3
Manufacturing	do	2,007.8	2,018.8	+.5
Contract construction	do	444.8	432.9	-2.7
Transportation and public utilities	do	546.3	553.0	+1.2
Wholesale and retail trade	do	2,266.9	2,316.6	+2.2
Finance, insurance, real estate	do	623.1	646.3	+3.7
Services	do	2,156.2	2,261.2	+4.9
Government	do	1,763.9	1,763.2	--
Total nonagricultural employment[1]	do	[2]9,852.4	10,040.0	+1.9
Personal income:				
Total	millions	$259,339	$291,715	+12.5
Per capita		$10,929	$12,057	+10.3
Construction activity:				
Number of private and public residential units authorized		144,796	105,197	-27.4
Value of nonresidential construction	millions	$6,583.5	$7,705.1	+17.0
Value of State road contract awards	do	$518.0	$300.0	-42.1
Shipments of portland and masonry cement to and within the State	thousand short tons	8,238	7,268	-11.8
Nonfuel mineral production value:				
Total crude mineral value	millions	$1,871.9	$1,975.0	+5.5
Value per capita, resident population		$80	$83	+3.8
Value per square mile		$11,883	$12,446	+4.7

[p]Preliminary.
[1]Includes oil and gas extraction.
[2]Data do not add to total shown because of independent rounding.

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

The decline in construction activity throughout the State was reflected in a production drop of most industrial minerals including boron, gypsum, cement, clays, asbestos, lime, diatomite, stone, and sand and gravel. Despite lower production, increased valuation resulted from commodity price increases.

Output of most metallic mineral commodities increased slightly including silver, copper, iron, lead, and rare earths; gold rose over 50%. Principal metallic minerals produced in the State were iron ore and tungsten, as well as rare earths, molybdenum, gold, copper, and silver.

Employment.—Direct metal and nonmetal mining employment showed little increase from that of 1980, although employment figures for the mineral industries increased 10.3% in 1981. The increase is attributed to gains in employment by oil and gas extraction workers who are included in the mineral industry statistics.

Legislation and Government Programs.—A comprehensive multiple-use plan for the California Desert Conservation Area, opening the way for increased mining activity, was approved by the U.S. Department of the Interior in April. The multiple-use plan permits mining and energy minerals development in the 23-million-acre area established by Congress in 1976 for the southern California desert.

Rules to allow development of all hardrock minerals in the 41,000-acre Whiskeytown Recreation Area, near Redding, were announced in December. The regulations were drafted in response to a 1979 court decision ordering the Government to issue rules governing mineral leasing in national recreation areas.

The University of California at Berkeley, selected as 1 of 31 mineral institutes under title III of Public Law 95-87 (Surface Mining and Reclamation Act of 1977), received $110,000 for operation of the institute in 1981, and an additional $202,000 for scholarships, fellowships, and research proposals.

The State Mining and Geology Board took actions on a number of propositions that addressed mineral resource conservation and mined lands reclamation objectives.

The Board designated regionally significant sand and gravel deposits in the San Fernando Valley area of Los Angeles County, and initiated the designation process for aggregate deposits needed to supply Ventura County's future needs. Classification of construction-quality aggregate resources in the Los Angeles and San Francisco Bay metropolitan areas also were reviewed.

Priorities for classifying threatened mineral deposits in nonurban areas of the State, specifically in the Sierra Nevada and California Desert areas, were established, and classification studies were initiated in these areas by the California Division of Mines and Geology (CDMG), Department of Conservation. Five petitions for classifying threatened mineral deposits were also accepted, and a completed classification report on a petitioned limestone deposit was sent to the affected lead agency for planning action.

A special publication, "Mines and Mineral Producers Active in California—1981" (SP 58), was prepared by CDMG.

The application of California's Surface Mining and Reclamation Act (SMARA) to Federal lands was reviewed by the Board in a workshop with representatives from the mining industry; local, State, and Federal agencies; and environmental protection groups. Ordinances from 71 lead agencies that regulate surface mining in the State were reviewed and 62 were certified.

The Board reviewed its State policy for surface mining and reclamation practices to ensure its conformance with requirements of Assembly Bill 1111, which requires that regulations be clearly written and properly authorized.

The Board also recommended that (1) information on California's potential for strategic mineral resources be developed and that nonurban classification be accelerated to aid future land use decisions, and (2) hazardous abandoned mines should be identified to aid local agencies mitigating associated hazards.

Under direction from a recent amendment to the Surface Mining and Reclamation Act, Senate Bill 1300, the CDMG began classification of mineral lands in nonurban areas. Classification activities were concentrated in the foothills of the Sierra Nevada, the California Desert, and in the Klamath Mountains, under priorities established by the Mining and Geology Board.

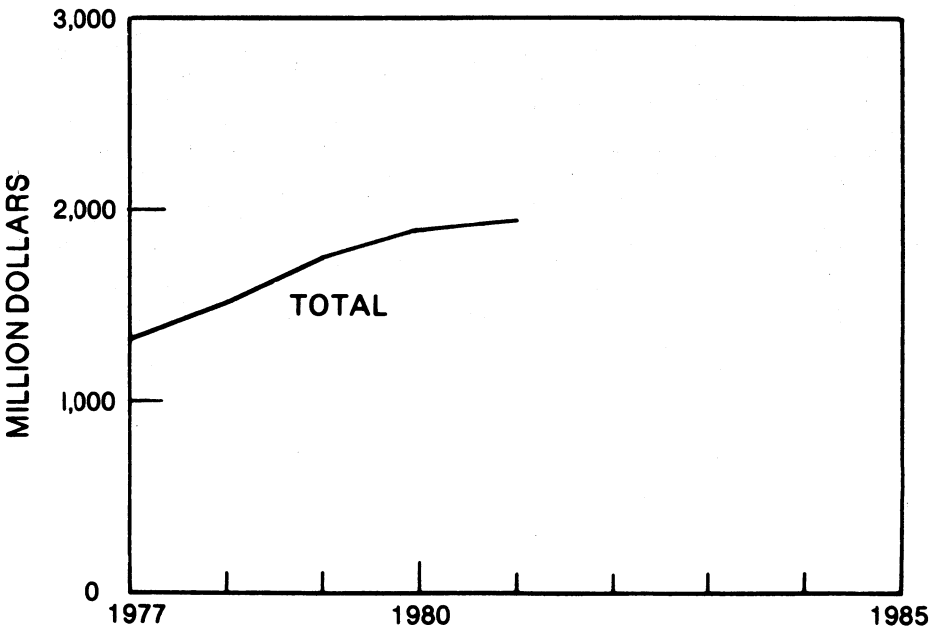

Figure 1.—Total value of nonfuel mineral production in California.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Asbestos.—California remained the leading U.S. producer of asbestos from mines in Calaveras and San Benito Counties. Calaveras Asbestos Corp.'s operations in Calaveras County, and Union Carbide Corp.'s Santa Rita Mine in San Benito County continued to be the main producers.

Barite.—The Upper Spanish Mine, a former gold producer, reportedly produced barite from an operation 3 miles west of Graniteville, in Nevada County. The open pit operation, owned by Ostlers Rocky Mountain Refractories of Salt Lake City, shipped crushed rock to Salt Lake City, Utah, and Sacramento, Calif., for use in oil well drilling mud.

ASARCO Incorporated proposed a project to mine and mill barite from an open pit silver-barite deposit in San Bernardino County.

Boron.—California operations in San Bernardino and Inyo Counties were the Nation's only domestic producers of boron. U.S. Borax and Chemical Corp. (a subsidiary of the United Kingdom-based Borax Holdings), which operates an open pit mine in San Bernardino County and a processing plant in Kern County, continued to be the world's largest source of boron. Kerr-McGee Chemical Corp. produced anhydrous borax-boric acid as well as pentahydrite and decahydrate at its plants in San Bernardino County. American Borate Corp. mined colemanite and ulexite from Inyo County.

Borax's Mojave facility in Kern County was completed after a 3-year construction project. Reportedly the world's largest boric acid plant, it will employ an additional 125 people and produce 200,000 tons of boric acid annually.

Calcium Chloride.—Natural calcium chloride was obtained from wells in San Bernardino County. Leslie Salt Co. and National Chloride Co. of America remained the largest producers.

Cement.—California continued in second place, behind Texas, in national cement production. Twelve plants reported portland cement production, down 11% from that of 1980. The State's largest producer was the Kaiser Cement Corp. Permanente plant.

Genstar Cement & Lime Co. completed a $42 million modernization and expansion of its plant near Redding, increasing the capacity from 290,000 to 600,000 tons per year. Genstar also announced the planned expansion and modernization of its San Andreas cement plant in Calaveras County from a present capacity of 600,000 tons to more than 1 million tons per year.

Kaiser Cement opened its $1 million cement distribution facility at Fresno in July. Upgrading, modernization, and expansion of the Lone Star Industries, Inc., Davenport plant was completed in September. About $1 million was spent to double annual capacity from 390,000 to 775,000 tons, and to reduce energy consumption by one-third. California Portland Cement Co. completed work on the expansion of its Mojave facility, making it the largest cement plant in California.

Pacific Coast Cement Corp. completed an import terminal capable of handling 600,000 tons per year at Long Beach Harbor, at a reported cost of $17 million. Initially, the cement will be produced to California standards by Adelaide Brighton Cement, Ltd., in Australia.

Delta Cement Co., a subsidiary of a Federal Republic of Germany industrial conglomerate, constructed an additional import terminal at the Port of Stockton. The 30,000-metric-ton terminal plans to handle imports of 150,000 tons per year from Nihon Cement Co. in Japan.

Table 4.—California: Portland cement salient statistics

(Short tons unless otherwise specified)

	Northern California		Southern California		California total	
	1980	1981	1980	1981	1980	1981
Number of active plants	4	4	8	8	12	12
Production	2,608,472	2,297,212	6,241,246	5,581,393	8,849,718	7,878,605
Shipments from mills:						
Quantity	2,556,225	2,413,013	6,241,051	5,483,060	8,797,276	7,896,073
Value	$151,156,310	$152,933,399	$391,331,064	$366,032,893	$542,487,374	$518,966,292
Stocks at mills, Dec. 31	277,609	234,863	207,927	304,272	485,536	539,135

Clays.—Production of over 2.3 million short tons of clay and shale was reported from 60 mines. Common clay and shale comprised the bulk of the clay produced, with smaller amounts of kaolin, fire clay, ball clay, and bentonite.

Lightweight Processing Co. was the State's leading producer from quarries in Ventura County. Additional important producers include Genstar, Pacific Holding Clay Products Co., Homestake Mining Co., Amcor Inc., and Lincoln Clay Products Co. The leading kaolin producer in California was North American Refractories Co. Southern Clay of California, Inc., was the leading producer of nonswelling bentonite.

Diatomite.—More than one-half of the 687,000 short tons of diatomite produced nationally last year was derived from California. Santa Barbara County accounted for all of the reported California production. Manville Products Corp., Lompoc, continued to be the State's largest producer.

Feldspar.—Production from two operations accounted for the total State output. The Owens-Illinois, Inc.'s Mission Viejo Mine, a feldspar-silica sand deposit in Orange County, and the Calspar Corp.'s Ord Mountain Mine (hard rock) in San Bernardino County, produced material for use in glassmaking and ceramics including sanitary ware.

Graphite (Synthetic).—Great Lakes Carbon Corp. produced most of the synthetic graphite in the State from Kern County, for use in the manufacture of electrodes.

Gypsum.—Despite a 12% drop from 1980 in gypsum production, California ranked second in the Nation in production of crude gypsum, and was the leading producer of calcined gyspum. Eight companies reported crude gypsum output in 1981. The bulk of the production was from three companies—United States Gypsum Co. (Imperial County), H. M. Holloway Inc. (Kern County), and Fannon Superior Gypsum Co. (Kern County).

Lime.—California was the 13th largest lime producer among the States in 1981, dropping from 12th in the Nation in 1980. Production by 7 companies was reported from 10 counties throughout the State. The Kaiser Aluminum & Chemical Corp. Natividad plant in Monterey County was the largest producer. Other important producers included Kerr-McGee, Genstar, Holly Sugar Corp., and Amstar Corp.

Peat.—Output and value of peat production declined from that reported in 1980. Radel, Inc. (Modoc County), and Delta Humas Co. (San Joaquin County) were the only producers. Consumption was primarily by nurseries.

Perlite.—American Perlite Co. was the sole source of crude perlite during 1981, producing 40,000 short tons of ore. Expanded perlite production, processed at eight plants in Los Angeles, San Bernardino, and San Diego Counties, declined to 36,478 short tons valued at over $5 million. The North Hollywood plant of American Perlite was the largest producer of expanded perlite in the State.

Potassium Salts.—Production of potassium salts by Kerr-McGee in San Bernardino County enabled California to record the second highest tonnage in the Nation after New Mexico.

Pumice and Pumicite.—Pumice production from five counties was recorded in 1981, with the largest portion reported in Siskiyou County. Output for the year increased 69%, but the total value increased only 12%, to $1,501,000. There were six producers from seven operations during 1981, one more than in 1980.

American Pumice Products, Inc., in Inyo County and Tionesta Aggregates Co. in Siskiyou County were the major producers. The largest use of pumice was in concrete aggregates.

Salt.—Salt production decreased 8% in 1981 when compared with that of 1980, but increased 15% in total value owing to higher prices. Cargill, Inc. (formerly the Leslie Salt Co.), produced most of the salt recovered in the State from plants around the southern end of San Francisco Bay. Other salt producers were Standard Salt Co., Oliver Brothers Salt Co., Pacific Salt and Chemical Co., and Western Salt Co.

Sand and Gravel.—To reduce reporting burdens and costs, the U.S. Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary statistics for construction sand and gravel production but contains complete data on industrial sand and gravel. The preliminary statistics for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Preliminary statistics indicate California continued to be the leading producer of sand and gravel in the United States, despite a 2% decline in production attributed to reduced activity in the construction industry. California ranked fifth in the Nation in industrial sand and gravel production.

Owens-Illinois, Inc., with operations in Amador and Orange Counties, was the State's largest producer of industrial sand and gravel. Other important producers included Ottawa Silica Co. in San Diego County, Martin Marietta Corp. in Contra Costa County, and Santa Cruz Aggregate Co. in Santa Cruz County.

Table 5.—California: Sand and gravel sold or used by producers

	1980[r]			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	47,050	$140,781	$2.99	NA	NA	NA
Gravel	65,444	195,264	2.98	NA	NA	NA
Total[1] or average	112,493	336,045	2.99	[p]109,900	[p]$353,400	[p]$3.22
Industrial sand	2,169	27,859	12.84	2,150	28,269	13.15
Grand total[1] or average	114,663	363,904	3.17	[p]112,050	[p]381,669	[p]3.41

[p]Preliminary. [r]Revised. NA Not available.
[1]Data may not add to totals shown because of independent rounding.

Sodium Compounds.—All sodium sulfate output came from Kerr-McGee plants in San Bernardino County. Production and value increased 7% and 38%, respectively, when compared with that reported in 1980. California remained the Nation's largest sodium sulfate producer in 1981.

Kerr-McGee also produced sodium carbonate at its Westend and Argus plants in San Bernardino County. In 1981, production and value increased 49% and 56%, respectively, compared with that of 1980.

Cominco American, Inc., a subsidiary of Cominco Ltd. of Canada, purchased Lake Minerals Corp., which mines sodium salts from the Owens Dry Lake bed, Inyo County. Lake Minerals produces about 85,000 tons of crude sodium carbonate per year, which is shipped to industrial customers within the State.

Stone.—Output of crushed stone in 1981 was reported from 252 quarries in 42 counties. Led by San Bernardino County, over 1 million short tons of crushed stone was produced from each of eight counties.

Dimension stone output came from 17 quarries in 13 counties. Production and value of dimension stone both decreased.

Limestone utilized in cement production was the leading type of stone produced. Leading producers of limestone were Kaiser Cement and California Portland Cement.

Dolomite and dolomitic limestone were mined for a variety of refractory, chemical, and decorative uses. Cutbacks in the manufacture of refractory brick caused Kaiser Refractories to announce the temporary closing of its refractory brick plants in late 1981 to reduce inventories. Employees were affected at the Moss Landing manufacturing plant and the Natividad quarry near Salinas.

Dolomitic limestone was mined intermittently by Merck & Co. from the Columbia quarry in Tuolumne County. The Lone Pine quarry in Inyo County was purchased by M & C Marble Co., and reportedly produced terrazzo chips for floors and decorative rock.

Slate, volcanic cinders, granite, sandstone, and shale were other significant varieties of stone produced.

Table 6.—California: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	39	216	W	W
Poultry grit and mineral food	145	1,387	21	338
Concrete aggregate	r2,223	r6,350	3,201	10,668
Bituminous aggregate	1,732	5,708	1,613	5,990
Macadam aggregate	893	3,261	760	2,905
Dense-graded road base stone	r8,775	r22,665	7,171	21,366
Surface-treatment aggregate	95	334	---	---
Other construction aggregate and road stone	4,639	9,990	4,136	10,655
Riprap and jetty stone	2,035	6,796	1,702	6,086
Railroad ballast	r217	r641	380	1,169
Filter stone	297	935	101	429
Manufactured fine aggregate (stone sand)	116	1,089	99	1,105
Terrazzo and exposed aggregate	r214	r1,932	129	1,350
Cement manufacture	12,214	31,894	12,329	37,071
Lime manufacture	416	1,146	W	W
Dead-burned dolomite	W	W	35	339
Flux stone	150	705	77	409
Mine dusting	24	63	28	79
Other fillers or extenders	302	3,032	W	W
Drain fields	67	131	---	---
Fill	1,005	1,917	711	1,672
Glass manufacture	413	4,889	292	3,978
Roofing granules	r577	r1,970	636	2,660
Sugar refining	638	3,504	440	2,941
Other[2]	r534	r7,588	700	7,485
Total[3]	r37,760	r118,140	34,560	118,698

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Other."

[1]Includes limestone, granite, sandstone, shell, traprock, miscellaneous stone, and slate and volcanic cinders and scoria.

[2]Includes stone used for agricultural marl and other soil conditioners, ferrosilicon (1980), whiting or whiting substitute, carbon dioxide, bedding materials (1980), floor slate (1980), other uses not specified, and items indicated by symbol W.

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

Sulfur.—Byproduct sulfur was recovered at 15 refineries—4 in Contra Costa County, 9 in Los Angeles County, 1 in Santa Barbara County, and 1 in Solano County. Total 1981 production was 477,208 metric tons valued at $31.4 million. California ranked third in the Nation for recovered sulfur shipped in 1981. Chevron USA Inc.'s refinery at El Segundo, Los Angeles County, was the largest producer.

Talc and Pyrophyllite.—Talc production increased 11% from that of 1980, but its value more than doubled. Major producers from mines in Inyo and San Bernardino Counties were Pfizer, Inc., and AMOCO Minerals Co. Standard Slag Co. produced pyrophyllite from two mines in Mono County.

Vermiculite (Exfoliated).—Production of exfoliated vermiculite increased 15% and value increased 32% from that of 1980. W. R. Grace & Co. produced all of California's vermiculite from plants in Santa Ana (Orange County) and Newark (Alameda County). California ranked second in the Nation in exfoliated vermiculite output.

METALS

Chromium.—Although there was no production of chromite in California during 1981, considerable exploration was carried out on the speculation that domestic reserves would become marketable.

U.S. Chrome Co. of Grants Pass, Oreg., completed extensive diamond drilling around the Ima Bell Mine near Seiad Valley in Siskiyou County. The Bar Rick and Tyson Mines near Gasquet, Del Norte County, were explored by Del Norte Chrome Corp. of Vancouver, British Columbia, Canada.

Copper.—Byproduct copper, principally from the Pine Creek Mine in Inyo County, accounted for most of the 1981 California copper production. Small lode gold and silver mines in Alpine, Inyo, Mono, Plumas, and San Bernardino Counties supplied the remainder. Production of copper increased 67% in 1981 and value rose 65%.

Two areas with prospects for new copper deposits were announced during the year. The Mount Emma area near Sonora Pass in

Mono County was cited as prospective for a copper-molybdenum porphyry or a vein-type deposit and a mineralized zone near Highway 19 in Del Norte County was traced across the California border from a massive sulfide (pyrite) deposit in Oregon containing visible sphalerite and chalcopyrite in drill cores.

Gold.—Lode and placer gold production increased 54% during 1981, and value rose 15%. The number of lode mines reporting increased to 14. Gold was also recovered from two placer mines, one heap-leaching operation, one hydraulic operation, and five stream gravel deposits.

Homestake Mining Co. more than tripled its estimate of gold resources at its McLaughlin property in Napa County in May, with the announcement of an expected 1984 startup in the mining of an ore body containing 3.4 million ounces of gold. Production of more than 100,000 ounces annually is anticipated initially.

Mother Lode Gold Mines received a permit from the Calaveras County Planning Commission to operate an open pit mine at the Mountain King-Royal Group near Copperopolis. The company announced delineation of 7 million tons of gold-bearing rock with an average grade of 0.07 ounce of gold per ton. Among the more significant gold producers were the Zaca Mine in Alpine County, the Blazing Star Mine in Calaveras County, the C & W and Keystone Mines in Inyo County, and the Morning Star Mine in San Bernardino County.

Two properties in Plumas County, the Gold Stripe property west of Greenville and the Rich Gulch property on Highway 70, were actively explored. Drilling and geologic mapping continues at both properties.

Table 7.—California: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Mines producing[1]		Material sold or treated[2] (metric tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1979 total	6	2	10,361	r5,010	r$1,540,578	64,185	$711,812
1980 total	7	2	7,856	r4,078	r2,498,020	49,257	1,016,666
1981:							
Trinity	--	--	717	33	15,168	6	63
Undistributed[3]	15	2	26,734	6,238	2,867,235	53,280	560,419
Total	15	2	27,451	6,271	2,882,403	53,286	560,482

County	Copper		Lead		Zinc		Total value
	Metric tons	Value	Metric tons	Value	Metric tons	Value	
1979 total	W	W	2	$1,889	W	W	$2,782,397
1980 total	W	W	W	W	--	--	3,844,945
1981:							
Trinity	--	--	--	--	--	--	15,231
Undistributed[3]	W	W	W	W	W	W	3,977,897
Total	W	W	W	W	W	W	3,993,128

rRevised. W Withheld to avoid disclosing company proprietary data.

[1]Operations from which gold and silver are recovered as byproducts from sand and gravel operations are not counted as producing mines.

[2]Does not include gravel washed.

[3]Alpine, Calaveras, Fresno, Inyo, Kern, Mono, Placer, Plumas, Sacramento, San Bernardino, San Joaquin, Sierra, and Stanislaus Counties combined to avoid disclosing company proprietary data.

Table 8.—California: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1981, by class of ore or other source material

Source	Number of mines[1]	Material sold or treated[2] (short tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode ore:							
Dry gold[3]	9	25,179	3,645	3,923	2	7	W
Gold-silver	2	1,311	312	10,447	W	W	W
Silver	3	233	14	1,851	W	W	W
Total	14	26,723	3,971	16,221	W	W	W
Lead-zinc and tungsten[4]	1	[5]11	[6]75	[6]36,930	W	W	W
Total	15	26,734	[6]4,046	[6]53,151	W	W	W
Other lode material: Gold tailings	--	717	W	W	--	--	--
Total lode	15	27,451	4,046	53,151	W	W	W
Placer	2	--	2,225	135	--	--	--
Grand total	17	27,451	6,271	53,286	W	W	W

W Withheld to avoid disclosing company proprietary data.
[1]Operations from which gold and silver are recovered as byproducts from sand and gravel operations, and an operation from which copper is processed as a byproduct from tungsten operations, are not counted as producing mines.
[2]Does not include gravel washed.
[3]Includes material that was leached.
[4]Combined to avoid disclosing company proprietary data.
[5]Excludes tungsten ore tonnage.
[6]Includes recovery from gold tailings in order to avoid disclosing company proprietary data.

Table 9.—California: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1981, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode:					
Amalgamation, cyanidation, and direct smelting of ore[1]	[2]697	[2]3,516	W	W	W
Smelting of concentrates[3]	3,349	49,635	W	W	W
Total lode material	4,046	53,151	W	W	W
Placer	2,225	135	--	--	--
Grand total	6,271	53,286	W	W	W

W Withheld to avoid disclosing company proprietary data.
[1]Combined to avoid disclosing company proprietary data.
[2]Includes recovery from tailings.
[3]Includes byproduct recovery from tungsten ore.

Iron Ore.—California ranked third in the Nation in 1981 for shipments of usable iron ore. Sizable reductions in ore shipments were again reported in 1981 when compared with those of 1979-80. Kaiser's Eagle Mountain Mine in Riverside County was the State's largest producer. Standard Slag Co. reopened the Beck Mine in San Bernardino County in late 1981. Relatively small quantities of magnetite ore were produced for California Portland Cement. No production was reported from California Portland Cement in 1981.

Iron and Steel.—Kaiser Steel Corp. announced plans to close its primary steelmaking facilities at Fontana, San Bernardino County, and its iron mine at Eagle Mountain. The proposed layoff of nearly 3,000 employees from the total work force of 7,000 was begun.

Lead.—Small quantities of lead were produced in California during 1981, principally as a byproduct gold and silver ores. Nearly all of the production was derived from the Zaca Mine in Alpine County, the C & W and Jackass Mines in Inyo County, and the Morning Star Mine in San Bernardino County.

Mercury.—Both mercury production and value declined in 1981 from that reported in 1980. Ore was mined only from the Gambles (Knoxville) open pit mine in Lake County.

Molybdenum.—All molybdenum produced in California was derived as a byproduct from Union Carbide's Pine Creek tungsten mine. Although tungsten produc-

tion increased during the year, the output and value of molybdenum decreased 57% and 60%, respectively, when compared with those of 1980.

Nickel.—Although no 1981 production was reported, interest continued in the Gasquet Mountain area of Del Norte County for potential nickel, cobalt, and chromium production. A feasibility study by Kaiser Engineers, Inc., was completed for California Nickel Corp., which announced plans to develop an open pit mine containing estimated reserves of 36 million short tons of ore. The project plans to extract nickel and cobalt from the ore by a roast-leach-electrowinning process. Chromite will be recovered by gravity separation to produce a concentrate. About 15 tons of the ore was reportedly extracted from test pits to evaluate extraction processes and to determine the feasibility of recovering the nickel and cobalt.

Rare-Earth Minerals.—Production and value of rare-earth oxides from the Molycorp, Inc., Mountain Pass bastnäsite deposit in San Bernardino County decreased slightly. This operation continued to be the major source of the Nation's rare-earth mineral production.

Silver.—Although output of silver increased 8% in 1981, a sharp drop in price during the year resulted in a 45% decline in value from that of 1980. Union Carbide's Pine Creek Mine in Inyo County continued to supply the bulk of output as a byproduct from tungsten ores. Other important silver producers were the Zaca Mine in Alpine County and the Morning Star Mine in San Bernardino County. Placer silver was produced from six dragline dredging operations.

The Anaconda Minerals Co. announced plans to recover silver and gold left in dump piles at the Darwin Mine in Inyo County using a cyanide leach process.

California Silver Ltd. of Vancouver, British Columbia, Canada, assumed operation of the Zaca Mine in 1981 and announced location of 4.1 million tons of ore containing 0.61 ounce of silver and 0.036 ounce of gold per ton.

An Environmental Impact Report on the Asarco Waterloo Silver Mine was submitted to the San Bernardino County Environmental Public Works Agency in May. The proposed project would permit the mining and milling of a large volume of low-grade silver-barite ore from deposits lying along the southwestern slope of the Calico Mountains.

Tungsten.—California was the leading national producer of tungsten in 1981, accounting for almost 60% of total production. Twelve mines reported production in 1981. The major producers were Union Carbide's Pine Creek Mine (Inyo County) and Teledyne Tungsten's Strawberry Mine (Madera County). Smaller producers operated in Inyo, Kern, Los Angeles, San Diego, and Tulare Counties.

Zinc.—Zinc output remained at low levels in 1981. Small amounts of byproduct zinc were recovered from mining operations in Alpine and Inyo Counties.

[1]State Liaison Officer, Bureau of Mines, Spokane, Wash.
[2]State geologist and Director, California Division of Mines and Geology, Sacramento, Calif.
[3]Associate geologist, California Division of Mines and Geology, Sacramento, Calif.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
Asbestos:			
Calaveras Asbestos Corp	Box 127 Copperopolis, CA 95228	Open pit mine	Calaveras.
Union Carbide Corp., Metals Div	Box K King City, CA 93930	do	San Benito.
Boron compounds:			
Kerr-McGee Chemical Corp.[1]	Box 367 Trona, CA 93562	Evaporators	San Bernardino.
U.S. Borax and Chemical Corp	Box 75128 Sanford Station Los Angeles, CA 90005	Open pit mine	Kern.
Calcium chloride:			
Leslie Salt Co.[2]	Box 364 Newark, CA 94560	Solar evaporators.	San Bernardino.
National Chloride Co. of America[2]	Box 604 Norwalk, CA 90605	do	Do.
Cement:			
California Portland Cement Co.[3]	800 Wilshire Blvd. Los Angeles, CA 90017	Plants	Various.
Kaiser Cement Corp.[4]	300 Lakeside Dr. Oakland, CA 94612	do	Do.

See footnotes at end of table.

Table 10.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Clays:			
Genstar Cement & Lime Co.[5]	215 Market St. San Francisco, CA 94105	Pits	Various.
Lightweight Processing Co	650 South Grand Ave. Los Angeles, CA 90017	do	Ventura.
Pacific Holding Clay Products Co	Box 549 Lake Elsinore, CA 92330	do	Various.
Diatomite:			
Manville Products Corp	2500 Miguelita Rd. Lompoc, CA 93436	Open pit mine	Santa Barbara.
Feldspar:			
Owens-Illinois, Inc.[6]	Box 248 San Juan Capistrano, CA 92675	Pit	Orange.
Gold:			
Cactus Hill Venture, Heavy Metals Development Corp.[7]	4640 South Decator Blvd. Las Vegas, NV 89103	Mine	San Bernardino.
Troy Gold Industries, Inc.[8]	Box 5 West Point, CA 95255	do	Calaveras.
Gypsum:			
United States Gypsum Co	Plaster City, CA 92269	Quarry and plant.	Imperial.
Iron ore:			
Kaiser Steel Corp	Box 158 Eagle Mountain, CA 92241	Mine	Riverside.
Lime:			
Kaiser Aluminum & Chemical Corp	300 Lakeside Dr. Oakland, CA 94612	Plant	Monterey.
Perlite:			
American Perlite Co	Box 579 Big Pine, CA 93513	Open pit mine	Inyo.
Pumice:			
Tionesta Aggregates Co	13290 Hodge Dr. Reno, NV 89511	do	Siskiyou.
Sand and gravel:			
Martin Marietta Corp	Box 216 Byron, CA 94514	Pit	Contra Costa.
Ottawa Silica Co	Box 1280 Oceanside, CA 92054	Pit	San Diego.
Silver:			
Claude B. Lovestedt[9]	Box 1496 Carson City, NV 89701	Mine	Alpine.
Stone:			
Basalt Rock Co., Inc	Box 2540 Napa, CA 94558	Quarries	Marin and Napa.
Gifford-Hill Co., Inc., Riverside Cement.	Box 832 Riverside, CA 92502	do	Riverside and San Bernardino.
Granite Rock Co	Box 151 Watsonville, CA 95076	Quarry	San Benito.
Kopper Co., Inc., South Coast Asphalt.	Box 218 Carlsbad, CA 92008	Quarries	San Diego.
Lone Star Industries, Inc., Pacific Cement Aggregate.[10]	2800 Campus Dr. San Mateo, CA 94403	do	Contra Costa and Santa Cruz.
Southwestern Portland Cement Co.[11]	Box 937 Victorville, CA 92392	do	San Bernardino.
Talc:			
AMOCO Minerals Co., Cyprus	7000 South Yosemite St. Englewood, CO 80112	Open pit mine	Inyo.
Pfizer, Inc.[12]	Drawer AD Victorville, CA 92394	Open pit mines	Do.
Tungsten:			
Teledyne Tungsten	4709 North El Capitan Ave. Fresno, CA 93703	Open pit mine	Madera.
Union Carbide Corp.[13]	Route 2 Bishop, CA 93514	Underground mine and plant.	Inyo.
Vermiculite (exfoliated):			
W. R. Grace & Co	1114 Avenue of the Americas New York, NY 10036	Plants	Alameda and Orange.

[1]Also lime, potassium salts, soda ash, sodium sulfate, and stone.
[2]Also salt.
[3]Also clays, gypsum, and stone.
[4]Also stone.
[5]Also cement, lime, and stone.
[6]Also industrial sand and gravel and stone.
[7]Also copper, lead, silver, and zinc.
[8]Also copper.
[9]Also copper, gold, lead, and zinc.
[10]Also cement and clays.
[11]Also clays.
[12]Also clays and wollastonite.
[13]Also copper, gold, molybdenum, and silver.

The Mineral Industry of Colorado

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Division of Mines of the State of Colorado, for collecting information on all nonfuel minerals.

By Karl E. Starch[1] and A. L. Hornbaker[2]

The value of nonfuel mineral production in Colorado in 1981 was $965.8 million, nearly 25% below that of 1980. This is the first time that the value of nonfuel mineral production in the State has declined in more than a decade. The major reason for this decline was the fall in price and production of molybdenum. In contrast, output of other major metal products of the State, such as gold, lead, silver, and zinc, which had been declining in recent years, increased in 1981 as it did in 1980. Declining gold and silver prices, however, resulted in lower total value of output for those two metals. The trend in output of the major industrial minerals produced in the State was mixed in 1981; sand and gravel and cement production declined slightly, while crushed stone production rose about 10%. Despite the onset of unfavorable market conditions in mid-1981, molybdenum continued to be the State's major nonfuel mineral product, comprising considerably more than one-half of the total value of mineral output.

Colorado was ranked seventh among all States in value of nonfuel mineral production. The State was ranked first in carbon dioxide, molybdenum, and vanadium production; second in tin and tungsten (byproducts of molybdenum); third in lead; fourth in silver; and seventh in gold and zinc. Twenty-four nonfuel minerals were produced in the State in 1981: 10 metals and 14 nonmetallic minerals.

In 1981, the mining sector in Colorado employed about 42,000; of this number, approximately 14,000 were employed in nonfuels production. Employment in mining increased about 18% in 1981, the fastest rate of increase among Colorado's economic sectors, as has been the case since 1974. Mining contributed about 2% of total employment in the State; however, the rapid growth rate in recent years reflects more the movement of energy-company headquarters to Denver than an actual increase in the number of miners. According to a First National Bancorporation survey, mining wages constituted about 5% of all wages paid in the State.

The relative importance of mineral production in Colorado was reflected in a per capita value of mineral production in the State of $334, which compared to a national average of $111.

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

Mineral		1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
Clays	thousand short tons	336	$2,223	276	$1,734
Copper (recoverable content of ores, etc.)	metric tons	461	1,041	W	W
Gem stones		NA	70	NA	80
Gold (recoverable content of ores, etc.)	troy ounces	39,447	24,164	51,069	23,473
Gypsum	thousand short tons	227	3,409	203	2,346
Lead (recoverable content of ores, etc.)	metric tons	10,272	9,615	11,431	9,207
Molybdenum	thousand pounds	102,498	915,304	73,615	636,037
Peat	thousand short tons	29	327	33	299
Sand and gravel[2]	do.	27,433	74,452	p25,700	p72,300
Silver (recoverable content of ores, etc.)	thousand troy ounces	2,987	61,653	3,009	31,650
Stone:					
Crushed	thousand short tons	rW	rW	6,969	24,083
Dimension	do.	6	259	1	64
Zinc (recoverable content of ores, etc.)	metric tons	13,823	11,406	W	W
Combined value of carbon dioxide, cement, iron ore, lime, perlite, pyrites, salt, sand and gravel (industrial), tin, tungsten concentrate, vanadium, and values indicated by symbol W		XX	r160,592	XX	164,493
Total		XX	1,264,515	XX	965,766

pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes industrial sand and gravel; value included in "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Adams	$7,567	$10,198	Sand and gravel.
Alamosa	W	W	Peat.
Arapahoe	4,430	4,009	Sand and gravel.
Archuleta	--	27	Do.
Boulder	30,922	36,671	Cement, sand and gravel, stone, gold, silver, clays, zinc, lead, peat, copper.
Chaffee	W	W	Stone, sand and gravel, peat.
Clear Creek	W	449,244	Molybdenum, sand and gravel, silver, gold, lead.
Conejos	--	W	Sand and gravel.
Costilla	W	W	Stone, sand and gravel.
Crowley	W	W	Sand and gravel.
Custer	W	W	Perlite.
Delta	789	921	Sand and gravel.
Denver	74	73	Do.
Dolores	26	313	Stone.
Douglas	W	W	Sand and gravel, clays, stone.
Eagle	W	7,195	Silver, sand and gravel, gold, copper, lead, stone.
Elbert	W	W	Clays, sand and gravel.
El Paso	W	W	Sand and gravel, stone, clays.
Fremont	47,816	W	Cement, stone, gypsum, clays, sand and gravel.
Garfield	W	W	Sand and gravel, stone.
Gilpin	W	65	Gold, silver, lead, copper.
Grand	339	W	Sand and gravel.
Gunnison	W	W	Sand and gravel, silver, lead.
Huerfano	100	W	Sand and gravel.
Jackson	26	--	
Jefferson	13,802	17,984	Sand and gravel, stone, clays.
Kit Carson	W	W	Sand and gravel.
Lake	344,998	527,867	Molybdenum, silver, tungsten, zinc, gold, lead, tin, copper, pyrites, sand and gravel.
La Plata	827	577	Sand and gravel, gold, silver, lead.
Larimer	W	29,357	Cement, sand and gravel, stone, gypsum, lime.
Las Animas	W	W	Sand and gravel, clays.
Lincoln	W	W	Sand and gravel.
Logan	W	W	Lime, sand and gravel.
Mesa	W	W	Sand and gravel, vanadium.
Mineral	W	W	Silver, lead, zinc, copper.
Moffat	W	1,375	Sand and gravel.
Montezuma	W	W	Carbon dioxide, sand and gravel.
Montrose	W	W	Vanadium, sand and gravel, salt.
Morgan	W	W	Sand and gravel, lime.
Otero	203	357	Sand and gravel.
Ouray	W	W	Silver, sand and gravel, lead, gold, copper.
Park	309	W	Silver, lead, peat, gold.
Phillips	34	61	Sand and gravel.
Pitkin	W	W	Iron ore, sand and gravel.
Prowers	131	W	Sand and gravel.
Pueblo	W	9,041	Lime, sand and gravel, clays, gold, silver, lead.

See footnotes at end of table.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Rio Blanco	$537	W	Sand and gravel, vanadium.
Rio Grande	W	W	Sand and gravel.
Routt	591	$328	Do.
San Juan	W	W	Gold, silver, zinc, lead, copper.
San Miguel	W	W	Vanadium, sand and gravel.
Sedgwick	W	W	Lime, sand and gravel.
Summit	1,214	2,047	Sand and gravel, silver, gold, lead.
Teller	W	W	Gold, peat, sand and gravel, silver.
Washington	42	26	Sand and gravel.
Weld	W	W	Sand and gravel, lime.
Yuma	375	--	
Undistributed[2]	r370,953	166,783	
Total	r826,105	3,1,264,515	

rRevised. 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: Baca, Bent, Cheyenne, Hinsdale, Kiowa, and Saguache.

[2]Includes gem stones and values indicated by symbol W.

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

Table 3.—Indicators of Colorado business activity

		1980	1981p	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	1,480.0	1,519.4	+2.7
Unemployment	do.	84.0	81.2	-3.3
Employment (nonagricultural):				
Mining[1]	do.	36.2	42.3	+16.8
Manufacturing	do.	180.4	184.4	+2.2
Contract construction	do.	77.0	72.7	-5.6
Transportation and public utilities	do.	79.3	81.5	+2.8
Wholesale and retail trade	do.	304.7	311.0	+2.1
Finance, insurance, real estate	do.	76.4	79.6	+4.2
Services	do.	253.4	265.9	+4.9
Government	do.	243.6	242.9	-.3
Total nonagricultural employment[1]	do.	2,1,251.1	1,280.3	+2.3
Personal income:				
Total	millions	$29,053	$33,039	+13.7
Per capita		$10,033	$11,142	+11.0
Construction activity:				
Number of private and public residential units authorized		30,436	27,657	-9.1
Value of nonresidential construction	millions	$730.8	$1,294.2	+77.1
Value of State road contract awards	do.	$115.0	$88.2	-23.3
Shipments of portland and masonry cement to and within the State	thousand short tons	1,432	1,559	+8.9
Nonfuel mineral production value:				
Total crude mineral value	millions	$1,264.5	$965.8	-23.6
Value per capita, resident population		$438	$334	-23.8
Value per square mile		$12,130	$9,264	-23.6

pPreliminary.

[1]Includes coal, natural gas, and petroleum.

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

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

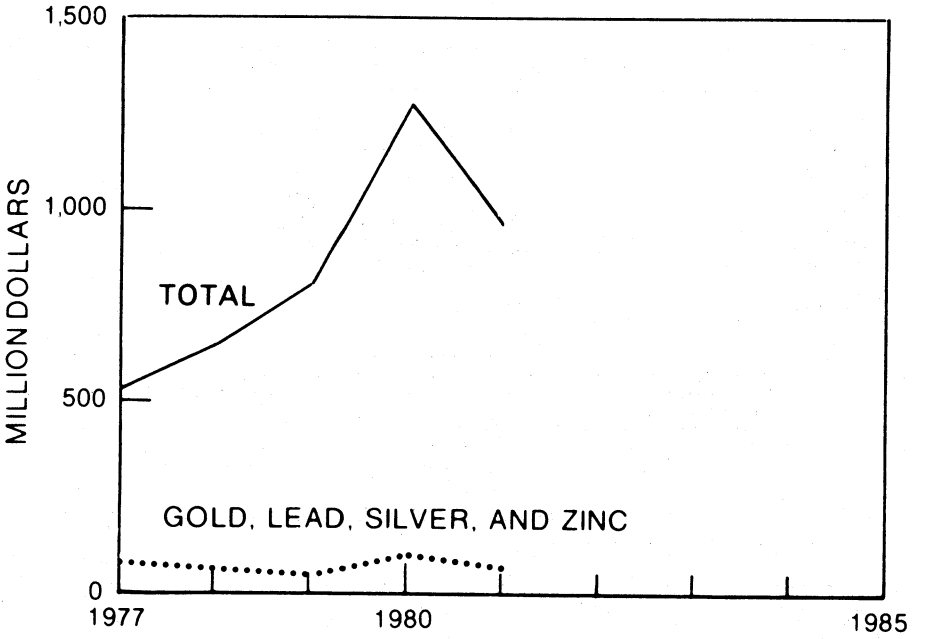

Figure 1.—Value of mine production of gold, lead, silver, and zinc, and total value of nonfuel mineral production in Colorado.

Legislation and Government Programs.—The first regular session of Colorado's 53d General Assembly, a "long session," was convened January 7, 1981, and adjourned November 30, 1981. Legislation enacted (except S.B. 170) and related to nonfuel minerals included—

S.B. 5, effective June 30, 1981, established the Colorado Division of Mines operational fund, reduced required mine inspections by that agency to 1 annually, limited inspections to mines having 75 or fewer employees, and redefined "mine" to exclude quarries and sand and gravel excavations and plants.

S.B. 161, effective April 30, 1981, exempted the State Department of Highways from some fee and bonding requirements of the Mined Land Reclamation Act.

S.B. 170, Colorado's "Sagebrush Rebellion" bill, created a State structure for managing certain federally administered public lands that would be transferred to the State. Governor Richard D. Lamm vetoed the proposal June 5, 1981, and a legislative attempt to override the veto failed by four votes.

S.B. 177, effective June 19, 1981, changed the allocation of the Federal leasing money fund to provide for payment of one-half of any excess over $10.1 million into the local government mineral-impact fund for 5 years.

H.B. 1097, effective May 21, 1981, removed the requirement for a permit amendment under the Colorado Mined Land Reclamation Act when the acreage to be affected by a mining operation is decreased.

H.B. 1172, effective April 30, 1981, conformed the annual filing date for affidavits of labor on mining claims to Federal law, which is December 30 of the year following the improvement period.

H.B. 1518, effective June 19, 1981, revised the requirements for a surety or bond under the Colorado Mined Land Reclamation Act and provided for self-bonding in certain circumstances.

H.B. 1558, effective July 1, 1981, provided for State participation in the Federal Superfund Act to clean up hazardous mining wastes.

The Legislative Council reported that State revenue from the severance tax on minerals was about $32.8 million in 1981, compared with about $6.6 million in 1978, the first year the present rates were in place. Of that total, about $4.1 million was derived from molybdenum and other metallic minerals. The Council felt, however, that these tax revenues had peaked and were declining in a number of areas.

The State of Colorado received more than $25 million as its share of Federal mineral

lease revenues for the fiscal year ending September 30, 1981. Colorado was ranked fourth among the States receiving such revenue.

In December, a loosely organized coalition of citizen groups calling itself IMPACT (Initiative on Mineral Policy Assisting Colorado Taxpayers) filed a draft constitutional amendment with the legislative council that would require the State legislature to impose a severance tax equal to 5% of the total value of minerals produced in the State. To put such a referendum on the ballot in the November 1982 general election, the group had to obtain a number of signatures on petitions equivalent to at least 5% of the voters in the last general election by July 27, 1982.

As part of its Inactive Mine Reclamation Program, the State Division of Mined Land Reclamation completed a physical survey of more than 8,000 inactive mines, rating each site for degree of hazard to the public. On November 19, with considerable input by the Colorado Mining Association and others, the Mined Land Reclamation Board approved and forwarded to the Secretary of the Interior the Colorado Inactive Mine Reclamation Plan. Such a plan was necessary before Federal funds could become available for correcting hazards.

During 1981, the Colorado Geological Survey's Mineral Resource Division continued to inventory the State's mineral resources and provide technical geological assistance to local governments within the State. Reports published during the year included Map Series 17, Inventory of Nonmetallic Mining and Processing Operations in Colorado, which locates pits, quarries, and industrial minerals operations and processing plants on 16 1° by 2° maps (1:250,000), and a Front Range Urban Corridor Strip Map (1:100,000) Report Series 21, Precambrian Tungsten and Copper-Zinc Skarn Deposits of South-Central Colorado, which describes the three main types of skarn deposits occurring in the Precambrian metamorphic rocks of Park, Fremont, Chaffee, and Custer Counties.

REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Cadmium, Indium, and Thallium.—ASARCO Incorporated (Asarco) recovered cadmium, indium, and thallium metal and thallous sulfate at its Globe smelter in Denver from flue dust, dross, and byproduct materials received from out-of-State smelters. At midyear 1981, Asarco announced it would no longer produce thallium at its Globe plant because of the liability risk associated with thallium toxicity. A West German plant remained as the world's sole producer of thallium. The output of these materials was not included in the State mineral production because the origin of the processed materials could not be determined. Cadmium, however, occurred in some base-metal ore in the San Juan area of Colorado.

Copper.—Although copper output increased significantly in 1981, production remained at about one-third that of the mid-1970's. The rate of increase in value of copper produced was not as great because the average price for copper declined from $1.02 per pound in 1980 to $0.85 per pound in 1981. Copper was produced in Colorado only as a byproduct in base-metal ores and was the least important of the gold-silver-copper-lead-zinc complex in value. Copper contributed about 2% of the total value derived from these ores. The metal was produced in 20 mines in 10 counties. Standard Metals Corp.'s Sunnyside Mine at Silverton, San Juan County, yielded the largest amount of copper, accounting for more than one-half the total. Other copper producers, in order of output, were Hecla Mining Co.-Leadville Corp.'s Sherman Mine (Sherman Tunnel) at Leadville, Asarco's Leadville unit (Black Cloud Mine), Homestake Mining Co.'s Bulldog Mountain Mine near Creede, New Jersey Zinc Co.'s Eagle Mine at Gilman, and Federal Resources Corp.'s Camp Bird Mine near Ouray. Copper output was not a factor in the economic health of any of these mines, and Colorado's contribution to the Nation's supply was insignificant.

Gold.—Gold was mined from 27 lode mines and 1 placer mine in 12 counties in Colorado in 1981. The 29% increase in gold production in 1981 over that of 1980 reflected the increased interest in gold generated by the high prices in 1980, when the price averaged more than $612 per ounce, return of the Sunnyside to full production, and greatly increased production at Globe Hill. The slight decline in value of gold

produced in 1981, compared with that in 1980, resulted from the decline in gold price from the average $612 in 1980 to an average of about $460 in 1981. The State's largest gold mine, Standard Metals Corp.'s Sunnyside Mine near Silverton, San Juan County, produced more gold than all the other gold mines in the State combined, and several times more than the second largest producer, Asarco's Leadville unit (Black Cloud Mine) near Leadville, Lake County. No other individual gold mine produced anywhere near the level of these two leaders. Other notable mines, in order of output, were the Globe Hill of Gold Resources, Inc., Teller County; New Jersey Zinc's Eagle, Eagle County; Gold Run Joint Venture's Mary Nevin, Teller County; the Cross Mine of Hendricks Mining Co., Boulder County; Federal Resources Camp Bird, Ouray County; and the Sherman, operated by Hecla, Lake County. The top three mines accounted for more than 90% of the State's gold production.

Table 4.—Colorado: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Mines producing[1]		Material sold or treated[2] (metric tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1979, total	15	1	411,473	13,850	$4,258,879	2,808,934	$31,151,078
1980, total	23	1	549,148	39,447	24,163,656	2,987,058	61,652,877
1981:							
Boulder	3	--	4,418	332	152,600	8,847	93,056
Clear Creek	2	--	9,888	66	30,336	1,947	20,479
Eagle	1	--	6,997	930	427,465	244,873	2,575,665
Hinsdale	1	--	73	30	13,789	24	252
Park	5	--	41,912	378	173,744	67,894	714,134
Summit	2	--	3,538	33	15,169	6,207	65,287
Teller	2	--	283,312	3,606	1,657,462	91	957
Undistributed[3]	12	1	744,944	45,694	21,002,792	2,679,111	28,179,880
Total	28	1	1,095,082	51,069	23,473,357	3,008,994	31,649,710

	Copper		Lead		Zinc		Total value
	Metric tons	Value	Metric tons	Value	Metric tons	Value	
1979, total	362	$742,120	7,554	$8,766,654	9,910	$8,149,288	53,068,019
1980, total	461	1,040,531	10,272	9,615,189	13,823	11,406,279	107,878,532
1981:							
Boulder	1	1,744	8	6,775	7	7,119	261,294
Clear Creek	2	3,928	7	5,366	5	5,219	65,328
Eagle	66	124,291	31	24,568	180	176,837	3,328,826
Hinsdale	--	--	--	--	--	--	14,041
Park	6	10,517	77	62,096	28	27,651	988,142
Summit	(4)	638	2	1,925	--	--	83,019
Teller	--	--	(4)	213	--	--	1,658,632
Undistributed[3]	W	W	11,306	9,105,574	W	W	75,428,478
Total	W	W	11,431	9,206,517	W	W	81,827,760

W Withheld to avoid disclosing company proprietary data.
[1]Operations from which gold, silver, copper, lead, or zinc were recovered as byproducts from sand and gravel or cleanup are not counted as mines.
[2]Does not include gravel washed.
[3]Gilpin, Lake, Mineral, Ouray, and San Juan Counties combined to avoid disclosing company proprietary data.
[4]Less than 1/2 unit.

Table 5.—Colorado: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1981, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode:					
Amalgamation, cyanidation, and direct smelting of ore[1]	[2]19,345	251,084	67	39	230
Smelting of concentrates[3]	31,724	2,757,910	W	11,393	W
Total	51,069	3,008,994	W	[4]11,431	W
Placer	W	--	--	--	--
Grand total	51,069	3,008,994	W	[4]11,431	W

W Withheld to avoid disclosing company proprietary data.
[1]Combined to avoid disclosing company proprietary data.
[2]Includes placer production.
[3]Includes recovery of gold, silver, copper, and lead from tailings.
[4]Data do not add to total shown because of independent rounding.

Table 6.—Colorado: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1981, by class of ore or other source material

Source	Number of mines[1]	Material sold or treated[2] (metric tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode ore:							
Dry gold[3] and lead-zinc[4]	16	[5]694,106	[5]48,561	[5]600,714	W	[5]11,431	W
Gold-silver	3	96,162	889	W	W	W	W
Silver	9	304,361	1,619	2,408,280	193	W	1,196
Total	28	[6]1,094,628	[7]51,069	[7]3,008,994	W	[7]11,431	W
Other lode material:							
Gold tailings	--	454	W	W	W	W	--
Total lode	28	1,095,082	51,069	3,008,994	W	11,431	W
Placer	1	--	W	--	--	--	--
Grand total	29	1,095,082	51,069	3,008,994	W	11,431	W

W Withheld to avoid disclosing proprietary data; included in recovery from lead-zinc ore.
[1]Some mines produce more than one class of material. Operations from which gold and silver are recovered as byproducts from sand and gravel operations or tailings are not counted as producing mines.
[2]Does not include gravel washed.
[3]Includes material that was leached.
[4]Combined to avoid disclosing company proprietary data.
[5]Includes columnar data indicted by symbol W.
[6]Data do not add to total shown because of independent rounding.
[7]Includes recovery from gold tailings.

Although all the flood damage suffered by the Sunnyside in 1978 had not yet been repaired, the mine and mill returned to full capacity in 1981. Through a program of cost-saving practices such as selective stope mining, reduction in work force, and bringing the mine and mill back to full capacity, Standard Metals was able to state in its 1981 annual report that unit costs were reduced from $87 per ton milled in 1980 to approximately $72 per ton milled in 1981. A major water-diversion project was completed to reduce ground water entering the mine through the Lake Emma hole. Since Lake Emma broke into the mine in 1978, 50,000 tons of mud had been cleaned out of the mine, and retimbering was required at a cost of more than $1.1 million in 1981 alone. The Sunnyside was operated under a lease which extends to 1999.

The milling facility, owned by Standard Metals, reached its full capacity of 1,000 tons per day in July and averaged 80% of capacity for the year, compared with 50% for 1980. Total production for the year approximated 200,000 tons, compared with 125,000 tons in 1980. Ore concentrates from the Sunnyside operation were sold under contract to Asarco, Engelhard Industries, Inc., and Phibro Corp. In a settlement with its casualty insurors, Standard Metals received nearly $6 million in cash in April as compensation for flood damage. A small open pit operation was developed at the top of the Spur Vein with ore dropped through an open stope below to be trammed out the American Tunnel. A threatened workers' strike over a management dispute was averted in February but resurfaced in July, resulting in a 4-day walkout. In December, using its Sunnyside property as security, Standard Metals reported a $6 million loan agreement with the Canadian Imperial Bank of Commerce. In an unusual occurrence, $120,000 worth of gold, in the form of a sand amalgam of half gold and half mercury in the last stage of refining, was stolen from the Standard Metals mill July 15.

Also in the San Juan area, Federal Resources continued to develop the Camp Bird and Bachelor Mines during the year but by yearend had cut its work force to about 35; Lake City Mines, Inc., completed purchasing the Golden Wonder Mine but at yearend the mine was idle while the company negotiated an operating contract with San Juan Geological and Mining Consultants, Inc.; the Silver Shield flotation mill, with a 250-ton-per-day capacity, was purchased by Moritz Mining Co., Inc., of Golden and Northern Arizona Gold and Silver Milling and Mining Co.; Union Mine Inc. worked to develop a mine at Platoro; in response to reduced mining in the area, the Bakers Park mill, the only custom mill in the San Juan area, cut its work force from 40 to 13; and The Anaconda Copper Co. continued its evaluation of sites at Summitville and Rico.

In the Cripple Creek-Victor area, the Cripple Creek and Victor Mining Co., a joint venture of Texasgulf, Inc., and the Golden Cycle Corp., continued restoring the famous old Cresson and Ajax Mines. At the Ajax, work consisted of cleaning up and extending old workings of the mine down to the 3,350-foot level. An estimated 300,000 tons of reserves was defined in the Ajax in a 1976-79 exploration program. At the Cresson, where the old shaft had deteriorated too much for use, a new 500-foot incline was driven to get under an indicated ore reserve of approximately 150,000 tons.

A part of the 30-year-old Carlton mill was reconstructed to provide a daily milling capacity of 300 tons of ore. In addition to the work at the Ajax and Cresson mines and Carlton mill, the company worked at cleaning debris out of the Carlton Tunnel to provide drainage and access to the mines.

Also in the Cripple Creek area, Standard Metals entered into a joint venture with Cripple Creek Gold Production Corp. to explore 159 claims on 850 acres owned by Cripple Creek Gold Mining Corp. Over the past several years, Cripple Creek had been developing the Mary Nevin Mine and other properties and was involved in the Gold Run Joint Venture with Crown Central Petroleum Corp. of Baltimore, Md. Cripple Creek and Victor Mining and Standard Metals-Cripple Creek Gold Production controlled 75% to 80% of the total valuation of gold properties in the area. Silver State Mining Corp., which operated a mill and several mines near Alma, Park County, built a 1,000-ton-per-day vat-leaching facility at its Ironclad property near Victor, where the company estimated its ore reserves at 2.6 million tons with an average grade of 0.06 ounce of gold per ton.

Yellow Gold of Cripple Creek, Inc., entered into separate agreements with St. Joe Development Corp. of Menlo Park, Calif., to develop its Rittenhouse property, and with Cripple Creek and Victor Gold Mining Co. to renovate and use its Moffat Tunnel property. Other companies developing properties in the Cripple Creek area included Gold Ore Ltd. of Cripple Creek, Havilah Mining Co., Fair Chance Mines, Ltd., of New Jersey, and Newport Minerals.

In the Leadville area, Day Mines, Inc., which operated the Sherman Mine under agreement with the Leadville Corp., was acquired by Hecla. The Sherman produced an average of 500 tons per day with about 110 employees working 2 shifts per day, 5 days per week. A major effort went into driving a track drift to connect the Sherman workings with those of the Hilltop Mine.

In the Clear Creek-Boulder area, the Hendricks Mining Co., Inc., produced ore from the fourth level of its Cross Mine, while a drilling program outlined new reserves; the Hendricks-Good Mining Co. began rehabilitating the Idaho Tunnel level of the Caribou Mine next door to the

Cross Mine, while processing material from the Caribou Mine dump at the Hendrick-Good Milling Co. mill in Boulder at about 2,200 tons per month. The Caribou Mine operation was closed in July because of court action on interest payments to owners of the mine and ownership of stockpiled ore. Equity Gold, Inc., began producing from the Stanley Mine near Idaho Springs and leased the Glory Hole Mine and mill near Central City, the Freeland group of claims west of the Stanley, and the Amazon property near Craig. The numerous other small mine operations in the Clear Creek area included Franklin Consolidated Mining Co., Jack Pine Mining Co., and Moritz Mining Co.

The Eagle Mine, fourth among Colorado's gold producers in 1981, was operated at a severely reduced level with a work force of 41; it was a scavenging operation, high-grading ore with no effort made to define future reserves. As described in the section on zinc, the Eagle shut down operations entirely in November.

Iron Ore.—Pitkin Iron Corp.'s Cooper Mine, the one iron ore mine in Colorado in recent years, continued in that position in 1981. Located near Ashcroft and Aspen and operated by the Morrison-Knudsen Co., Inc., the mine produced a magnetite ore of about 65% iron for shipment to the CF&I Steel Corp.'s Pueblo steel mill. The iron ore fines, no longer used at CF&I's facility since the closing of its sintering plant, were shipped for use in manufacturing cement. The iron ore was shipped by truck to a railhead at Woody Creek and then by railroad to Pueblo.

In October, CF&I began constructing a $140 million continuous caster and seamless-tube mill at its Pueblo steel plant, the largest single investment ever made by CF&I, a subsidiary of Crane Co. The cross-rolled piercing and elongating-type seamless mill will be the first of its type in the United States. Planned to begin production in 1983, the mill will nearly double CF&I's production capacity for oil-industry tubular goods, which have become a major product of the Pueblo plant in the past year.

The amount of iron ore produced in Colorado was a very small portion of the Nation's total.

Lead.—Lead was also produced as a by-product of more important base and precious metals in Colorado. Output in 1981 increased moderately, but value fell by a similar amount as the price of lead moved from $0.425 in 1980 to $0.365 in 1981. Although produced at 25 mines in 11 counties, lead comprised only about 10% of the total value derived from precious and base metal ore mined in the State in 1981. Asarco's Leadville unit in Lake County produced more lead in 1981 than the combined output of all the other mines reporting production. Other mines reporting lead output, in the order of lead produced, were Standard Metal's Sunnyside Mine near Silverton, Homestake Mining Co.'s Bulldog Mountain Mine at Creede, and the Sherman Mine operated by Hecla under license from the Leadville Corp. The 1981 level of lead production was less than one-half that of the early and mid-1970's. Lead, however, was the major income producer at several small mines and second in value at the Leadville unit, Sherman Mine, and Bulldog Mountain Mines. Colorado was third among the 50 States in lead output in 1981, but the amount produced was less than 3% of the national total.

Molybdenum.—Again in 1981, molybdenum was the most important nonfuel mineral produced in the State. Colorado molybdenum provided 60% of the Nation's production of this metal, or about 40% of the free world's output. Climax Molybdenum Co., a division of AMAX Inc., produced all the primary molybdenum in Colorado; output came from two mines, the Climax Mine near Leadville in Lake County and the Henderson Mine near Empire in Clear Creek County.

AMAX's Form 10K annual report to the Securities and Exchange Commission reported production of about 90.4 million pounds of molybdenum in 1981, nearly 50 million pounds from the Climax Mine and more than 40 million pounds from Henderson. This output compares with about 102 million pounds produced in 1980, 92 million pounds in 1979, and about 84 million pounds in 1978. Thus the decline in output of molybdenum in 1981 was the first such decline experienced by AMAX in many years.

Reasons for this reduced output were twofold: (1) a decline in the production of steel and steel products, which normally consumed about 90% of the molybdenum output as an alloying element in steel and in the production of specialty steels, and (2) added molybdenum production from new mines and as a byproduct of copper production. These factors have reduced AMAX's

share of the free world molybdenum production from about 65% to about 40% in the past 15 to 20 years. Declining demand in 1981 resulted in increased producers' molybdenum inventories at the end of 1981. During the year AMAX inventories exceeded a 12-month supply; the company considers a 3-month supply an adequate working inventory. AMAX's Form 10K valued yearend 1981 inventories at $186 million, compared with $86 million at yearend 1980. The dealers' spot market price for molybdenum slid dramatically from about $32 in 1979 to less than $4 in 1981. The producers' price delined late in 1981 to $6.85 per pound from $9.35 earlier in the year.

A hiring freeze instituted December 15, 1980, and normal attrition at the Climax and Henderson Mines decreased the total work force by about 700 workers, or approximately 14% of the total work force of 5,100, by the end of 1981. There were reductions from about 2,000 to 1,700 at Henderson and 3,100 to 2,700 at Climax. Although mine crews were producing at record rates early in the year, as inventories grew to unacceptable levels, AMAX began to reduce daily output and look at ways to reduce costs. At yearend the Henderson Mine and mill were reduced to a 5-day week, and daily output declined from the 30,000 tons that prevailed at the beginning of the year to 27,000 tons by yearend.

One shovel was curtailed at the Climax open pit in September and another in November, leaving just two shovels working. Saturday day shift work was ended November 28. Climax production, which was about 48,000 tons per day at the beginning of 1981, was only about 33,000 tons per day by yearend. In addition, the company was considering laying off 300 people at Henderson, 600 at Climax, and 50 at the Western Headquarters after the first of the year 1982; the company also was considering closing both mines for the month of June 1982, all with the object of reducing output by 25% to 30%.

At the Climax Mine, which had operated as an underground mine since 1918 and with an added open pit operation since 1973, estimated reserves were 146 million tons averaging 0.314% molybdenum disulfide (containing approximately 60% molybdenum), minable by open pit methods, and 272 million tons of reserves averaging 0.308% molybdenum disulfide, minable by underground methods, approximately a 40-year supply at the normal rate of mining.

The two producing underground levels, the Storke and the 600 Level, averaged about 21,000 tons per day and 10,000 tons per day, respectively; and the open pit was averaging 18,000 tons per day when the mine was producing at the 49,000-ton-per-day rate.

Capital expenditures at Climax in 1981 were approximately $92 million, including mine preparation. Projects included constructing a new crushing system, the No. 6 crusher, to handle output of the open pit. In addition to the gyratory crusher, a new tertiary crusher and conveyor delivery system comprised most of this $40 million capital investment. Other major capital investments included the west tailing delivery line, notable for its plastic pipe, utility and plant service relocation, 900 Level developments, and the No. 7 shaft compressor.

The Henderson Mine lies on the east side of Berthoud Pass; the mill is located on the west side of the Continental Divide in the Williams Fork Valley south of Parshall. AMAX calculated the proven and probable ore reserves at the Henderson Mine at 230 million tons, averaging 0.420% molybdenum disulfide, a 22-year supply based on the normal mining plan. As at Climax, the extent of the mineralized zone had not been fully defined. In 1981, capital expenditures at Henderson, including mine development, were approximately $44 million, including another one-half-million-dollar warehouse at the Kremmling loading facility to accommodate the increased stockpile, a fifth shaft at the mine site for ventilation, and a fourth ball mill.

In August, AMAX announced a delay until at least 1984 in developing its Mount Emmons molybdenum prospect near Crested Butte, Gunnison County. This delay was related to the decline in demand for, and increased inventories of, molybdenum. AMAX estimated that the Mount Emmons prospect contained approximately 155 million tons of reserves averaging 0.44% molybdenum disulfide. By the end of 1981, AMAX had invested approximately $145 million in Mount Emmons.

AMAX paid nearly $132 million in wages in its Colorado molybdenum operations, $76 million at Climax alone. More than $4 million was withheld from employees for State income taxes.

The AMAX Urad Mine and mill reclamation project was granted the 1981 National Environmental Industry Award from the President's Council on Environmental Quality.

Molybdenum exploration during the year included that of AMAX near Pagosa Springs, Amoco Minerals Co. southeast of Ridgeway, Anaconda Copper in agreement with Silver State Mining southwest of Twin Lakes, Minerals Engineering of Denver in the West Cross Creek-Holy Cross Wilderness, Monarch Molybdenum Co. at Mount Etna, Noranda Exploration, Inc., near Jamestown, and Union Oil Co. near Tin Cup.

Silver.—The output of silver in Colorado increased slightly in 1981, but the value of that output declined nearly 50% because of the fall in the average price of silver from $20.63 in 1980 to $10.52 in 1981. Silver production was reported at 27 mines in 12 counties; in 9 of these mines, silver was the most important metal produced. In Colorado, silver is produced from a complex base and precious metal ore, which means that most lode mines produce several or all of the metals, copper, gold, lead, silver, and zinc in varying proportions. For many years, silver has exceeded in value the other four metals in this group. In 1981, the total value of silver produced in the State exceeded that of gold, the second in rank of value of these metals, by 35%, compared with 55% in 1980. Silver accounted for about 39% of the total value of all base and precious metals produced in the State. The largest silver producer continued to be the Bulldog Mountain Mine of Homestake at Creede, Mineral County. The Bulldog yielded nearly as much silver as the other leading silver producers in the State combined. The second largest producer was the Sherman Mine, operated by Hecla, the merger partner with Day Mining Co., which had operated the Sherman under lease from the Leadville Corp. since 1974. The Sherman, near Leadville, Lake County, consisted of approximately 3,500 acres of patented and unpatented claims. In August, the underground haulage system in the Sherman was connected with the Hill Top Mine to enhance development work and provide for more efficient movement of ore if the Hill Top is reactivated. Hecla's annual report indicated production of 120,000 tons of ore averaging 8.3 ounces of silver per ton and 0.6% lead in 1981. About 116,000 tons had been produced in 1980.

The other major silver producers in the State, in order of output, were Asarco's Leadville unit (Black Cloud Mine) at Leadville, New Jersey Zinc's Eagle Mine in Eagle County, and Standard Metals' Sunnyside Mine near Silverton in San Juan County. Silver was the highest value product in all six mines except the Leadville unit and the Sunnyside. The Bulldog was the only one of the six that did not also produce gold.

The Bulldog Mine comprised 30 patented claims and 690 unpatented claims. Ore was extracted from five working levels spaced at 200-foot intervals, connected to the surface by two adits. Rubber-tired diesel loaders were introduced into the mine in 1981, improving productivity. Homestake's 1981 annual report notes 103,609 tons of ore produced in 1981 and 100,579 tons in 1980; silver output was 1.41 million ounces in 1981 and 1.45 million ounces in 1980. Average silver content was 14.6 ounces per ton, and lead 1.6%; in 1980 these figures were 15.2 ounces and 1.4%, respectively. Depressed prices for silver, however, resulted in a sharp reduction in revenues and operating earnings, about $13 million in 1981, compared with $26 million in 1980. To combat rising costs and falling prices, several marginal stopes were withdrawn from production and the work force was cut from 180 at the end of 1980 to 163 at yearend 1981. The flotation mill operated near its 300-ton-per-day capacity in 1981. The carbon-in-pulp plant, which treated the slime portion of the mill tailings and also tailings during the summer months, was shut down in October because low silver prices made it uneconomical to operate. Proven and probable reserves were increased in 1981 to 794,000 tons, averaging 16.3 ounces of silver per ton and 2.8% lead. Results of a diamond-drilling program were not encouraging, however, indicating the area of mineralization did not extend much beyond the newly opened 9,200-foot level, and the West Strand potential appeared less than had been expected.

Exploration was continued at the Creede Formation, or Bachelor Mountain property, jointly owned by Homestake and Minerals Engineering Co. of Denver, also known as MECO. An independent evaluation of the property estimated proven and probable mineral reserves of about 3.3 million tons of ore containing 6.39 ounces of silver per ton.

The Caribou Mine rehabilitation, begun by Hendricks-Good Mining Co., Boulder County, was aimed at producing 75 to 100 tons of ore per day with an average silver content of 31 ounces per ton, using selective mining techniques. Ranchers Exploration

and Development Corp. continued work on the Revenue-Virginius Mine in Ouray County.

The Eagle County commissioners granted permits to the Gold Fields Mining Corp. to conduct a 3-year exploration project on several old silver properties in the Red Cliff area.

Ranked fourth among the Nation's silver-producing States in 1981, Colorado was the source of about 7% of the country's total silver output.

Tin.—Colorado remained the only reported source of tin in the conterminous United States in 1981. Alaska was the only other producer among the 50 States. Tin was produced as a byproduct of molybdenum at AMAX's Climax Mine, where the ore contains about 0.002% tin. The annual output of tin at Climax has been 150,000 to 180,000 pounds. Reported production in 1981 was considerably greater than in 1980.

Tungsten.—Colorado was second among the seven States reporting tungsten production in 1981. California was the only other substantial producer. The sole source of tungsten in the State was AMAX's Climax Mine near Leadville, where it was a byproduct of molybdenum production. AMAX's Form 10K report for 1981 indicated an output of about 2.6 million pounds of tungsten trioxide, containing about 2.1 million pounds of tungsten, about 15% more than was produced the previous year. Climax exceeded its previous tungsten production record during August. With a gravity separation process such as Climax's tungsten circuit, recovery generally improves with a reduction in tonnage processed. The concentrates recovered at Climax contained 69% tungsten trioxide (WO_3). The actual percentage of tungsten recovered from the ore processed was 26.6% in 1981, a record high from ore that is ground fine for the recovery of molybdenum. The tungsten was shipped from Climax as iron manganese tungstate in 33-gallon drums weighing about 1,000 pounds. Most was purchased by the General Electric Co. and GTE, who refined and processed it into tungsten carbide products such as saw blades, high-speed tool steel, and tungsten wire light bulb filament.

Vanadium.—The production of vanadium continued to decline in 1981 for two reasons: (1) vanadium is used largely as an alloying element in steel and consumption dropped because of the decline in steel production, and (2) in Colorado, vanadium occurs as a coproduct from uranium ores and reduced demand for uranium affected vanadium production. Vanadium was produced by two companies, Union Carbide Corp. at its Uravan-Rifle facilities and Cotter Corp. at its Canon City mill; Union Carbide was by far the larger producer in 1981. Colorado ores were also processed in Utah at Atlas Corp.'s Moab mill and at Energy Fuels Nuclear, Inc.'s, Blanding Mill. A major source of ore was the Uravan mineral belt in western Colorado located generally in Mesa, Montrose, and San Miguel counties. Declining prices for vanadium and uranium resulted in a loss of nearly 50% of mining and business employment in the West End area in western Mesa, Montrose, and San Miguel Counties.

The Union Carbide uranium-vanadium mill at Uravan was closed from March to September. About 90 of the mill's 180 employees remained for maintenance work during the shutdown, the first in 20 years at the plant. The State license to operate the Uravan facility expired in 1975. Since that time, it has operated under special extensions allowed by the Colorado Department of Health while the tailings ponds, liquid-waste handling, and other problems were corrected. Operations at the company's vanadium-finishing facility at Rifle and heap leaching operation at Maybell were not affected by the mill shutdown. Reopening the 750-ton-per-day mill in September did not reflect improvement in the uranium market but was necessary to meet the company's contractual commitments.

Although threats from the Colorado Department of Health to withdraw its operating license were dropped, the Cotter Corp. uranium-vanadium mill at Canon City remained the center of local environmental controversy. In March, the mill was granted a new, amended license, and Health Department officials commended the company for correcting deficiencies. The amended license established a nearer deadline of March 31, 1984, for moving 1.5 million tons of processed ore stored at the mill to a new, lined collection pond, instead of the 7 years previously allowed. Cotter contracted with Goodfellow Bros., Inc., of Wenatchee, Wash., to move the material. Efforts to bring the mill up to its 1,200-ton-per-day capacity ended in April when 75 of the mill's 200 employees were laid off, the workweek shortened, and daily output reduced to 500 tons. Almost all the 75 workers laid off had worked in the vanadium section of the plant; thus, vanadium production at

the mill ended for the year. The $3-per-pound price for vanadium pentoxide was reportedly not sufficient to justify continued production. Hearings before the Colorado Air Quality Control Commission on Cotter's request for exemptions from required air-emission permits were postponed beyond yearend. The Colorado Court of Appeals ruled in September that a consortium of citizens' organizations had no right to seek an injunction stopping Cotter from using its mill and tailings facility.

In March, Homestake received a radioactive-materials license from the Colorado Department of Health for a 600-ton-per-day mill as part of its Pitch Project on Marshall Pass, about 36 miles southeast of Gunnison. Homestake had originally applied for the license in October 1976. Part of the $57 million project, the mill had previously been approved by the State Mined Land Reclamation Board, the State Water Quality Control Commission, and the Saguache County Commissioners. An environmental group, the Gunnison Valley Alliance, had opposed the project. Despite these approvals, however, Homestake decided in April to delay indefinitely actual construction of the mill and to cut back on production from the open pit mine it had been operating as part of the project. Market conditions and purchase of full ownership of a mill at Grants, N. Mex., to which Pitch Project ore had been shipped, were given as reasons for delaying construction of the new mill. According to Homestake's 1981 10K report, nearly 35,000 tons of ore was mined at Pitch in 1981 compared with the more than 93,000 tons produced in 1980.

Pioneer Uravan, Inc., closed four of its five mines near Uravan in April but proceeded with the permitting process for a proposed 1,000-ton-per-day uranium-vanadium mill near Slickrock, holding out the possibility of beginning construction of the mill next year.

Colorado remained the Nation's number one producer of vanadium in 1981.

Zinc.—Of the three base metals produced in Colorado in 1981, zinc was the most important, although exceeded in value by several other metals produced in the State, such as gold, molybdenum, silver, tungsten, and vanadium. Although the 1981 level of zinc production substantially surpassed that of 1980 and 1979, it remained well below pre-1978 levels. Thirteen mines in nine counties reported zinc production in 1981. Most production was from Asarco's Leadville unit (Black Cloud Mine). Standard Metals' Sunnyside Mine at Silverton was the only other significant zinc producer in 1981. No other mine accounted for more than 4% of the total. The average price of zinc was $0.45 per pound in 1981, compared with $0.37 in 1980.

New Jersey Zinc, a division of Gulf + Western Natural Resources Group, announced closing of the Eagle Mine at Gilman, November 1, 1981. The Eagle was Colorado's largest zinc producer for many years, and one of the State's major mines since early in the century. The work force at the mine was reduced from 250 to around 40 in 1977 because of the declining zinc market. The unique underground mill was partly dismantled and removed. The mine continued to operate at an approximate 500-ton-per-month level, extracting those ores having a higher gold and silver content and shipping them directly to the Asarco smelter at Tacoma, Wash. The faltering silver market led to the decision to shut down further. Perched on the side of a mountain in Eagle County, the town of Gilman was built by New Jersey Zinc in the 1920's and 1930's to house workers at the mine. New Jersey Zinc merged with Gulf + Western Industries, Inc., in 1966. The 5,000-acre townsite, the mine, and the tailings ponds were offered for sale in 1981.

With 5% of total output, Colorado was ranked sixth in the Nation in zinc production in 1981.

NONMETALS

Carbon Dioxide.—Colorado was the Nation's largest producer of carbon dioxide in 1981. About 5 years ago, Shell Oil Co. and Mobil Oil Co. began exploration and development of the carbon dioxide (CO_2) resource from rocks at McElmo Dome near Cortez, Montezuma County. In 1981, Shell decided to proceed with an expanded $1.6 billion project to use the CO_2 in an enhanced recovery project for a 28,000-acre unit in the West Texas Wasson oilfield. The CO_2 will be injected at high pressure into the old oilfield, where it will provide the pressure needed to recover an additional 280 million barrels of oil. The CO_2 reserves, believed to be substantially in excess of 1.2 trillion cubic feet, will be recovered from more than 200 wells in Montezuma and Dolores Counties and shipped to Texas through a 495-mile-long pipeline. The amount of CO_2 involved is more than that required for the present project and undoubtedly will be

applied to other oil recovery projects as well. Shell held a 44% average interest in the leases; Mobil held 43%. Mobil had yet to spell out its involvement in the pipeline venture. Of about 104 working-interest owners reportedly involved in the project, Shell was the largest with a 31.6% interest; Conoco had 16.9%, Texaco 8.6%, Exxon 8.6%, Arco 7.6%, and Getty 7.2%. About 25 CO_2 wells had been drilled at the McElmo Canyon and Doe Canyon sites, and acquisition of the pipeline right-of-way began in 1981. Project completion was scheduled for 1982.

Cement.—As in previous years, cement was produced in Colorado in 1981 at just three plants: Ideal Basic Industries, Inc.'s, two plants, the Boettcher plant in Larimer County and the Portland plant in Fremont County; and Martin Marietta Corp.'s Lyons plant in Boulder County. All three plants produced portland cement; two of them also produced masonry cement. Most of the cement produced was type I and II, moderate-heat-resistant type. Ready-mix concrete companies were the major customers for Colorado's cement-plant output, followed by concrete-product manufacturers and other contractors. Most was shipped in bulk, by truck, directly to the ultimate consumer.

Despite the depressed state of the housing industry, Ideal Basic's Cement Div. reported an operating profit in 1981, albeit smaller than in 1980, and shipments slightly ahead of the 1980 level, even though U.S. demand for cement dropped about 6% below that of 1980. This was not true of its Colorado operations, where the Portland plant was slightly behind its 1980 shipments and the newly renovated Boettcher plant did not come up to the level of 1980's output. The renovated and expanded Boettcher plant was brought on line in 1981 when the new traveling-grate preheater kiln was fired up in July. Two old kilns, initially installed in 1928, were shut down. The new system utilizes the kerogen in the raw limestone to provide 25% of the fuel required in the cement-production process. New roller mills were installed to grind raw material, while the old raw grinding mills were converted to finish mills, increasing the plant's capacity to grind clinker into cement. Annual rated capacity of the new Boettcher plant is 460,000 tons compared with 325,000 tons at the old facility. A new distribution terminal, with an annual shipping capability in excess of 100,000 tons, was approved for Rifle, Colo., to serve the anticipated development in the oil shale industry.

Martin Marietta's Lyons plant countered the national trend of lower cement production and increased shipments of cement in 1981. A new cement plant, expected to serve the western Colorado market, began production in the Leamington Valley, Utah.

Clays.—Fifteen companies at 35 sites in 7 counties produced clays in 1981. Counties were typically Front Range, metropolitan counties. Common clay was produced in all seven counties and accounted for around three-fourths of the total; fire clay in El Paso, Fremont, and Pueblo Counties; and bentonitic clay (both swelling and nonswelling types) only in Fremont County. Common brick and face brick were the most common clay products; a small amount was used for sewer pipe, and some bentonite was used as a water sealant, in drilling mud, and in animal feed. Robinson Brick & Tile Co., operating seven mines in four counties, was by far the largest producer of clay in the State; Silver Rocker Bentonite Co., with four mines in Fremont County, was second; and Lakewood Brick and Tile Co., with two mines in Jefferson County, was third. These three largest companies produced about 60% of total clay output. The unit value of common clay ranged from as low as $1 per ton to $6.83 per ton, fire clay from $3.86 per ton to $19.06, and bentonite from $10 to $14 per ton.

Table 7.—Colorado: Clays sold or used by producers, by county

(Short tons)

County	1980		1981	
	Quantity	Value	Quantity	Value
Boulder	W	W	W	W
Douglas	45,613	$365,106	W	W
Elbert	W	W	W	W
El Paso	W	W	W	W
Fremont	55,523	650,767	58,403	531,349
Jefferson	144,523	694,875	99,867	533,201
Las Animas	W	W	--	--
Pueblo	45,115	247,194	37,444	195,193
Other[1]	45,668	265,336	80,166	474,491
Total	336,442	2,223,278	275,880	1,734,234

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Consists of data indicated by symbol W.

Gem Stones.—Cominco American Inc. constructed a $2.5 million plant north of Fort Collins to test diamond-bearing rocks. Cominco had been testing samples of kimberlite from the Colorado-Wyoming Stateline area. A 5-mile-square testing site just north of the Colorado border was being worked under an agreement with the State of Wyoming and Rocky Mountain Energy Co. and was known as the Fish Creek Project. Testing involved crushing and screening the kimberlitic rock; concentrating the heavy material, including the diamonds; using an X-ray machine to locate any diamonds in the concentrate; and hand-separating them. If the project proves commercially feasible, mining could begin within about 5 years.

Turquoise continued to be produced on a small scale at a turquoise mine east of Manassa in Conejos County. The mine has been worked since the late 1800's by the King family who hand-cut and polish the turquoise which the Navajo Indians then use for jewelry.

Gypsum.—Three companies in Fremont County and three in Larimer County produced crude gypsum in 1981; nearly 90% of production was in Fremont County. Genstar Building Materials Co. of Florence was the major producer, and only Genstar produced calcined gypsum. Crude gypsum was marketed as a soil conditioner and cement retarder. Calcined gypsum was used mainly in producing wallboard. Production in 1981 was about 10% less than in 1980, reflecting the continuing slump in home building. Genstar Corp., a Canadian-based conglomerate involved in building materials, land and real estate development, and financial and marine services, acquired the Flintkote Co., former operator of the Florence gypsum plant, in 1980. Genstar increased capacity of the plant, reporting in its 1981 annual report an annual capacity of 200 million square feet of wallboard. The Flintkote product name was retained.

Lime.—Three companies in six counties produced lime. The Great Western Sugar Co. produced quicklime in Larimer, Logan, Morgan, Sedgwick, and Weld Counties for use in processing sugar beets into sugar at its plants at Fort Morgan, Greeley, Loveland, Ovid, and Sterling. CF&I produced lime for use in its steelmaking operations at Pueblo, using limestone from its quarry on the eastern slope of Monarch Pass in Chaffee County. CF&I produced more than one-half of the lime manufactured in the State in 1981. Calco, Inc., a new company in Chaffee County in 1980, also produced quicklime in 1981. The company took limestone from the Monarch Quarry west of Salida during its quarrying season, June to October.

Output of lime in 1981 was about 5% below that of 1980.

Peat.—Six companies produced peat in five counties: Alamosa, Boulder, Chaffee, Park, and Teller. One company, Universal Peat Co. in Park County, produced more than 80% of the total output. Some production was of the humus and reed-sedge type of peat, but most was unidentified. Most peat was shipped in bulk; only about 5% was packaged. About 50% was used in fertilizer mixtures, 26% as an ingredient in potting soil, and 24% for general soil improvement. Prices ranged from $1.66 per ton to $29.91 per ton, with $8 to $10 being a common price range.

Perlite.—Crude perlite was produced

from one mine in Colorado in 1981, the Rosita Mine of Persolite Products, Inc., in the Wet Mountain Valley, Custer County. Output was shipped about 36 miles to Persolite's expanding plant at Florence. Two companies expanded perlite, Persolite Products at its Florence plant, Fremont County, and Grefco, Inc., at a plant in Antonito, Conejos County. The Grefco plant was by far the larger of the two. Most of the perlite for the Grefco plant came from a deposit several miles south of Antonito at No Agua, N. Mex., reportedly the largest known deposit of commercial-grade perlite ore in the country. The expanded perlite was used mainly as filter aid, and minor amounts were used as insulation, construction aggregate, and horticultural aggregate.

Perlite production, although small in Colorado, increased substantially in 1981.

Pyrites.—At its Climax Mine near Leadville, AMAX produced pyrite as a byproduct of molybdenum. Three to 5 pounds of pyrite were removed from each ton of ore processed at the Climax mill. The output of pyrite in 1981 increased considerably over that of 1980. Some of the pyrite was sold to a company that mixed it with peat moss and sold it as a soil conditioner.

Salt.—Union Carbide recovered salt in the form of brine from a well in Montrose County for use in the company's uranium-vanadium mill at Uravan. Production, related to need by the Uravan mill which was closed 6 months in 1981, was less in 1981 than in 1980.

Sand and Gravel.—To reduce reporting burdens and costs, the Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production, but complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Industrial sand and gravel represents a small percentage of total sand and gravel produced in Colorado. Only two companies, with a single plant each, produced industrial sand and gravel in the State. Almost all industrial sand and gravel was mined in El Paso County by the Fountain Sand and Gravel Co., a subsidiary of Crane Co. The second producer was in Arapahoe County. More than three-fourths of the industrial sand produced was used for hydraulic fracturing.

Stone.—Twenty-six companies produced stone at 34 quarries in 11 counties. Dimension stone, constituting only about 1/100 of 1% of the total production, was quarried only in Boulder, Douglas, and Larimer Counties; it was used as flagstone, as moss rock for veneer, and in making monuments. Most of the crushed stone output was produced from limestone, and most of the balance from granite. Sandstone and traprock were the other sources of crushed stone. About 40% of all crushed rock was used in manufacturing cement. The second and third largest uses, at about 15% each, were dense-graded road base and concrete aggregate. Other uses, in order of quantity used, included unspecified aggregate, flux stone, riprap, bituminous aggregate, filter stone, and sugar refining. Prices of crushed stone ranged from around $2 per ton for filter stone to around $17 per ton for terrazzo stone. Prices of dimension stone were around $20 per ton for flagstone and around $193 per ton for monumental stone.

About one-third of all stone was quarried in Jefferson County and one-fourth in Fremont County; following, in order of production, were El Paso, Larimer, and Boulder Counties.

Major producers, in order of output, were Ideal Basic Industries; Cooley Gravel Co.; Mobil Premix Concrete, Inc.; Castle Concrete Co.; Martin Marietta; CF&I; and the Asphalt Paving Co. The top four producing companies accounted for more than two-thirds of the total output. All stone produced was transported by truck. Nineteen of the State's 33 quarrying operations were smaller than 100,000 tons per year and produced less than 5% of the total stone output. The two quarries that produced 1 million tons or more during the year accounted for more than 40% of total stone output.

A major factor in stone production continued to be public opposition to new or expanded quarry sites. Among proposals receiving the most public opposition and comment were those to quarry stone on South Table Mountain near Golden, which the Jefferson County Commissioners denied in December after more than 5 years of

hearings; a request to quarry at the mouth of Clear Creek Canyon, also near Golden, which also was denied; the Deer Creek Canyon and south Draw proposals in Jefferson County, unresolved at yearend; and the Geer Canyon proposal in Boulder County, also unresolved at yearend.

Table 8.—Colorado: Crushed stone[1] sold or used by producers in 1981, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Agricultural limestone	3	11
Poultry grit and mineral food	52	224
Concrete aggregate	1,044	4,364
Bituminous aggregate	276	1,124
Macadam aggregate	12	32
Dense-graded road base stone	1,118	3,219
Surface treatment aggregate	W	W
Other construction aggregate and road stone	478	1,102
Riprap and jetty stone	314	1,106
Manufactured fine aggregate (stone sand)	52	361
Cement manufacture	2,826	9,419
Lime manufacture	49	171
Flux stone	394	W
Sugar refining	97	409
Waste materials	12	48
Other[2]	244	2,491
Total[3]	6,969	24,083

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, granite, sandstone, traprock, miscellaneous stone, and volcanic cinders and scoria.
[2]Includes stone used for filter stone, refractory stone, mine dusting, and roofing granules.
[3]Data may not add to totals shown because of independent rounding.

Sulfur.—Continental Oil Co. recovered elemental sulfur from acid gases at its petroleum refinery near Denver. Elemental sulfur is not included in table 1 because it is considered a byproduct.

Vermiculite.—W. R. Grace & Co. exfoliated beneficiated vermiculite from Montana at its Denver plant and used the product for concrete and plaster aggregates, insulation, fireproofing, and horticulture.

[1]State Liaison Officer, Bureau of Mines, Denver, Colo.
[2]Geologist, Colorado Geological Survey.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Ideal Basic Industries, Inc.[1]	Box 8789 750 17th St. Denver, CO 80201	Plants	Fremont and Larimer.
Martin Marietta Corp.[1]	6801 Rockledge Dr. Bethesda, MD 20817	Plant	Boulder.
Clays:			
Lakewood Brick and Tile Co	1325 Jay St. Lakewood, CO 80214	Mines	Jefferson.
Robinson Brick & Tile Co	Box 5243 Denver, CO 80217	do	Douglas, Elbert, El Paso, Jefferson.
Silver Rocker Bentonite Co	Box 718 Salida, CO 81201	do	Fremont.
Gold:			
Standard Metals Corp.[2]	Box 247 Silverton, CO 81433	Mine and mill	San Juan.
Gypsum:			
Genstar Building Materials Co	1153 State Hwy. 120 Florence, CO 81226	Mine and plant	Fremont.
U.S. Soil Conditioning Co	Box 926 Salida, CO 81201	do	Do.

See footnotes at end of table.

Table 9.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Iron ore:			
Pitkin Iron Corp	105 W. Adams St. Chicago, IL 60603	Mine	Pitkin.
Lead:			
ASARCO Incorporated[3]	Box 936 Leadville, CO 80461	Mine and mill	Lake.
Lime:			
CF&I Steel Corp.[1]	Box 316 Pueblo, CO 81002	Mine	Pueblo.
The Great Western Sugar Co	1530 16th St. Denver, CO 80217	Plants	Adams, Boulder, Larimer, Logan, Morgan, Sedgwick, Weld.
Molybdenum:			
AMAX Inc.[4]	13949 W. Colfax Ave. Golden, CO 80401	Mine and mill	Clear Creek and Lake.
Peat:			
Universal Peat Co	1557 S. Ingalls St. Lakewood, CO 80422	Bog	Park.
Perlite (crude and expanded):			
Grefco, Inc	Box 308 Antonito, CO 81120	Plant	Conejos.
Persolite Products, Inc	Box 105 Florence, CO 81226	Mine and plant	Custer and Fremont.
Silver:			
Hecla Mining Co.[5]	Box D Leadville, CO 80461	Mine and mill	Lake.
Homestake Mining Co.[6]	Box 98 Creede, CO 81130	____do	Mineral.
The New Jersey Zinc Co.[7]	Gilman, CO 81634	Mine	Eagle.
Stone:			
Castle Concrete Co	Box 2379 Colorado Springs, CO 80901	Quarries	El Paso.
Cooley Gravel Co.[8]	Box 5485 Denver, CO 80217	Quarry	Jefferson.
Mobile Pre-Mix Sand and Gravel Co.[8]	7620 Madison St. Denver, CO 80204	____do	Do.
Vanadium:			
Cotter Corp	Box 352 Golden, CO 80401	Mine and mill	Fremont and Jefferson.
Union Carbide Corp	270 Park Ave. New York, NY 10017	Mine and mills	Garfield, Mesa, Montrose, San Miguel.

[1]Also stone.
[2]Also zinc, lead, silver, and copper.
[3]Also zinc, gold, silver, and copper.
[4]Also pyrites, tin, and tungsten.
[5]Also lead, gold, zinc, and copper.
[6]Also lead, zinc, and copper.
[7]Also copper, gold, and lead.
[8]Also sand and gravel.

The Mineral Industry of Connecticut

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the State Geological and Natural History Survey of Connecticut, Department of Environmental Protection, for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.[1]

The value of nonfuel mineral production in Connecticut in 1981 was $62.7 million, a decrease of about $3 million from that of 1980. Construction aggregate—stone and sand and gravel—were again the leading commodities produced, and combined, accounted for over four-fifths of the State's value of output.

Nationally, Connecticut was second in feldspar production and fifth in mica. In New England, the State ranked second in crushed stone and lime output.

During the year, enactment of a State law forming "enterprise zones" was expected to eventually result in new construction projects and stimulate demand for aggregate. Local legislation affecting the State's mineral industry, however, trended towards more stringent requirements, particularly for sand and gravel mining and restoration.

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

Mineral	1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	92	$482	73	$391
Lime do.	19	1,352	16	1,190
Sand and gravel[2] do.	7,103	18,692	[p]6,500	[p]18,100
Stone:				
Crushed do.	7,977	40,283	7,247	38,115
Dimension do.	15	723	19	910
Combined value of feldspar, gem stones, mica, and industrial sand	XX	4,231	XX	3,985
Total	XX	65,763	XX	62,691

[p]Preliminary. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes industrial sand; value included in "Combined value" figure.

Table 2.—Value of nonfuel mineral production in Connecticut, by county

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Fairfield	$1,899	$1,854	Sand and gravel.
Hartford	W	W	Stone, sand and gravel, clays.
Litchfield	10,968	9,746	Sand and gravel, stone, lime.
Middlesex	4,224	4,643	Feldspar, sand and gravel, stone, mica, clays.
New Haven	W	W	Stone, sand and gravel.
New London	4,025	2,964	Sand and gravel.
Tolland	W	1,198	Sand and gravel, stone.
Windham	W	W	Stone, sand and gravel.
Undistributed[1]	48,120	45,357	
Total	69,236	[2]65,763	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Includes gem stones and values indicated by symbol W.
[2]Data do not add to total shown because of independent rounding.

Table 3.—Indicators of Connecticut business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	1,627.1	1,625.0	-0.1
Unemployment	do	94.0	106.6	+13.4
Employment (nonagricultural):				
Mining	do	([1])	([1])	--
Manufacturing	do	440.8	437.2	-.8
Contract construction	do	[2]50.2	[2]50.8	+1.2
Transportation and public utilities	do	60.8	61.0	+.3
Wholesale and retail trade	do	299.0	303.1	+1.4
Finance, insurance, real estate	do	105.1	110.6	+5.2
Services	do	285.7	289.8	+1.4
Government	do	185.2	184.0	-.6
Total nonagricultural employment	do	1,426.8	[3]1,436.6	+.7
Personal income:				
Total	millions	$36,423	$40,724	+11.8
Per capita		$11,692	$12,995	+11.1
Construction activity:				
Number of private and public residential units authorized		10,103	9,084	-10.1
Value of nonresidential construction	millions	$441.3	$720.8	+63.3
Value of State road contract awards	do	$29.6	$77.5	+161.8
Shipments of portland and masonry cement to and within the State	thousand short tons	630	606	-3.8
Nonfuel mineral production value:				
Total crude mineral value	millions	$65.8	$62.7	-4.7
Value per capita, resident population		$21	$20	-4.8
Value per square mile		$13,129	$12,516	-4.7

[p]Preliminary.
[1]Included with "Contract construction."
[2]Includes mining.
[3]Data do not add to total because of independent rounding.

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

Trends and Developments.—Connecticut's brass mill industry, which started to decline in the 1970's after the Vietnam war, continued to deteriorate in 1981. Industry observers noted that during the peak war years, many mills operated at total capacity, but facilities were seldom upgraded. When expansion and modernization became necessary, producers relocated nearer to the expanding housing and automotive markets in the Midwest rather than retool mills in Connecticut. The depressed U.S. economy, volatile copper prices, imports of mill products, and substitution with competitive-priced materials have added to the industry's problems.

Two of the State's larger mills struggled to remain operative. Bristol Brass Co. filed for reorganization under Chapter 11 of the Federal Bankruptcy Code in August, and later in the year received an extension until February 22, 1982. In 1980, the company was purchased and the new owners announced plans to upgrade facilities and increase output 20%. Officials at Bristol reported that sales for the first 6 months of

1981 had equaled the 1980 total, but cash flow difficulties forced the Chapter 11 proceedings. Century Brass Products Inc. considered a shutdown around midyear after initial efforts to reach a labor contract settlement failed. However, an agreement was worked out with help from the Governor, and normal operations resumed.

The sand and gravel sector of Connecticut's mineral industry faced difficulties of another type. Production declined about 8% compared with that of 1980, and the trend toward imposing stricter local requirements for sand and gravel mining and restoration continued in 1981. In many towns throughout the State, zoning and planning commissions, usually upon request of the local residents, strengthened measures including those relating to bonding fees, insurance coverage, buffer zones, time limitations on restoration, and acreage available for excavation. Various citizen groups have also brought lawsuits against mining companies and planning and zoning commissions to delay or stop expanding sand and gravel operations.

In other mining related activity, a proposal to excavate approximately 700,000 cubic yards of peat from a 48-acre swamp in Killingworth, Middlesex County, remained pending at yearend. Clintworth County Estates, Inc., planned to remove the peat over a 5- to 10-year period and sell the material to a nursery for processing into potting soil. After mining, the swamp site would be developed for homes.

Plans for a $4 million, 13,000-ton cement distribution center in Willington, Tolland County, were canceled 7 months after the original announcement. Independent Cement Corp., a subsidiary of St. Lawrence Cement, Inc., of Canada, which spent $50,000 on the proposal, was unable to obtain zoning variances needed to construct the center.

Legislation and Government Programs.—A bill designed to stimulate business in areas of high unemployment and low personal income was enacted during the 1981 legislative session. Firms locating in these areas, which were termed enterprise zones, would receive certain incentives including a 50% corporation business tax credit, a 7-year freeze on increased property tax assessments on renovations, a $1,000 grant for each new employee, the elimination of State sales tax on repair and replacement of manufacturing parts, and State bonding to finance loans for small businesses.[2] Connecticut's construction-related mineral industries (sand and gravel and stone) were expected to benefit from the legislation because of the potential for new building projects and renovation work in the enterprise zones.

Other legislation that broadly affected segments of the State's varied industries is described in capsule summary form in "The Classified Index of Legislation Enacted by the 1981 General Assembly." The index lists measures by bill number and includes amendments to existing statutes.[3]

Although Connecticut's mineral industry produced only nonmetallic minerals, firms awarded defense contracts used a wide spectrum of ferrous and nonferrous commodities. Nationally, the State ranked fourth in military procurement prime contract awards, accounting for 5.8% of the U.S. total based on the most recent date (1980).[4] Among the companies receiving contracts in 1981 were The Anaconda Company; Analysis & Technology, Inc.; Colt Industries, Inc.; Combustion Engineering, Inc., Electric Boat Div.; Electro-Methods, Inc.; Kaman Aerospace Corp.; and Pratt and Whitney Aircraft Div., United Technologies Corp.

The Connecticut Geological and Natural History Survey completed a statewide, high-altitude aerial photography program during the year. Information compiled from the project was used for land cover and land use mapping and national wetlands mapping program. Other continuing activities by the survey included studies on base-metal mineralization, mapping of mined lands, and fault investigations.

A study by the University of Hartford's Construction Institute reported that construction was the State's leading industry. About 10% of the work force, or 139,000 people, was directly employed in the industry, and 30%, or 418,000 workers, was economically dependent on the construction industry. The study also showed that employment related to construction was approximately 40% larger than either the State's aerospace or defense sectors.[5]

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Clays.—In 1981, production dropped for the second consecutive year. A decline in residential construction resulting from high interest rates adversely affected demand for brick.

Output was from two companies located in the central part of the State in adjoining Hartford and Middlesex Counties. All the brick was shipped by truck to markets in New England, New Jersey, and New York.

Feldspar.—Connecticut again ranked second nationally among the six States that produced feldspar. Output in 1981 was about the same as that of the previous year. Future production in Connecticut as well as the United States was expected to be affected by the trend toward increased use of plastic for bottle manufacturing and the cost of required pollution and noise control equipment. The Feldspar Corp.'s Connecticut facilities, in operation since the 1960's, continued mining and milling feldspar in Middletown, Middlesex County. The material was beneficiated using a flotation system to recover feldspar. Both the granular form used by the glass industry and the powder form sold to the ceramic industry were produced.

Gem Stones.—Iron Mine, located in Roxbury, in the south-central part of Litchfield County, was once the site of a flourishing iron industry. In the 1860's, pig iron was produced by the Shepaug Spathic Iron & Steel Co. and shipped by rail to Bridgeport for markets throughout the Northeast.

The Roxbury Land Trust (R.L.T.) was formed to purchase and preserve the historic 360-acre Iron Mine site. The tract annually attracts numerous rockhounds and collectors seeking siderite, garnet, and other mineral specimens. At yearend, R.L.T. was within $23,000 of completing the $356,000 acquisition of the Iron Mine area.

Lime.—Output remained at depressed levels for the second consecutive year. In 1979, 33,000 tons of lime were produced; in 1980, 19,000; and in 1981, 16,000. The decline in production that started in 1980 and continued in 1981 reflected the downturn in construction that similarly affected the State's clay, crushed stone, and sand and gravel producers.

Pfizer, Inc., Connecticut's sole operator, manufactured dolomitic hydrated lime and quicklime at Canaan in Litchfield County. Limestone mined at the company's quarry was crushed to varying degrees of fineness and sold as filler for use in plastics, joint compounds, paint, and vinyl floor products. Other applications for Pfizer's lime products included mason's lime, sewage treatment, and glass manufacturing. The company's rapid processing capability eliminates the need to maintain an extensive inventory. The company was also the only U.S. manufacturer of calcium metal.

Mica.—Production of crude mica, a coproduct of the Feldspar Corp.'s operations in Middlesex County, remained about the same in 1981. Recovered by flotation, the mica was marketed as a filler and for oil well drilling applications.

Sand and Gravel.—In 1981, construction sand and gravel output dropped 600,000 tons compared with that of 1980 but the value per ton increased from $2.63 to $2.78. The State ranked third in tonnage among the six New England States accounting for about 18% of the region's output. Sales of sand and gravel for use in commercial and nonresidential building projects helped compensate for the weakened demand from the depressed residential market.

The U.S. Bureau of Mines, to reduce reporting burden and costs, implemented new sand and gravel canvassing procedures for the 1981 survey of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel operators will be conducted for even numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production, but complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd years will be revised and finalized the following year.

Stone.—Connecticut ranked second in New England in crushed stone output, accounting for about 39% of the region's production. Crushed stone was again the State's leading commodity based on the value of output, contributing $38.1 million of the $62.7 million total. During the past decade, nearly 78 million tons of stone valued at about $260 million was mined. For the same period, the value of production of all commodities extracted in Connecticut was about $468 million.

Nationally, crushed stone output dropped about 11% in 1981 compared with that of 1980; in Connecticut, the decline was 9%. The slight difference was due in part to an

increase in aggregate sales around midyear resulting from State road and highway resurfacing programs. Sales from this program offset weakened demand from other markets, particularly residential construction.

Traprock, granite, limestone, and sandstone were the types of stone mined. Most of Connecticut's 25 quarries were located in New Haven (8) with others in Hartford (6) and Litchfield (5) Counties.

[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.

[2]Chicago Tribune. July 7, 1981, p. 27.

[3]State Legislation Committee, Greater Hartford Chamber of Commerce. The Classified Index of Legislation Enacted by the 1981 General Assembly. August 1981, 18 pp. For more information write to the Greater Hartford Chamber of Commerce, 250 Constitution Plaza, Hartford, CT 06103.

[4]Federal Reserve Bank of Boston. New England Economic Indicators. October 1981, pp. A3-A6.

[5]Connecticut Business Journal. V. 3, No. 9. Mar. 9-15, 1982, p. 6

Table 4.—Connecticut: Sand and gravel sold or used by producers, by use

Use	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	3,616	$9,281	$2.57	NA	NA	NA
Gravel	3,487	9,411	2.70	NA	NA	NA
Total or average	7,103	18,692	2.63	[p]6,500	[p]$18,100	[p]$2.78
Industrial sand	W	W	23.34	W	W	25.67
Grand total or average	W	W	2.75	W	W	[p]2.92

[p]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.

Table 5.—Connecticut: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	80	585	80	651
Concrete aggregate	1,172	5,817	1,036	5,445
Bituminous aggregate	2,170	12,205	1,984	11,852
Dense-graded road base stone	1,534	6,816	1,330	6,504
Surface treatment aggregate	42	145	W	W
Other construction aggregate and road stone	1,506	6,140	1,699	6,883
Riprap and jetty stone	445	2,218	W	W
Filter stone	19	61	W	W
Cement manufacture	11	20	37	76
Lime manufacture	8	15	22	42
Whiting or whiting substitute	78	1,007	86	1,198
Other filler or extenders	83	1,094	28	410
Other[2]	827	4,159	945	5,054
Total[3]	7,977	40,283	7,247	38,115

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

[1]Includes limestone, granite, and traprock.

[2]Includes macadam aggregate, railroad ballast, and flux stone.

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

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
The Michael Kane Brick Co	654 Newfield St. Middletown, CT 06457	Pit and mill	Middlesex.
K-F Brick Co	Route 5, Box 375 East Windsor Hill, CT 06028	Mine and mill	Hartford.
Feldspar:			
The Feldspar Corp.[1]	Box 99 Spruce Pine, NC 28777	Mines and plant	Middlesex.
Lime:			
Pfizer, Inc.[2]	Daisy Hill Rd. Canaan, CT 06018	Pit and limekiln	Litchfield.
Sand and gravel:			
Connecticut Sand & Stone Corp	7 West Main St. Plainville, CT 06062	Pit and plants	Hartford and Litchfield.
O'Connor Bros	Greenwood Rd. East Norfolk, CT 06058	Pit	Litchfield.
O & G Industries[3]	Casson Ave. Torrinton, CT 06790	Pit and plant	Do.
Roncari Industries, Inc.[4]	1776 South Main St. East Granby, CT 06026	Plant	Hartford.
Sega Sand and Gravel Co., Inc	271 Danbury Rd. New Milford, CT 06776	Pit	Litchfield.
Stone (crushed and broken):			
Edward Balf Co	Box 11190 Newington, CT 06111	Quarry	Hartford.
Tilcon Tomasso	Box 67, 909 Foxen Rd. North Branford, CT 06471	Quarries	Hartford, New Haven, Windham.
York Hill Trap Rock Quarry Co.	Westfield Rd. Meriden, CT 06450	Quarry	New Haven.

[1]Also crude mica.
[2]Also limestone.
[3]Also stone.
[4]Also traprock.

The Mineral Industry of Delaware

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Delaware Geological Survey for collecting information on all nonfuel minerals.

By William Kebblish[1] and Thomas E. Pickett[2]

The value of Delaware's nonfuel mineral production, excluding magnesium compounds, was $2.8 million in 1981, a $400,000 increase over that of 1980. Sand and gravel was the major mineral commodity produced, although other commodities were recovered as byproducts during mineral processing and manufacturing. Slag was recovered from steelmaking operations and sulfur from oil refining. Gypsum was imported into the State and processed into products of higher value. Nationally, Delaware continued to rank 50th in value of nonfuel mineral output.

Trends and Developments.—During the year, Delaware was one of seven States in which magnesium compounds were produced from seawater. The Barcroft Co., at Lewes, Sussex County, plans to use 130° F water obtained from a geothermal well to be drilled on company property for production of magnesium compounds. The $1.1 million Federal project is to be administered by the Delaware Energy Office with assistance from Delmarva Energy Resources, a private company.

Another proposal by private entrepreneurs involved construction of a deepwater port at Lewes to be used by oceangoing vessels transporting coal to foreign countries. Coal, produced in the Appalachian region, would be shipped by rail to the ocean port. The port would also serve nonfuel mineral producers.

In a new mineral-related development, E.I. du Pont de Nemours & Co., Inc., planned to construct a chromium dioxide facility at Newport, New Castle County. Steel for use in the new industrial building will be produced by a firm in Pottstown, Pa.

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

Mineral	1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Sand and gravel thousand short tons	1,075	$2,398	[p]1,200	[p]$2,800
Total	XX	[2]2,398	XX	[p] [2]2,800

[p]Preliminary. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Partial total; excludes the value of magnesium compounds, which must be concealed to avoid disclosing company proprietary data.

Table 2.—Indicators of Delaware business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	281.0	282.9	+0.7
Unemployment	do	20.7	22.1	+6.8
Employment (nonagricultural):				
Mining	do	[1]	[1]	--
Manufacturing	do	70.9	70.9	--
Contract construction	do	14.7	13.4	-8.8
Transportation and public utilities	do	12.1	12.1	--
Wholesale and retail trade	do	56.0	56.4	+.7
Finance, insurance, real estate	do	12.3	12.8	+4.1
Services	do	[2]48.0	[2]48.8	+1.7
Government	do	45.2	44.3	-2.0
Total nonagricultural employment	do	259.2	[3]258.6	-.2
Personal income:				
Total	millions	$6,140	$6,749	+9.9
Per capita		$10,291	$11,279	+9.6
Construction activity:				
Number of private and public residential units authorized		2,895	2,302	-20.5
Value of nonresidential construction	millions	$135.3	$93.0	-31.3
Value of State road contract awards	do	$45.0	$40.0	-11.1
Shipments of portland and masonry cement to and within the State	thousand short tons	139	130	-6.5
Nonfuel mineral production value:				
Total crude mineral value	millions	$2.4	$2.8	+16.7
Value per capita, resident population		$4	$5	+25.0
Value per square mile		$1,166	$1,361	+16.7

[p]Preliminary.
[1]Included with "Services."
[2]Includes mining.
[3]Data do not add to total shown because of independent rounding.

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

Legislation and Government Programs.—New legislation impacting the State's mineral industry included the Farmland Preservation bill, which discourages development in prime farmland areas, and transfer of the Coastal Management Program from the abolished State Office of Management, Budget, and Planning to the Department of Natural Resources and Environmental Control. Other legislation included amendments to the Erosion and Sediment Control Program and a precious metals bill regulating functions of precious metals dealers. The Delaware Geological Survey assisted in developing two mineral-regulatory bills introduced into the Delaware General Assembly: Hard Mineral Resources (H.R. 472) and Oil, Gas,and Related Minerals (H.R. 474).

On the Federal level, the Federal Trade Commission ruled in early 1981 that Du Pont had not violated Federal antitrust laws in achieving a dominant position in the titanium dioxide market. One of the company's four titanium dioxide plants is located at Edgemoor, New Castle County, with an annual capacity of 100,000 tons produced by the chloride process.

Activities of the Delaware Geological Survey in 1981 included a statistical cooperative program with the U.S. Bureau of Mines and investigations of the uses of glauconite. Water resource projects included quality studies, stream gauging, and digital modeling with the U.S. Geological Survey; and preparation of a hydrologic atlas. Other projects involved onshore and offshore hydrocarbon data assessment and coordination, and implementation of a benchmark data repository funded by the Federal Emergency Management Agency.

A State Geological Survey report published during the year expressed concern over increased importation of sand and gravel from Maryland.[3] This trend, if it persists, could inhibit the growth of Delaware's principal mineral resource industry by ignoring available sources of undeveloped sand and gravel deposits present in the State. In addition, higher transportation costs for the commodity may be passed on to consumers.

Of significant interest was the preservation of recreational facilities along the seashore. Unusually high tides in late 1981 caused excessive erosion to Delaware's beaches, especially along State Route 1 south of Rehoboth Beach at Indian River Inlet. One proposal involved a revetment (retaining wall) with pumping of beach sand from the south jetty to the seaward side of

he revetment. At Slaughter Beach, Sussex ounty, a project funded by the National Shoreline Erosion Control Demonstration Program was completed in late 1979. The perched beach concept restores beaches by providing a low-profile barrier to trap sand moving along the shoreline owing to littoral drift. In addition, 20,000 cubic yards of sand and gravel was dredged nearby and used for replenishment purposes. A 3-year monitoring period follows to determine effectiveness of the project.

State officials completed a list of rivers for inclusion into the Recreational Rivers Study. Requirements of consideration include proximity to outstanding geologic features. Waterways meeting this prerequisite are the Delaware River (example of a drowned river mouth) and Blackbird Creek (presence of Carolina Bay topographic features).

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Gypsum.—Crude gypsum imported from Nova Scotia, Canada, was calcined by Georgia-Pacific Corp., Wilmington, New Castle County. Production and value declined from 1980 to 1981 because of the slumping housing market. Calcined gypsum was used for wallboard manufacture.

Magnesium Compounds.—The Barcroft Co. at Lewes, Sussex County, was the sole producer of magnesium compounds in Delaware. Both production and value increased from 1980 to 1981. Water was pumped from the Delaware Bay into the plant for extraction of magnesium compounds for ultimate use in pharmaceuticals, including milk of magnesia.

A proposal was formulated by Delmarva Energy Resources to drill a geothermal well on company property. Federal and State funds will be used to drill a 1-mile hole into the earth to determine if heated water is present. If the temperature of the water from the well exceeds 130° F, it will be sold to Barcroft for use in processing magnesium compounds.

Sand and Gravel.—In late 1980, the U.S. Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production. Estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Table 3.—Delaware: Construction sand and gravel sold or used by producers

	1980			1981[p]		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Sand	510	$1,193	$2.34	NA	NA	NA
Gravel	565	1,205	2.13	NA	NA	NA
Total or average	1,075	2,398	2.23	1,200	$2,800	$2.33

[p]Preliminary. NA Not available.

Estimated production of construction sand and gravel in 1981 totaled 1.2 million tons valued at $2.8 million, an increase of 12% in quantity and 17% in value compared with those of 1980. Sand and gravel was used mainly for concrete aggregate, road base, and fill.

In 1980, construction sand and gravel was produced by five companies in Kent County and three companies in New Castle County. No production was reported from Sussex County. The Delaware Geological Survey estimated that 40 sand and gravel pits operated intermittently throughout the State in addition to pits leased by the State Department of Transportation, and that approximately 230 pits have been licensed to produce sand and gravel since 1970.

Slag.—International Mill Service Co., a subsidiary of IU International Corp., processed and sold steel slag produced at the Phoenix Steel Corp. facility in Claymont. Sales increased in both quantity and value from 1980 to 1981. The slag was used mainly

for road base.

Sulfur.—Byproduct sulfur was recovered from refining crude petroleum by Getty Refining & Marketing Co. in Delaware City, New Castle County. Shipments increased in both quantity and value from 1980 to 1981. The Getty refinery processed an average of 120,500 barrels per day of crude oil during 1981. Construction began on a $110 million methanol plant at the company's Delaware City complex. Also, plans were announced for the construction of a second sulfur recovery plant, with completion anticipated by mid-1983.[4]

METALS

Iron and Steel.—Phoenix Steel at Claymont, New Castle County, produced carbon, alloy, and clad plate used for construction of railroad cars and marine vessels. Armorplate was also produced and used for military vehicles. In 1981, a new furnace became operational, providing additional heat-treating capabilities.[5] Phoenix Steel also expanded its plate product line through an arrangement with Du Pont to produce Detaclad, an explosion-bonded product used by the chemical industry.

[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]Associate director, Delaware Geological Survey, University of Delaware, Newark, Del.
[3]Doyle, R. G., and T. E. Pickett. Delaware's Extractive Mineral Industry. Delaware Geol. Survey Open File Rept. 13, January 1981, 17 pp.
[4]Getty Oil Co. 1981 Annual Report. Pp. 20, 29.
[5]Phoenix Steel Corp. 3d Quarter Report. 1981.

Table 4.—Principal producers

Commodity and company	Address	Type of activity	County
Gypsum, calcined:			
Georgia-Pacific Corp	900 SW. 5th Ave. Portland, OR 97204	Plant	New Castle.
Magnesium compounds:			
The Barcroft Co	Box 474, Henlopen Dr. Lewes, DE 19958	do	Sussex.
Sand and gravel:			
Barber Sand & Gravel	R.F.D. 1 Harrington, DE 19952	do	Kent.
Contractors Sand & Gravel Co	Box 2630 Wilmington, DE 19805	Pit	New Castle.
Dover Equipment & Machine Co	113 West 6th St. Dover, DE 19901	Dredge	Kent.
Parkway Gravel, Inc	4048 New Castle Ave. New Castle, DE 19720	Pits	New Castle.
Staytons Select Borrow	R.D. 1, Box 305 Felton, DE 19943	Pit	Kent.
Whittington Sand & Gravel Co	U.S. Route 40 Bear, DE 19701	Pit	New Castle.
Slag:			
International Mill Service Co	1500 Walnut St. Philadelphia, PA 19102	Plant	Do.
Sulfur, elemental:			
Getty Refining & Marketing Co	Delaware City, DE 19706	Refinery	Do.

The Mineral Industry of Florida

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

By James R. Boyle[1] and Charles W. Hendry, Jr.[2]

The value of nonfuel mineral production in 1981 in Florida was $1.7 billion, an increase of $216.3 million over that of 1980. Florida ranked fourth nationally in total value of nonfuel minerals produced, and nonmetals accounted for over 95% of the value of the State's mineral output. The State ranked first in the production of phosphate rock and was second in crushed stone, fuller's earth, masonry cement, and peat. Staurolite and zircon concentrates were produced only in Florida. Principal nonmetals, in order of value, were phosphate rock, stone, cement, clays, and sand and gravel.

Of the 53.6 million tons of phosphate rock produced in the United States, Florida was the predominant producer and for the 88th consecutive year supplied more than any other State. Florida and North Carolina supplied 86.3% of the domestic phosphate rock output; Florida supplied most of the exports.

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

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
Cement:				
Masonry thousand short tons	285	$22,074	288	$20,757
Portland do	3,574	182,590	3,518	199,064
Clays do	614	[2]24,164	731	[2]35,319
Gem stones	NA	5	NA	6
Lime thousand short tons	195	12,434	191	11,343
Peat do	154	2,398	157	2,885
Sand and gravel do	[r][3]14,412	[r][3]28,766	[p]14,149	[p]32,719
Stone (crushed) do	66,209	215,972	65,067	226,192
Combined value of clays (kaolin), magnesium compounds, phosphate rock, rare-earth concentrate, sand and gravel (industrial, 1980), staurolite, titanium concentrates (ilmenite and rutile), and zircon concentrates	XX	[r]1,020,855	XX	1,197,304
Total	XX	[r]1,509,258	XX	1,725,589

[p]Preliminary. [r]Revised. NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes kaolin; value included with "Combined value" figure.
[3]Excludes industrial sand; value included with "Combined value" figure.

In 1981, Florida fared better economically than the Nation as a whole. Although residential construction and road maintenance programs decreased late in the year, nonresidential construction increased. The effect on individual mineral producers depended on the construction market supplied, with output mixed throughout the industry. Road maintenance programs decreased because of reduced Federal input.

Alexander Grant & Co., a Chicago-based accounting firm, conducted a study, in cooperation with the Conference of State Manufacturers' Association, on the general manufacturing business climate of the 48 contiguous States. The study concluded that in 1981, Florida had the best overall business climate for manufacturing among the 48 States. Florida ranked 12th in 1979 and 8th in 1980.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Alachua	$2,789	$4,391	Stone.
Bay	1,040	1,021	Sand and gravel.
Brevard	W	W	Clays, stone, sand and gravel.
Broward	20,607	28,587	Stone, sand and gravel.
Calhoun	52	46	Sand and gravel.
Charlotte	--	717	Stone.
Citrus	6,002	7,594	Stone, phosphate rock.
Clay	26,526	27,858	Titanium, zirconium, staurolite, sand and gravel, clays, monazite.
Collier	6,236	8,339	Stone.
Dade	W	W	Cement, stone, sand and gravel.
Escambia	605	617	Sand and gravel.
Gadsden	W	20,339	Clays, sand and gravel.
Glades	W	W	Sand and gravel.
Gulf	W	W	Magnesium compounds, lime.
Hamilton	W	W	Phosphate rock.
Hardee	W	W	Do.
Hendry	W	534	Stone.
Hernando	W	W	Cement, stone, lime, clays.
Highlands	W	W	Peat.
Hillsborough	W	W	Phosphate rock, cement, stone, peat.
Jackson	620	W	Stone.
Lake	W	W	Sand and gravel, peat, clays.
Lee	W	W	Stone, sand and gravel.
Leon	W	W	Sand and gravel.
Levy	2,846	3,985	Stone.
Manatee	W	W	Cement, stone.
Marion	12,772	W	Stone, clays, phosphate rock.
Monroe	2,447	4,020	Stone.
Nassau	W	--	
Okaloosa	36	17	Sand and gravel.
Orange	64	58	Do.
Palm Beach	W	6,319	Stone.
Pasco	W	3,437	Do.
Polk	676,298	784,741	Phosphate rock, sand and gravel, peat, stone.
Putnam	W	W	Sand and gravel, clays, peat.
St. Lucie	W	W	Sand and gravel, stone.
Sarasota	W	W	Do.
Sumter	W	W	Lime, stone.
Suwannee	W	777	Stone.
Taylor	2,787	3,922	Do.
Walton	W	W	Sand and gravel.
Undistributed[2]	507,884	601,938	
Total[3]	1,269,607	1,509,258	

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: Baker, Bradford, Columbia, De Soto, Dixie, Duval, Flagler, Franklin, Gilchrist, Holmes, Indian River, Jefferson, Lafayette, Liberty, Madison, Martin, Okeechobee, Osceola, Pinellas, St. Johns, Santa Rosa, Seminole, Union, Volusia, Wakulla, and Washington.

[2]Includes gem stones and values indicated by symbol W.

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

Table 3.—Indicators of Florida business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	3,980.0	4,134.8	+3.9
Unemployment	do	199.0	300.9	+51.2
Employment (nonagricultural):				
Mining[1]	do	11.0	11.2	+1.8
Manufacturing	do	456.4	466.4	+2.2
Contract construction	do	263.9	282.5	+7.0
Transportation and public utilities	do	220.8	228.6	+3.5
Wholesale and retail trade	do	939.8	983.0	+4.6
Finance, insurance, real estate	do	254.2	271.9	+7.0
Services	do	811.3	863.4	+6.4
Government	do	618.8	614.6	-.7
Total nonagricultural employment[1]	do	3,576.2	[2]3,721.7	+4.1
Personal income:				
Total	millions	$88,693	$102,333	+15.4
Per capita		$8,993	$10,050	+11.8
Construction activity:				
Number of private and public residential units authorized		174,451	149,241	-14.5
Value of nonresidential construction	millions	$2,199.0	$2,930.3	+33.3
Value of State road contract awards	do	$316.0	$416.0	+31.6
Shipments of portland and masonry cement to and within the State	thousand short tons	5,820	5,724	-1.6
Nonfuel mineral production value:				
Total crude mineral value	millions	$1,509.3	$1,725.6	+14.3
Value per capita, resident population		$155	$177	+14.2
Value per square mile		$25,764	$29,467	+14.4

[p]Preliminary.
[1]Includes oil and gas extraction.
[2]Data do not add to total shown because of independent rounding.

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

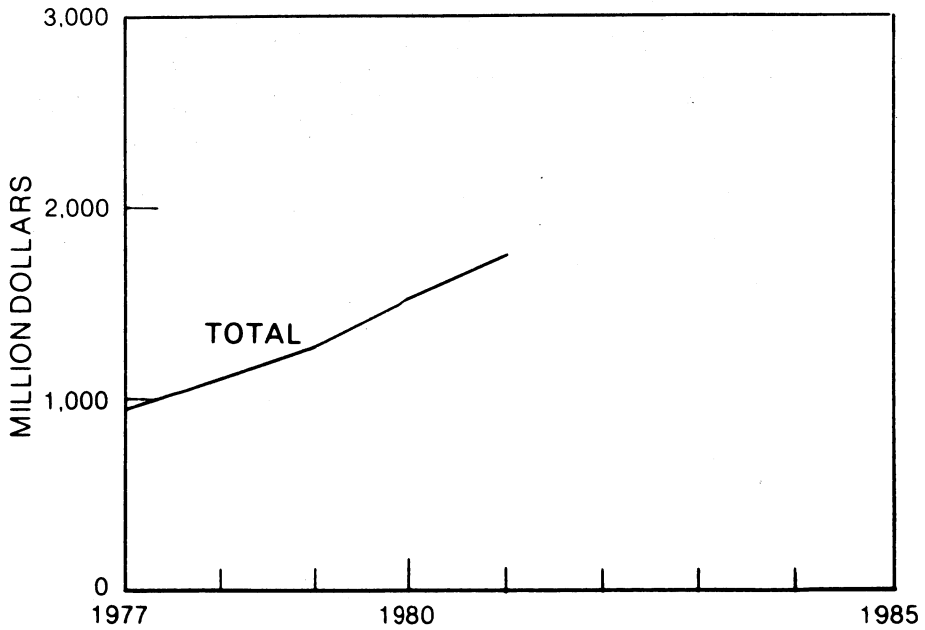

Figure 1.—Total value of nonfuel mineral production in Florida.

Trends and Developments.—The Port of Tampa, which handled over 45 million tons of cargo in 1981, shipped the major portion of exported phosphate. Phosphate rock and processed phosphate exports totaled 13 million tons, down from 16 million tons in 1980. These exports included 9 million tons of bulk phosphate, down from 12 million tons in 1980. Phosphate accounted for about 90% of all export cargo through the Port of Tampa. A new market in bagged phosphate chemicals developed in China, and nearly one-half million tons was exported through the port to that market. About 750,000 tons of aragonite was imported from the Bahamas for use in the manufacture of cement, down from 1.2 million tons in 1980.

In contrast, Port Manatee's phosphate exports increased when Beker Industries opened its new mine, with plans to export 1 million tons per year through the facility. Shipments from Beker were expected to increase up to 3 million tons per year in the next several years, according to the company.

Texasgulf, Inc., started operations at its new $8 million sulfur terminal on Hooker's Point in Tampa. The terminal, on a 10-acre site leased from the Tampa Port Authority, can store 60,000 tons of liquid sulfur. The terminal is supplied by tankers from sulfur mines in Texas and Mexico.[3]

Occidental Petroleum Corp. (Oxy) resumed shipments of superphosphoric acid to the Soviet Union after the trade embargo was lifted in April. The original agreement called for Oxy to ship 1 million tons per year of superphosphoric acid to the Soviet Union in exchange for urea, potash, and anhydrous ammonia. The 20-year agreement would be worth about $20 billion. Plans called for Oxy to ship 72,000 tons per month for the balance of 1981. The National Safety Council awarded Oxy's White Springs Mine first place in safety for achieving the lowest accident incident rate among member companies. Second place went to Oxy's Suwannee River Mine.

Legislation and Government Programs.—The Florida Coastal Management Program was approved by the U.S. Department of Commerce Office of Coastal Zone Management in September 1981. The entire State and its territorial waters were included within the Coastal Zone Boundary. The Florida Coastal Management Program is based on existing State laws. Twenty-five statutes specifically serve as the authorities for a direct State control management technique with the Department of Environmental Regulation as the designated State agency. Major first-year work projects include hazard mitigation planning, port dredging and soil disposal, and technical assistance for areas designated as areas of critical State concern.

The Florida phosphate industry impacted economically within the State and nationally. The U.S. Bureau of Mines released a study in 1981 (IC 8850, "Economic Significance of the Florida Phosphate Industry") on the impact. The study assessed the economic significance of the Florida phosphate industry to selected counties in Florida, the State of Florida, and the Nation; it also included a brief survey of the industry's international impact. Based on forecasts of Florida phosphate production in 1981, and using constant 1977 dollars, estimates were given for 1981 for regional and national output, the value of this output, income, and employment created by the phosphate industry in Florida. Federal, State, and county tax revenues generated by the State's phosphate industry were also estimated for 1981. The concentrated impact of the phosphate industry on certain areas of Florida and on the State's regional industries was examined using economic base analysis complimented by an industrial complex approach. The industry's impact at the State and national levels was examined through input-output analysis.

In addition, an attempt to forecast for 1990 the effects of constraints on phosphate rock mining as a result of economic conditions and other factors was included as an appendix to the report. Also discussed was the phosphate industry's importance to the U.S. balance of trade; U.S. agricultural production, including forward linkages; the U.S. sulfur industry; and the phosphate industry's importance to the production of fluorine and uranium byproducts from fertilizer manufacturing.

Other U.S. Bureau of Mines publications on phosphate included RI 8576, "Fluorine and Uranium in Phosphate Rock Processing and Waste Materials"; RI 8609, "Beneficiation of High-Magnesium Phosphate from Southern Florida"; and RI 8611, "Large-Scale Dewatering of Phosphate Clay Waste from Central Florida."

The Bureau, in association with Agrico Chemical Co., initiated tests of borehole mining of deep phosphate ore in St. Johns County. The tests were made to determine if deep phosphate ores in St. Johns County could be mined economically and in an

environmentally compatible manner. Agrico plans to start additional borehole mining experiments in 1983.

Since 1972, the Bureau's Tuscaloosa Research Center has been involved in projects to eliminate holding ponds of phosphate waste slimes or develop an improved dewatering system. In-house Bureau project activity during the year included research on water recovery from phosphate clay slimes, continuous flocculation dewatering and floc formation studies, and reuse and purification of low-quality water for processing. Research continued on devising new or improved beneficiation methods applicable to high-magnesium phosphate deposits.

The Bureau reported that the apparent consumption of industrial explosives and blasting agents in the State in quarrying and nonmetal mining was 23.2 million pounds in 1981. Of that total, the top two types, water gels and slurries and other high explosives, accounted for 87% of the explosives used.

During the year, the Florida Bureau of Geology completed six geologic projects in the State. Thirteen other projects were underway on stratigraphy, lithostratigraphy, and geomorphology of specific formations and in geographic areas; mineral deposits, such as peat and dolomite, were also investigated. In addition, the Bureau of Geology maintained a geologic well log library and a computerized list of mineral producers and statistics. Six publications were issued during the year, including RI 91, "The Hawthorn Formation of Central Florida," and several publications in the map series were also issued. The Bureau of Geology, also involved in mined land reclamation, developed a Master Reclamation Plan, proposed Chapter 16C-17, Florida Administrative Code, addressing lands mined or disturbed by the severance of phosphate prior to July 1, 1975. The plan, scheduled for adoption in 1982, provides procedures to reclaim approximately 86,000 acres of disturbed land.

The Florida Institute of Phosphate Research funded six major projects during the year. The funded projects were a Virginia Polytechnic Institute study of a clay separation process ($49,622), a University of South Florida investigation on the utilization of waste gypsum to produce cement ($26,857), and a National Council on Radiation Protection and Measurements study of radiation exposure ($34,080). Three projects were with the U.S. Bureau of Mines: (1) a comprehensive evaluation of slime treatment and storage methods ($269,000), (2) the development of techniques for utilization of high-magnesia phosphate ore ($12,000), and (3) the production of 12,000 ceramic tiles from phosphate slimes and fly ash to be tested at the Institute's new headquarter's sidewalks in Bartow ($5,000).

The U.S. Geological Survey studies include the geology, geochemistry, and resources of peat; geochemistry and hydrochemistry of marine sediments, mineral resources, and ground water systems; research in geophysical data interpretation off southern Florida; and environmental geologic studies of the west Florida continental shelf.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Cement.—Shipments of both portland and masonry cement remained at about the same level as those of 1980; portland cement shipments decreased slightly, while those of masonry cement increased slightly. Production of masonry cement in Florida ranked second nationally, while portland cement production ranked sixth. Four companies produced portland cement at five plants; masonry cement was also produced at five plants. A fifth company operated a grinding plant to produce portland cement from imported clinker. Most of the shipments of both portland and masonry cement were to users within the State; Florida was a net importer of cement, with about 1 million tons being imported. Portland cement shipments, mainly in bulk form, were made by truck and rail. Principal consumers were ready-mix concrete dealers, highway contractors, building material dealers, and concrete products manufacturers, with the remainder being consumed by other contractors and government agencies.

Most raw materials used to manufacture cement were mined within the State and included limestone, clay, sand, and staurolite; the use of staurolite is diminishing because of higher value uses. Oölitic aragonite imported from the Bahamas was used as well as small amounts of gypsum, clinker, fly ash, clay, iron ore, and slag; most

were obtained from out-of-State sources.

Eleven rotary kilns were operated at five plants. Of the 11, 10 were wet process, and 1 was dry process. About 447 million kilowatthours of electrical energy, in addition to natural gas, fuel oil, and coal, were consumed in the manufacture of cement.

Moore McCormack Resources, Inc., continued its $68 million expansion program at the Brooksville plant. The expansion includes a second coal-fired kiln and enlarged grinding and storage capabilities, which, when operational in 1982, would double cement output to 1.2 million tons annually. The company also purchased two cement plants in Tennessee from Penn Dixie Industries, Inc.

Lonestar Florida Pennsuco, Inc., installed a new finish mill and increased storage capacity at the 1.2-million-ton-per-year cement plant at Hialeah. Conversion to coal at its wet-process plant was also completed.

Clays.—Clays mined in Florida included common clay, fuller's earth, and kaolin. Total clay production and value increased 117,000 tons and $11.2 million, respectively.

Common clay output and value increased. Common clay was produced by four companies at four pits in Clay, Gadsden, Hernando, and Lake Counties in the northern part of the State. The clay was used in the manufacture of cement and lightweight aggregate.

Florida continued to rank second in the Nation in fuller's earth production, with production increasing. Fuller's earth was mined by four producers from nine pits in Brevard, Gadsden, and Marion Counties. Main end uses were for pet waste and oil and grease absorbents, and in fertilizers, pesticides, and saltwater drilling muds. Pennsylvania Glass Sand Corp. completed an expansion of its processing plant at Quincy. New facilities were installed for clay extrusion, bagging, dust collection, and pneumatic bulk loading.

Kaolin was produced by one company at two pits in Putnam County; production increased slightly from that of 1980. A coproduct was silica, which was recovered for glass and other industrial uses. Principal uses for kaolin were in electrical porcelain, whiteware, and wall tile; major markets were in the Southeast.

Fluorine.—Fluorine in the form of fluosilicic acid was recovered at six plants as a byproduct of wet-process phosphoric acid manufacture. Fluosilicic acid was used to produce cryolite, aluminum fluoride, sodium silicofluoride, and was also used in water fluoridation.

Gypsum.—Imported gypsum was calcined at two plants in Duval County and one plant in Hillsborough County. United States Gypsum Co., Jim Walter Corp., and National Gypsum Co. calcined gypsum in kettles, a rotary kiln, and a holoflite unit, respectively, prior to wallboard manufacture. Production in 1981 remained at the 1980 level, with value decreasing. Florida gypsum wallboard was marketed primarily in south Georgia and Florida. Byproduct gypsum was recovered by Occidental Petroleum Corp. at its plant in Hamilton County; output remained at about the 1980 level.

Lime.—Both quicklime and dehydrated lime were produced in Florida. Quicklime was produced by Basic Magnesia, Inc., Gulf County; Chemical Lime, Inc., Hernando County; and Dixie Lime & Stone Co., Sumter County. Hydrated lime was also produced by Chemical Lime, Inc. Production and value decreased 2.1% and 8.8%, respectively, from those of 1980. Lime was used for magnesia, water treatment, and sewage disposal systems.

Magnesia.—Florida ranked second nationally in the recovery of magnesium compounds from seawater. Basic Magnesia, Inc., Port St. Joe, Gulf County, produced caustic calcined magnesia and refractory-grade magnesia from seawater; plant capacity is 100,000 tons of MgO equivalent. Shipments in 1981 increased 6.9%; value increased 17.7% over that of 1980.

Peat.—Florida ranked second nationally in peat production in 1981. Production increased slightly, while unit value increased nearly 18%. Eight plants produced moss, reed-sedge, and humus peat from five counties. Most of the peat, shipped in bulk, was used for general soil improvement and for potting soils.

Perlite (Expanded).—Four companies produced expanded perlite from crude ore shipped into the State. Production decreased to 29,900 tons, while value increased to $3.9 million. Perlite was expanded at plants in Broward, Duval, Escambia, and Indian River Counties and was used for construction aggregate, horticultural purposes, insulation, and fillers.

Phosphate Rock.—Florida ranked first in the Nation in the production of phosphate rock. Marketable production of phosphate rock in 1981 decreased slightly in quantity, but increased 17.6% in value. The phos-

phate industry continued to be the principal mineral industry in the State.

Phosphate production decreased gradually throughout the year. Inventories increased, resulting in reduced operating levels and temporary closure of some mines and plants. By yearend, mining output was reportedly at 47% of capacity, with chemical plants at about 59% capacity. Decreased demand and large inventories of processed phosphates resulted in prices frequently below stated production costs. The drop in sales of about 20% was attributed to high interest rates and low crop prices. Adequate phosphorus levels in the soil permitted deferments of applications. Exports, reported to be off as much as 3 to 4 million tons, were down because of increased competition and the strength of the U.S. dollar. In spite of reduced demand and increased inventories, reported expansions underway or planned for completion by 1985 exceeds $2 billion, with expenditures in 1981 approaching $600 million. Environmental constraints and the low demand for phosphates may cause delays in meeting planned schedules.

The Florida Phosphate Council estimated that about $78.5 million was collected in severance taxes from phosphate producers during the year. The $1.67-per-ton rate was to increase to $1.84 per ton in 1982. Discussions continued over returning a portion of severance taxes to the producing counties; at present, all monies go to the State treasury.

Soft-rock phosphate was produced by four companies in 1981, operating five mines in Citrus and Marion Counties. The soft-rock phosphate was used for direct application to the soil and, if low in fluorine, as an animal feed supplement.

Land-pebble phosphate was produced at 21 mines by 12 companies in Hamilton, Hardee, Hillsborough, Manatee, and Polk Counties. In 1981, agricultural uses accounted for 75%; industrial, 1%; and exports, 24%. Normal superphosphate, triple superphosphate, wet-process phosphoric acid, and defluorinated phosphate rock were produced for agricultural uses. Industrial chemicals were produced from the production of elemental phosphorus.

AMAX Phosphate, Inc., had its first full year of operations after purchasing the mining operations and phosphate reserves of Borden, Inc., in mid-1980. The company had one active mine, the Big Four Mine, in southeast Hillsborough County, with plans to expand capacity from 1.6 to 2.5 million tons per year by early 1982. Also planned for DeSoto County was a 4-million-ton-per-year mine near Pine Level. To guarantee environmental protection, county officials levied a tax to be used in developing a review procedure. AMAX will spend over $3 million at its Plant City defluorination plant to control fugitive dust. Wet scrubbers were also to be redesigned for improved efficiency.

Beker Phosphate, Inc., started operating its Wingate Creek Mine and beneficiating plant late in the year, with two floating dredges removing overburden and matrix. Capacity should increase to 1 million tons per year, with output shipped through the company's new facilities at Port Manatee to the company's fertilizer plant in Louisiana. Manatee County officials questioned company transportation modes when they used trucks instead of rail to move the phosphate to the port. By yearend, negotiations were underway to settle the dispute.

The C. F. Industries, Inc., proposed mine in Hardee County would require a Natural Pollutant Discharge Elimination System permit. The mine's capacity was to be 2 million tons per year for the first 4 years, possibly increasing to 4 million tons per year. Construction of the company's second phosphate plant in Hardee County continued, with completion of the 2-million-ton-per-year facility expected by 1984.

Estech, Inc., continued to plan development of its proposed 3-million-ton-per-year Duette Mine in Manatee County. In an effort to ensure no damage to the area's main water supply near the minesite, county officials adopted the toughest phosphate restrictions in the State and denied permit approval. The Governor and Cabinet agreed to granting of the permits, but the action was challenged in the courts by Manatee County officials. The court upheld the State's decision, and negotiations between county and company officials began. In Polk County, Estech began mining phosphate rock that was previously buried under slime ponds. By dewatering the ponds, about 3.5 to 4 million tons of phosphate will be recovered, extending the life of the mine nearly 2 years.

Farmland Industries, Inc., continued efforts to develop its first mining operation in Hardee County; the company presently operates a chemical plant near Bartow. Jacobs Engineering Group was awarded a contract for engineering and design work for the

proposed mine and beneficiation plant. Engineering and design work was scheduled for completion by mid-1982, with plant startup for late 1983. The facility's capacity was rated at 2 million tons per year.

W. R. Grace & Co. continued construction and participated in two joint ventures; one with International Minerals & Chemical Corp. (IMC) in the Four Corners Mine and beneficiation plant, and the other with U.S.S. Agri-Chemicals, Inc. (USSAC), in a chemical complex. The Four Corners Mine is a $615 million investment to produce 5 million tons of phosphate per year. The mine, located in Hardee, Hillsborough, Manatee, and Polk Counties, was scheduled to start operating in 1983. The other project involves a $200 million phosphoric acid plant at Fort Meade, with completion scheduled for July 1982.

IMC, the world's largest private producer of phosphate and phosphate chemical products, completed construction of its New Wales sulfuric acid plant in Polk County. Through the venture with W. R. Grace and purchase of other properties, IMC reported an increase in reserves by an estimated 270 million tons of phosphate rock. The new IMC 61-yard dragline, the largest in the area, began mining at the company's Clear Spring Mine. IMC, with funding by the Florida Institute of Phosphate Research, is working with the other phosphate companies on a process to reduce the number of phosphate slime ponds. The experiment calls for pumping thickened clay, stored in a centralized slime pond for 6 months, to mining sites. The clays would be topped with overburden. The objective is to restore the mining site and reduce the need for large storage areas. Early in the year, IMC signed an agreement to ship 360,000 tons of phosphate rock per year by unit train to Canada. Approximately 58 unit trains would be required each year.

Mobil Chemical Co. proceeded with the permitting process to develop the South Fort Meade Mine scheduled for operation in 1984. The 3-million-ton-per-year mine will replace Mobil's Fort Meade Mine, scheduled to close in 1988. Mobil plans to construct a new phosphate rock terminal in Tampa. The terminal would have loading and unloading facilities, a storage area, and berthing facilities for large ore carriers. The facility was scheduled to be operational in 1984.

USSAC and W. R. Grace started constructing a new phosphoric acid plant at Fort Meade. Completion and startup was scheduled for July 1982. The planned $24 million expansion of the company's Rockland Mine has been deferred because of reduced market demands.

Sand and Gravel.—To reduce reporting burdens and costs, the Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but contains complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Total sand and gravel production decreased from that of 1980. The Florida Rock Industries, Inc., sand plant at Keuka was refurbished, and a new sand plant in Marion County went onstream during the year.

Table 4.—Florida: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	r13,253	r$26,174	$1.97	NA	NA	NA
Gravel	1,159	2,592	2.24	NA	NA	NA
Total or average	r14,412	r28,766	1.99	p13,800	p$28,300	p$2.05
Industrial sand	W	W	r6.82	349	4,419	12.66
Grand total or average	W	W	r2.27	p14,149	p32,719	p2.31

pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data.

Staurolite.—Florida was the only State with a recorded production of staurolite. Staurolite was recovered as a byproduct of ilmenite processing at the Highland and Trail Ridge plants of E. I. duPont de Nemours & Co. and the Green Coves Springs plant of Associated Minerals (USA) Ltd., both in Clay County. Although production and total value decreased, unit value increased. Staurolite was mainly used in sandblasting, with minor amounts used in cement and as foundry sand.

Stone.—Florida ranked second in the Nation in crushed stone production, which included limestone, marl, and oyster shell. Output dropped slightly, but unit value increased.

Stone was produced by 88 companies at 131 quarries in 25 counties. The three leading counties were Dade, Broward, and Hernando, which supplied 70.1% of the State's total production. Thirteen companies produced over 1 million tons each from 28 quarries and accounted for 67% of the production and 72% of the value.

Crushed stone was transported mainly by truck and railroad and was used for dense-graded road base, concrete and bituminous aggregate, and cement manufacture. Six companies processed oyster shell for roadbed material. Companies supplying crushed stone throughout the State often utilized a dedicated train concept for markets over 60 miles distant.

The Florida Rock Industries, Inc., modernization and expansion program at the Gulf Hammock plant was completed during the year, with capacity tripling to 450 tons per hour of finished product.

Table 5.—Florida: Crushed stone [1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	1,729	8,299	1,264	7,064
Agricultural marl and other soil conditioners	115	632	136	840
Poultry grit and mineral food	497	3,064	W	2,748
Concrete aggregate	14,583	57,691	15,168	65,208
Bituminous aggregate	4,604	17,010	3,465	14,565
Dense-graded road base stone	16,497	40,325	15,485	42,605
Surface-treatment aggregate	3,708	14,716	2,482	11,536
Other construction aggregate and road stone	12,164	32,946	13,088	37,739
Riprap and jetty stone	59	398	256	687
Filter stone	W	W	139	850
Manufactured fine aggregate (stone sand)	5,813	23,134	4,498	17,909
Cement manufacture	2,337	5,615	2,432	7,816
Lime manufacture	449	1,120	387	1,062
Asphalt filler	20	221	26	264
Other fillers	184	1,288	191	1,447
Fill	2,288	5,068	5,539	13,334
Glass manufacture	20	191	21	214
Other [2]	1,140	4,257	490	304
Total [3]	66,209	215,972	65,067	226,192

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, shell, and marl.
[2]Includes stone used for macadam aggregate, railroad ballast (1980), whiting or whiting substitute (1981), and other uses not specified (1981).
[3]Data may not add to totals shown because of independent rounding.

Sulfur.—Florida ranked fifth in the Nation in the production of byproduct elemental sulfur. Recovered sulfur from Exxon's natural gas desulfurization plants in Santa Rosa County decreased in 1981 compared with that of 1980.

Vermiculite (Exfoliated).—Exfoliated vermiculite was produced by two operators at four plants in Broward, Duval, and Hillsborough Counties from crude ore shipped into the State. Production increased slightly over that of 1980, while unit value increased 19.6%. Principal uses were for concrete aggregate, horticulture, and insulation.

METALS

Mineral Sands.—Du Pont and Associated Minerals (an Australian-based company) produced concentrates from their heavy mineral operations in Clay County. In 1980, Associated Minerals acquired the Titanium Enterprise operation at Green Cove Springs. Since then, Associated Minerals has been modifying the operation to increase efficiency and capacity. Changes have been made in the dredging sequence and wet mill facilities.

Rutile shipments increased, while ilmenite shipments decreased.

Rare-Earth Minerals.—Associated Minerals produced monazite concentrates as a byproduct from its operations in Clay County. Florida was the only domestic producer of rare earth from mineral sands mining. Production and value increased substantially over that of 1980.

Titanium Concentrates.—Du Pont and Associated Minerals, in Clay County, produced titanium concentrates for use in titanium dioxide pigment manufacture.

Zircon.—Production and value of zircon concentrates from Du Pont and Associated Minerals, both in Clay County, increased in 1981. Florida was the only producer of zircon concentrates in the United States.

[1]State Liaison Officer, Bureau of Mines, Tuscaloosa, Ala.
[2]State geologist, Florida Bureau of Geology, Tallahassee, Fla.
[3]Chemical Week. Mar. 18, 1981, p. 25.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
General Portland, Inc	12700 Park Central Place Suite 2100 Dallas, TX 75251	Plants	Dade and Hillsborough.
Lonestar Florida Pennsuco, Inc	Box 2035 PVS Hialeah, FL 33012	Plant	Dade.
Moore McCormack Resources, Inc.	Box 23965 Tampa, FL 33622	do	Hernando.
Rinker Portland Cement Corp	Box 650679 Miami, FL 33165	do	Dade.
Clays:			
Engelhard Minerals & Chemical Corp.	Menlo Park Edison, NJ 08817	Open pit mines and plant.	Brevard.
Mid-Florida Mining	Box 68-F Lowell, FL 32663	do	Marion.
Pennsylvania Glass Sand Corp	Berkeley Springs, WV 25411	do	Gadsden.
Gypsum (calcined):			
Jim Walter Corp	Box 135 Jacksonville, FL 32226	Plant	Duval.
National Gypsum Co	4100 First Intl. Bldg. Dallas, TX 75270	do	Hillsborough.
United States Gypsum Co	101 South Wacker Dr. Chicago, IL 60606	do	Duval.
Lime:			
Basic Magnesia, Inc	Box 160 Port St. Joe, FL 32456	do	Gulf.
Chemical Lime, Inc	Box 317 Leesburg, FL 32748	do	Hernando.
Dixie Lime & Stone Co.[1]	Drawer 217 Sumterville, FL 33585	do	Sumter.
Magnesia:			
Basic Magnesia, Inc	Box 160 Port St. Joe, FL 32456	do	Gulf.
Peat:			
F. E. Stearns Peat	Route 1, Box 542D Dover, FL 33527	Bog	Hillsborough.
Peace River Peat Co	Box 1192 Bartow, FL 33830	Bog	Polk.
Superior Peat & Soil	Box 1688 Sebring, FL 33870	Bog	Highlands.
Perlite (expanded):			
Airlite Processing Corp. of Florida.	Route 2, Box 740 Vero Beach, FL 32960	Plant	Indian River.
Armstrong Cork Co	Box 1991 Pensacola, FL 32589	do	Escambia.
Chemrock Corp	End of Osage Street Nashville, TN 37208	do	Duval.
W. R. Grace & Co.[2]	62 Whittemore Ave. Cambridge, MA 02140	do	Broward.

See footnotes at end of table.

Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Phosphate rock:			
Agrico Chemical Co	Box 3166 Tulsa, OK 74101	Open pit mines and plants.	Polk.
AMAX Phosphate, Inc	402 South Kentucky Ave. Lakeland, FL 33801	Open pit mine and plant.	Hillsborough.
Beker Phosphate, Inc	Box 9034 Bradenton, FL 33506	____do	Manatee.
Brewster Phosphates	Bradley, FL 33835	____do	Hillsborough and Polk.
C. F. Industries, Inc	Box 790 Plant City, FL 33566	____do	Hardee.
Estech, Inc	Box 208 Bartow, FL 33830	Open pit mines	Polk.
Gardinier, Inc	Box 3269 Tampa, FL 33601	Open pit mine and plant.	Do.
International Minerals & Chemical Corp.	Box 867 Bartow, FL 38830	Open pit mines	Do.
Mobil Chemical Co.[3]	Box 311 Nichols, FL 33863	____do	Do.
Occidental Petroleum Corp	White Springs, FL 32096	____do	Hamilton.
U.S.S. Agri-Chemicals, Inc	Box 867 Fort Meade, FL 33841	Open pit mine	Polk.
W. R. Grace & Co	Box 471 Bartow, FL 33830	Open pit mine and plant.	Do.
Sand and gravel:			
Florida Rock Industries, Inc., Shands & Baker.	744 Riverside Ave. Jacksonville, FL 32201	Pits	Clay, Glades, Lake, Lee, Marion, Polk, Putnam.
General Development Corp	1111 South Bayshore Dr. Miami, FL 33131	____do	St. Lucie and Sarasota.
E. R. Jahna Industries, Inc., Ortona Sand Co. Div.	First & East Tillman Lake Wales, Fl 33853	____do	Glades, Lake, Hendry, Polk.
Silver Sand Co. of Clermont Inc	Route 1, Box US 1 Clermont, FL 32711	Pit	Lake.
Staurolite:			
Associated Minerals (USA) Ltd., Inc.	Green Cove Springs, FL 32043	Mine and plant	Clay.
E. I. duPont de Nemours & Co	DuPont Bldg. D-10084 Wilmington, DE 19898	Mines and plants	Do.
Stone:			
Florida Crushed Stone Co	Box 317 Leesburg, FL 32748	Quarries	Hernando, Sumter, Taylor.
Florida Rock Industries, Inc	Box 4467 Jacksonville, FL 32201	____do	Collier, Hernando, Lee, Levy, St. Lucie.
Lone Star Florida, Inc	Box 6097 Fort Lauderdale, FL 33310	Quarry	Dade.
Rinker Southeastern Materials, Inc.	Box 2634 Hialeah, FL 33012	Quarries	Do.
Vulcan Materials Co	Box 7324-A Birmingham, AL 35223	____do	Broward and Dade.
Titanium concentrates:			
Associated Minerals (USA) Ltd., Inc.	Green Cove Springs, FL 32043	Mine and plant	Clay.
E. I. duPont de Nemours & Co	DuPont Bldg. D-10084 Wilmington, DE 19898	Mines and plants	Do.

[1]Also stone.
[2]Also exfoliated vermiculite.
[3]Also elemental phosphorus.

The Mineral Industry of Georgia

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

By James R. Boyle[1] and Bruce J. O'Connor[2]

The value of Georgia's nonfuel mineral production in 1981 was $804.5 million, an increase of $33.2 million over that of 1980. Production of most nonfuel minerals decreased or remained at 1980 levels; unit values for most commodities were higher. Clays and crushed stone accounted for 87.9% of the total production value.

Georgia ranked fifth nationally in value of nonmetallic mineral output. The State led the Nation in the production of fuller's earth, kaolin, and dimension stone; was second in kyanite; third in bauxite, feldspar, and crude iron oxide pigments; and fourth in barite, byproduct gypsum, and mica. In terms of value, kaolin was the leading mineral commodity produced in Georgia, accounting for about 65% of the State's total mineral value in 1981, and since the inception of recordkeeping, has accounted for over 35% of the State's total mineral value of approximately $7 billion.

Georgia's minerals industry was affected by depressed economic conditions nationally. Most industries supplying raw materials to the automotive, paper, and steel industries experienced a periodic decline in sales. According to the Federal Reserve Bank of Atlanta, Georgia's economy eased into recession late in the summer of 1981. Slowdowns occurred in the construction, transportation, and metal industries. The slump in construction, one of Georgia's important industries, impacted on suppliers providing raw materials, such as stone, clay, cement, and sand and gravel.

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

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:					
Masonry	thousand short tons	89	$5,464	89	$4,392
Portland	do.	1,231	55,463	1,150	45,423
Clays	do.	8,283	500,555	8,029	553,726
Gem stones		NA	20	NA	20
Sand and gravel[2]	thousand short tons	4,858	11,898	p4,700	p12,000
Stone:					
Crushed	do.	40,884	162,642	35,730	153,751
Dimension	do.	231	17,466	268	17,894
Talc	do.	25	116	26	182

See footnotes at end of table.

Table 1.—Nonfuel mineral production in Georgia[1] —Continued

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
Combined value of barite, bauxite, feldspar, iron oxide pigments (crude), kyanite, mica, peat, and sand and gravel (industrial)	XX	r$17,663	XX	$17,067
Total	XX	r771,287	XX	804,455

[p]Preliminary. [r]Revised. NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes industrial sand; value included with "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Baldwin	W	W	Sand and gravel.
Barrow	$60	--	
Bartow	W	W	Barite, iron oxide pigments, clays.
Bibb	W	W	Clays, sand and gravel.
Carroll	W	W	Stone.
Charlton	--	W	Sand and gravel.
Chatham	W	W	Do.
Cherokee	99	W	Do.
Clarke	W	W	Stone.
Clayton	W	$2,764	Do.
Cobb	W	W	Stone, sand and gravel.
Coffee	W	--	
Columbia	W	W	Stone, clays.
Columbus (city)	W	W	Do.
Cook	W	W	Sand and gravel.
Coweta	W	W	Stone.
Crawford	1,320	W	Sand and gravel.
Decatur	W	W	Clays, sand and gravel.
De Kalb	10,386	W	Stone, sand and gravel.
Dougherty	399	W	Sand and gravel.
Douglas	W	W	Stone, clays, sand and gravel.
Effingham	W	W	Sand and gravel.
Elbert	W	W	Stone, sand and gravel.
Evans	179	207	Sand and gravel.
Fannin	W	W	Stone.
Fayette	W	W	Do.
Floyd	W	W	Stone, clays, sand and gravel.
Forsyth	4,107	W	Stone.
Fulton	W	W	Cement, stone, clays, sand and gravel.
Gilmer	W	6,015	Stone.
Glynn	50	W	Sand and gravel.
Gordon	2,126	2,300	Stone.
Greene	W	W	Sand and gravel.
Gwinnett	W	W	Stone.
Habersham	W	W	Do.
Hall	4,889	7,175	Do.
Hart	W	W	Mica.
Henry	W	W	Stone.
Houston	W	W	Cement, clays, stone.
Jasper	W	W	Feldspar.
Jefferson	W	W	Clays.
Jones	W	W	Stone.
Laurens	W	W	Sand and gravel.
Lee	W	W	Stone, sand and gravel.
Lincoln	W	W	Kyanite.
Long	244	--	
Lowndes	W	--	
Lumpkin	788	839	Stone.
Madison	2,528	2,789	Do.
Marion	W	W	Sand and gravel.
Miller	W	W	Peat.
Monroe	W	4,418	Stone.
Montgomery	W	450	Sand and gravel.
Murray	W	116	Talc.
Newton	--	W	Stone, sand and gravel.
Oglethorpe	2,858	3,357	Stone.
Paulding	W	W	Do.

See footnotes at end of table.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Pickens	$17,649	W	Stone.
Pike	60	$69	Sand and gravel.
Polk	13,497	W	Cement, stone, clays, sand and gravel.
Rabun	1,004	862	Stone.
Richmond	12,432	W	Clays, stone, sand and gravel.
Screven	W	W	Peat.
Seminole	W	W	Sand and gravel.
Spalding	W	1,591	Stone.
Stephens	W	W	Do.
Sumter	W	W	Clays, bauxite.
Talbot	W	W	Sand and gravel.
Taylor	W	W	Do.
Thomas	W	10,928	Clays.
Troup	W	W	Stone.
Twiggs	W	96,465	Clays.
Union	2,434	W	Sand and gravel, stone.
Walker	W	W	Stone, clays.
Ware	204	W	Sand and gravel.
Warren	W	W	Clays, stone.
Washington	131,949	149,809	Clays.
Wheeler	W	W	Sand and gravel.
Whitfield	3,347	3,822	Stone.
Wilkes	--	W	Do.
Wilkinson	69,128	68,794	Clays.
Undistributed[2]	417,831	408,510	
Total[3]	699,571	771,287	

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: Appling, Atkinson, Bacon, Baker, Banks, Ben Hill, Berrien, Bleckley, Brantley, Brooks, Bryan, Bulloch, Burke, Butts, Calhoun, Camden, Candler, Catoosa, Chattahoochee, Chattooga, Clay, Clinch, Colquitt, Crisp, Dade, Dawson, Dodge, Dooly, Early, Echols, Emanuel, Franklin, Glascock, Grady, Hancock, Haralson, Harris, Heard, Irwin, Jackson, Jeff Davis, Jenkins, Johnson, Lamar, Lanier, Liberty, McDuffie, McIntosh, Macon, Meriwether, Mitchell, Morgan, Muscogee, Oconee, Peach, Pierce, Pulaski, Putnam, Quitman, Randolph, Rockdale, Schley, Stewart, Taliaferro, Tattnall, Telfair, Terrell, Tift, Toombs, Towns, Treutlen, Turner, Upson, Walton, Wayne, Webster, White, Wilcox, and Worth.

[2]Includes gem stones and some clays 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 Georgia business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	2,387.6	2,455.7	+2.9
Unemployment	do	141.9	168.0	+18.4
Employment (nonagricultural):				
Mining[1]	do	7.8	7.8	--
Manufacturing	do	519.2	519.9	+.1
Contract construction	do	105.2	102.4	-2.7
Transportation and public utilities	do	140.4	143.6	+2.3
Wholesale and retail trade	do	499.6	503.1	+.7
Finance, insurance, real estate	do	112.1	113.7	+1.4
Services	do	345.7	358.5	+3.7
Government	do	429.2	434.0	+1.1
Total nonagricultural employment[1 2]	do	2,159.4	2,183.1	+1.1

See footnotes at end of table.

Table 3.—Indicators of Georgia business activity —Continued

		1980	1981[p]	Change, percent
Personal income:				
Total	millions	$44,044	$49,942	+13.4
Per capita		$8,041	$8,960	+11.4
Construction activity:				
Number of private and public residential units authorized		35,993	31,604	-12.2
Value of nonresidential construction	millions	$898.4	$911.3	+1.4
Value of State road contract awards	do	$230.5	$493.0	+113.9
Shipments of portland and masonry cement to and within the State	thousand short tons	2,209	2,033	-8.0
Nonfuel mineral production value:				
Total crude mineral value	millions	$771.3	$804.5	+4.3
Value per capita, resident population		$141	$147	+4.3
Value per square mile		$13,090	$13,664	+4.4

[p]Preliminary.
[1]Includes bituminous coal extraction.
[2]Data may not add to totals shown because of independent rounding.

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

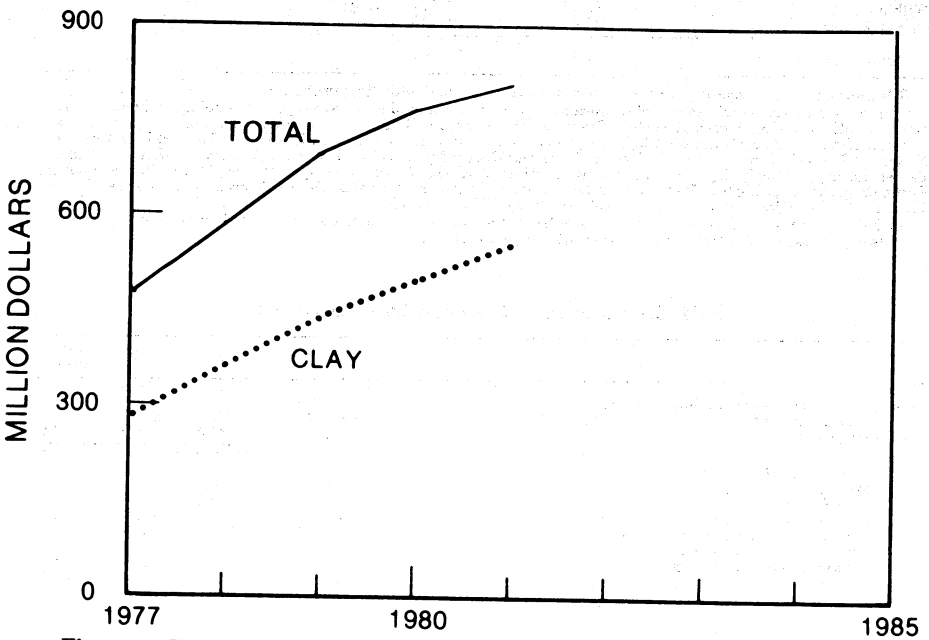

Figure 1.—Value of clays and total value of nonfuel mineral production in Georgia.

Trends and Developments.—Georgia Port Authority's Brunswick Terminal has increased tonnages of bulk commodities since completion of its dry bulk handling complex. Mineral materials handled during the year included potash from Canada and glass sand exported from Florida to Ecuador. Minerals shipped through the Authority's Savannah Port included mullite, kyanite, fuller's earth, and kaolin. The majority of kaolin was exported through Georgia Kaolin International's facilities, also at Savannah.

American Cyanamid Co. announced plans to increase capacity of its Savannah titanium dioxide plant by 10%, to 100,000 tons per year. The project was to involve both the sulfate and chloride processes. In 1981, the sulfate process accounted for 60% of plant output, and the chloride process, 40%. Completion was scheduled for late 1982.

Legislation and Government Programs.—The U.S. Bureau of Mines conducted preliminary tests to determine the suitability of using borehole mining methods for recovery of kaolin at depths of 100 to 150 feet. Laboratory tests demonstrated the feasibility of recovery of the kaolin with a water jet, generating a fine-sized product suitable for hydraulic transport. During the year, the Bureau had contracts with Morehouse College (Feasibility Study of the Reclamation of the Common Precious Metals From Seawater, and A Quantitative Review of Burn and Impact Tests of Hybrid Polymeric Composites) and with Spelman College (Detoxication of Arsenic and Characterization of the Organic Compounds Produced by Roasting of Phosphates).

The Bureau reported that the apparent consumption of industrial explosives and blasting agents in the State in quarrying and nonmetal mining was 12.4 million pounds in 1981. Of the total, the top two types, ammonium nitrate fuel mixed blasting agents, and water gels and slurries, accounted for 93% of the explosives used.

The Georgia Geologic Survey continued basic geologic mapping, ground water investigations, mineral resources investigations, and expanded technical programs. Major improvements in physical facilities included a $500,000 renovation of laboratory facilities and purchase of downhole geophysical logging equipment. Published during the year were studies on gold, pyrite, asbestos, and crushed granite. To improve communications and be more responsive to the mineral industry of the State, an advisory committee met to discuss an accelerated economic mineral program. The committee's responsibilities would include determining priorities for types of minerals to be investigated and overall scope of projects.

The State Department of National Resources, through the Surface Mined Land Reclamation Program, was responsible for enforcement of the State Surface Mining Act of 1967, requiring licensing and reclamation of mined land. During the year, 396 mining operations were active in 116 counties in the State. Major commodities mined, by acreage permitted, were kaolin, granite, sand, and limestone, which together accounted for 74% of total acres permitted.

The U.S. Geological Survey conducted a literature review and surface studies of the Cartersville District for "Lead-Zinc-Barite-Fluorite Resources of the East-Central U.S." Geologic mapping was started in the west Georgia Coastal Plain and Atlanta areas.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Nonmetals accounted for nearly all of the State's total mineral production value in 1981. The principal nonmetals produced, in descending order of value, were clays, crushed stone, cement, dimension stone, and sand and gravel.

Barite.—Georgia ranked fourth nationally in barite output. Production in 1981 remained at about the 1980 level and was significantly lower than that of 1979; value decreased from that of 1980. Barite production was limited to the Cartersville District in Bartow County in the northwestern part of the State, and New Riverside Ochre Co. and Paga Mining Co. were the only producers. During the year, Paga constructed a new washer and reconditioned its dragline to commence mining early in 1982. Imports of chemical-grade barite into the gulf region continued to adversely affect the State's

barite output. Georgia's barite concentrates were used in the manufacture of chemicals and as fillers and extenders in paint and rubber products.

Cement.—Three companies, Medusa Cement Co., Marquette Co., and Martin Marietta Corp., produced portland and masonry cement from plants in Houston, Polk, and Fulton Counties, respectively. Masonry cement accounted for less than 10% of the total production. During the year, Marquette shut down its single-kiln, dry process facility at Rockmart in Polk County. The plant was built in 1955.

Major sales of portland cement in 1981 were for ready-mix concrete (56.9%) to highway contractors (16.3%), and for concrete products (15.2%). The majority of shipments were by truck. Both portland and masonry cement production decreased from that of 1980.

Raw materials used were mainly cement rock, limestone, and shale, with smaller amounts of clay, sand, iron ore, and gypsum. Of the five kilns, four used the dry process.

Clays.—Georgia continued to lead the Nation in the production of clays. Although total clay production decreased slightly, total value increased. Clays mined in the State, in order of decreasing value, were kaolin, fuller's earth, and common clay.

Georgia led the Nation in the production of kaolin, accounting for 81% of the Nation's output. Kaolin was also the leading commodity in the State in terms of value. In the last 5 years, kaolin has provided over 59% of the total value of minerals produced in Georgia. The State's industry in 1981 was composed of 20 companies operating along the Fall Line kaolin belt in east-central Georgia. Production in 1981 totaled 6.2 million tons valued at $519.5 million, compared with 6.3 million tons valued at $463.7 million in 1980. Major uses for premium-grade kaolin were paper coating and filler applications.

Table 4.—Georgia: Kaolin sold or used by producers, by kind and use

(Short tons)

Use	1980				1981			
	Air-floated	Unprocessed[1]	Water-washed[2]	Total	Air-floated	Unprocessed[1]	Water-washed[2]	Total
Domestic:								
Adhesives	40,663	--	16,835	57,498	5,685	--	41,906	47,591
Alum (aluminum sulfate) and other chemicals	9,511	219,520	9,252	238,283	58,769	229,717	260	288,746
Animal feed	10,220	--	--	10,220	3,131	--	209	3,340
Asphalt tile and linoleum	5,744	6,000	--	11,744	--	4,955	--	4,955
Catalysts (oil refining)	--	--	67,082	67,082	--	--	99,093	99,093
China and dinnerware; crockery and earthenware	25,827	2,096	8,547	36,470	7,915	2,490	8,444	18,849
Electrical porcelain	22,741	--	--	22,741	11,923	--	--	11,923
Face brick	289	32,083	--	32,372	--	27,524	--	27,524
Fiberglass and mineral wool	69,611	--	56	69,667	14,698	--	12,690	27,388
Firebrick, block, shapes	352	2,658	--	3,010	464	11,121	--	11,585
Floor and wall tile, ceramic	W	--	--	W	W	--	--	W
Flue linings and high-alumina brick	40,176	4,492	--	44,668	64,291	2,934	--	67,225
Foundry sand	671	--	510	1,181	571	--	235	806
Glazes, glass, enamels, hobby ceramics	W	--	--	W	W	--	--	W
Grogs and crudes, refractory	W	444,748	--	444,748	W	445,789	--	445,789
Ink	W	--	--	W	W	--	--	11,805
Kiln furniture, mortar, cement	W	W	--	33,132	W	W	--	22,422
Medical, pharmaceutical, cosmetic	W	--	W	1,990	W	--	W	980
Paint	33,262	--	103,426	136,688	9,239	--	66,886	76,125
Paper coating	65,887	--	2,217,027	2,282,914	--	--	2,405,505	2,405,505
Paper filling	448,736	--	734,193	1,182,929	421,275	--	758,503	1,179,778
Plastics	5,277	--	42,557	47,834	7,472	--	44,889	52,361
Pottery	14,203	6,607	--	20,810	5,821	5,500		11,321
Roofing granules	17,361	--	--	17,361	9,747	--	--	9,747
Roofing and structural tile	434	--	--	434	106	--	--	106
Rubber	66,849	--	10,657	77,506	32,620	--	42,545	75,165
Sanitary ware	111,054	--	69	111,123	36,794	--	52	36,846
Miscellaneous, air-floated:								
Animal oil (1980), fertilizers, gypsum products, oil and grease absorbents (1980), pesticides and related products, textiles (1980), waterproofing and sealing, other, unknown	40,280	--	--	40,280	39,625	--	--	39,625
Miscellaneous, unprocessed:								
Drain tile, flower pots, gypsum products, other (1981)	--	6,263	--	6,263	--	19,441	--	19,441
Miscellaneous, water-washed:								
Gypsum products, pesticides and related products, waterproofing and sealing, other, unknown	--	--	42,569	42,569	--	--	73,800	73,800

See footnotes at end of table.

Table 4.—Georgia: Kaolin sold or used by producers, by kind and use —Continued

(Short tons)

Use	1980				1981			
	Air-floated	Unprocessed[1]	Water-washed[2]	Total	Air-floated	Unprocessed[1]	Water-washed[2]	Total
Domestic —Continued								
Undistributed	24,934	18,935	890	[3]9,637	9,035	17,646	11,360	[3]2,834
Total	1,054,082	743,402	3,253,670	5,051,154	739,181	767,117	3,566,377	5,072,675
Exports:								
Paint	--	--	25,494	25,494	87	--	31,310	31,397
Paper coating	--	--	691,446	691,446	--	--	604,296	604,296
Paper filling	30	--	72,399	72,429	--	--	77,992	77,992
Plastics	--	--	21,997	21,997	--	--	23,895	23,895
Refractories	--	260,040	--	260,040	--	219,372	--	219,372
Rubber	78	--	498	576	55	--	364	419
Undistributed	12,894	--	175,377	188,271	14,607	--	191,214	205,821
Total	13,002	260,040	987,211	1,260,253	14,749	219,372	929,071	1,163,192
Grand total	1,067,084	1,003,442	4,240,881	6,311,407	753,930	986,489	4,495,448	6,235,867

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Includes high-temperature calcined.
[2]Includes low-temperature calcined and delaminated.
[3]Complete total difference included in totals for specific uses.

Table 5.—Georgia: Kaolin sold or used by producers, by kind

Kind	1980		1981	
	Short tons	Value	Short tons	Value
Air-floated	1,067,084	$38,748,311	753,930	$29,574,295
Calcined[1]	984,465	109,048,491	1,075,769	124,061,091
Delaminated	438,310	40,600,948	470,998	43,603,922
Unprocessed	295,996	1,925,839	313,841	3,435,670
Water-washed	3,525,552	273,376,731	3,621,329	318,821,686
Total	6,311,407	463,700,320	6,235,867	519,496,664

[1]Includes both low-temperature filler and high-temperature refractory grades.

Table 6.—Georgia: Kaolin sold or used by producers, by use

(Short tons)

Use	1980	1981
Domestic:		
Adhesives	57,498	47,591
Chemicals	238,283	288,746
Fiberglass and mineral wool	69,667	27,388
Firebrick, block, shapes	3,010	27,524
Floor and wall tile, ceramic	8,244	W
Paint	136,688	76,125
Paper coating	2,282,914	2,405,505
Paper filling	1,182,929	1,179,778
Plastics	47,834	52,361
Rubber	77,506	75,165
Sanitary ware	111,123	36,846
Whiteware	36,470	18,849
Other	798,988	836,797
Exports	1,260,253	1,163,192
Total	6,311,407	6,235,867

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

Table 7.—Georgia: Kaolin sold or used by producers, by county

County	1980			1981		
	Number of mines	Quantity (thousand short tons)	Value (thousands)	Number of mines	Quantity (thousand short tons)	Value (thousands)
Twiggs	6	1,345	$96,465	5	1,098	$91,343
Warren	3	824	47,828	3	837	52,669
Washington	6	1,974	149,809	6	2,222	195,124
Wilkinson	5	854	68,794	6	823	77,418
Other[1]	5	1,314	100,804	7	1,255	102,942
Total[2]	25	6,311	463,700	27	6,236	519,497

[1]Includes Columbia, Houston, Richmond, and Sumter Counties.
[2]Data may not add to totals shown because of independent rounding.

Expansions in the industry continued and were expected to keep pace with planned expansions in the coated paper industry. Freeport Kaolin Co., Gordon, continued its $23 million expansion plan to increase production 100,000 tons per year. Engelhard Minerals & Chemicals Corp., with mining operations in Baldwin, Twiggs, Washington, and Wilkinson Counties, announced a $20 million program to increase production by 150,000 tons per year. Engelhard completed the expansion of its McIntyre facility, which included a large magnetic separator and other processing units. Georgia Kaolin Co. installed a new magnetic separator at its Dry Branch plant. Nord Kaolin Co., Jeffersonville, completed installation of a $2.5 million magnetic separator with a rated capacity of 285,000 tons of kaolin per year. Many kaolin operations export through facilities in Savannah, which also handled kaolin from South Carolina operations.

Georgia ranked first in the Nation in the production of fuller's earth. Fuller's earth was the fourth ranking commodity in terms of value in the State, behind kaolin, crushed stone, and cement. In 1981, eight companies in Decatur, Houston, Jefferson, and Thomas Counties produced a total of 584,000 tons valued at $30.1 million compared with 649,000 tons valued at $32.7 million in 1980. Fuller's earth was used in liquid fertilizers, paints, pet absorbents, and oil well drilling muds; markets are worldwide.

Common clay and shale, used in brick, cement, and tile, was produced by 11 companies operating 18 pits in 9 counties. Production in 1981 was 1.2 million tons valued at $4.2 million, essentially unchanged from that of 1980.

Merry Companies, Inc., Augusta, a leading brickmaker in the southeast, purchased Burns Brick Co. of Macon. Merry's capacity is now in excess of 600 million bricks per year. Burns just completed a modernization program involving a new production plant, kiln, settling equipment, extruder, dryer, and transport system. Rated capacity is 125,000 bricks per day. Merry was awarded a contract by the U.S. State Department to furnish 1.4 million bricks for the new U.S. Embassy in Moscow, U.S.S.R. Griffin Pipe Products Co., Milledgeville, closed its clay pipe plant because of decreased demand.

Feldspar.—Georgia ranked third nationally in the production of feldspar. Production and value decreased 2.9% and 14.6%, respectively. Low potash feldspar was mined from a hard-rock pit, the Shady Dale deposit, in Jasper County by The Feldspar Corp. The company also mined a granite saprolite from a new mine near Siloam in Greene County. After concentration and desliming the material from Siloam, the mixture of feldspar and quartz sand was trucked 50 miles to Monticello for further processing.

Gypsum (Calcined).—Calcined gypsum and gypsum board products were produced by three companies from materials mined in other States. National Gypsum Co. and Genstar Building Products Co. in Chatham County and the Gypsum Div. of Georgia-Pacific Corp. in Glynn County produced wallboard, plasters, fillers, and agricultural land plaster. American Cyanamid Co. recovered gypsum as a byproduct in its titanium dioxide plant in Savannah. Some of the byproduct gypsum was converted into briquets by Lemco Gypsum, Inc., for use by the cement industry. Production of calcined gypsum decreased, while that of byproduct gypsum increased over that of 1980.

Kyanite-Mullite.—Georgia was one of two States producing kyanite; production and value decreased. C-E Minerals, Inc., a division of Combustion Engineering, operated a surface mining operation and a flotation plant at Graves Mountain in Lincoln County.

Synthetic mullite, a product of sintering a mixture of aluminous and siliceous material, was produced by the Mulcoa Div. of C-E in Sumter County. C-E expanded its operations, including synthetic mullite and calcined kaolin, to a capacity of over 600,000 tons per year with the installation of two additional rotary kilns. After the expansion, the operation had seven kilns, two coal fired, with the remaining to be converted. About one-third of production was exported through the Port of Savannah.

Mica.—Georgia ranked fourth nationally in the production of crude mica. Franklin Mineral Products Co., Inc., mined mica from an open pit mine in Hart County. The material was trucked to Franklin, N.C., for grinding. Production and value increased slightly over that of 1980. Ground mica was used as an extender and filler in various products including paint, wallpaper, and rubber products.

Peat.—Production of peat increased over that reported in 1980. Two companies in Lowndes and Screven Counties produced peat for use as a potting medium and general soil conditioner.

Perlite (Expanded).—Armstrong World Industries, Inc., expanded perlite at a plant near Macon in Bibb County; production and value decreased. The product was used in formed products. Raw material was obtained from mines in the Western United States.

Sand and Gravel.—To reduce reporting burdens and costs, the U.S. Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production, but contains complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Table 8.—Georgia: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	4,094	$9,198	$2.25	NA	NA	NA
Gravel	764	2,700	3.53	NA	NA	NA
Total or average	4,858	11,898	2.45	ᵖ4,700	ᵖ$12,000	ᵖ$2.55
Industrial sand	W	W	8.56	W	W	10.07
Grand total or average	W	W	2.91	W	W	ᵖ3.24

ᵖPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.

Production of industrial sand was reported from two companies, with output increasing slightly over that of 1980; construction sand and gravel output decreased.

Stone.—Crushed stone production decreased, while dimension stone increased over that of 1980. Georgia ranked eighth in the Nation in crushed stone output. Crushed stone produced included limestone, granite, marble, sandstone, and slate. Leading producing counties were Gwinnett, De Kalb, and Jones. Georgia led the Nation in the production of dimension stone, which included granite, marble, and sandstone.

In 1981, 73 companies produced crushed stone and/or dimension stone at 110 quarries, compared with 65 companies from 114 quarries in 1980. Although most dimension stone quarries produced relatively small tonnages, 10 crushed stone quarries each produced in excess of 1 million tons of stone per year. Of the total stone tonnage, 91% was produced by eight companies.

Crushed stone was produced at 68 quarries in 1981 compared with 66 quarries in 1980. Leading producers were Vulcan Materials Co., Florida Rock Industries, Inc., and Martin Marietta Aggregates. Shipments were mainly by truck, followed by railroad and waterway. Crushed stone was used mainly for dense-graded road base, concrete and bituminous aggregates, railroad ballast, and cement manufacture. Although output decreased, individual operations experienced various degrees of demand, depending on nearby construction activities.

Table 9.—Georgia: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	242	1,316	718	3,042
Concrete aggregate	6,940	27,829	6,675	29,232
Bituminous aggregate	7,724	30,055	5,998	24,738
Dense-graded road base stone	8,045	28,023	8,534	31,836
Surface-treatment aggregate	2,160	7,263	1,538	6,098
Other construction aggregate and road stone	7,461	27,018	5,035	19,352
Riprap and jetty stone	152	659	221	911
Railroad ballast	3,054	9,660	2,853	9,902
Filter stone	930	3,605	75	306
Manufactured fine aggregate (stone sand)	671	2,543	716	3,007
Cement manufacture	1,758	4,227	1,941	5,873
Other[2]	1,746	20,445	1,426	19,453
Total[3]	40,884	162,642	35,730	153,751

[1]Includes limestone, granite, marble, sandstone, and slate.
[2]Includes stone used for macadam aggregate (1981), terrazzo and exposed aggregate, asphalt filler, whiting or whiting substitute, other fillers or extenders, lightweight aggregate, and other uses not specified.
[3]Data may not add to totals shown because of independent rounding.

Table 10—Georgia: Dimension stone[1] sold or used by producers, by use

Use	1980			1981		
	Short tons	Cubic feet (thousands)	Value (thousands)	Short tons	Cubic feet (thousands)	Value (thousands)
Rough stone:						
Rough blocks	37,368	393	$1,207	54,589	589	$2,409
Irregular-shaped stone	23,732	281	868	W	W	W
Rubble	36,556	366	692	104,564	1,053	3,601
Monumental	110,863	1,084	5,722	75,608	735	3,754
Flagging	W	W	W	1,632	59	56
Dressed stone:						
Monumental	13,918	152	5,835	13,766	151	5,900
Other[2]	9,059	99	3,141	17,712	186	2,173
Total[3]	231,496	2,374	17,466	267,871	2,773	17,894

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, granite, marble, sandstone, and slate.
[2]Includes stone used for cut stone, sawed stone, house stone veneer, curbing, other uses not specified, and items indicated by symbol W.
[3]Data may not add to totals shown because of independent rounding.

Martin Marietta Aggregates finalized plans to purchase the assets of Dalton Rock Products Co., Dalton. Dalton has five plants and quarries and has an annual capacity in excess of 4 million tons of crushed stone per year.

Georgia Marble Co., Marble Hill, completed installation of an underground crusher and added a small bank of flotation cells at its surface facilities.

Dimension stone was produced at 43 quarries in 1981 compared with 49 quarries in 1980. Dimension stone was used for rough monumental stone, dressed monumental stone, and rough blocks. The State's dimension granite industry was centered in Elbert County, northeast of Atlanta, while the dimension marble and sandstone industries were located in Pickens County, north of Atlanta.

The Elberton granite industry is rapidly converting from wire saws to diamond block saws. More than 50 were estimated to be in operation by yearend.

Talc.—Georgia ranked sixth nationally in the production of talc. Output remained at the 1980 level, while value increased. The Southern Talc Co. produced talc from two mines in the Fort Mountain area of Murray County in the northern part of the State. Crude talc was trucked to the company's Chatsworth mill where it was ground for use in ceramics, insecticides, roofing, rubber, paper, and various other products.

METALS

Base and Precious Metals.—Exploration continued in the northwestern part of the State for gold and base metal sulfides. Several prospectors were also active in the Dahlonega gold area.

Bauxite.—Georgia was one of three bauxite-producing States in the Nation. Bauxite was used in refractories and aluminum-based chemicals. Production decreased considerably because of reduced demand for refractory uses.

Iron Oxide Pigments.—Georgia was one of four States with crude iron oxide pigment production and ranked third nationally. Ochre and umber was produced by New Riverside Ochre Co. from surface mined material in Bartow County. Production decreased slightly while value increased.

[1]State Liaison Officer, Bureau of Mines, Tuscaloosa, Ala.
[2]Senior economic geologist, Georgia Geologic Survey, Environmental Protection Division, Georgia Department of Natural Resources.

Table 11.—Principal producers

Commodity and company	Address	Type of activity	County
Barite, primary:			
New Riverside Ochre Co.[1]	Box 387 Cartersville, GA 30120	Open pit mine and mill.	Bartow.
Paga Mining Co	Box 130 Cartersville, GA 30120	____do ___	Do.
Bauxite:			
American Cyanamid Co	Box 38 Andersonville, GA 30120	Open pit mine and plant.	Sumter.
Mullite Co. of America	Box 37 Andersonville, GA 31711	____do ___	Do.
Cement:			
Marquette Co	1 Commerce Pl. 9th Floor Nashville, TN 37239	Plant _____	Polk.
Martin Marietta Corp	6901 Rockledge Dr. Bethesda, MD 20817	____do ___	Fulton.
Medusa Cement Co	Box 5668 Cleveland, OH 44101	____do ___	Houston.
Clays:			
American Industrial Clay Co	433 North Broad St. Elizabeth, NJ 07207	Open pit mines.	Warren and Washington.
Engelhard Minerals & Chemicals Corp	Menlo Park Edison, NJ 08817	____do ___	Decatur, Washington, Wilkinson.
J. M. Huber Co	Thornall St. Edison, NJ 08817	____do ___	Twiggs and Warren.
Thiele Kaolin Co	Box 1056 Sandersville, GA 31082	____do ___	Warren and Washington.
Feldspar:			
The Feldspar Corp	Box 99 Spruce Pine, NC 28777	Open pit mines and plant.	Greene and Jasper.
Gypsum, calcined:			
Genstar Building Products Co	480 Central Ave. East Rutherford, NJ 07073	Plant _____	Chatham.
Georgia-Pacific Corp	Box 311 Portland, OR 97207	____do ___	Glynn.
National Gypsum Co	4100 First International Bldg. Dallas, TX 75270	____do ___	Chatham.
Kyanite:			
C-E Minerals, Inc	901 East Eighth Ave. King of Prussia, PA 19406	Open pit mine and plant.	Lincoln.
Mica:			
Franklin Mineral Products Co., Inc	Box O Wilmington, MA 01887	Open pit mine	Hart.
Peat:			
Colonial Peat Co	Box 161 Newington, GA 30446	Bog _____	Screven.
Georgia Global Peat, Inc	Box 238 Twin Lakes, GA 31605	Bog _____	Lowndes.
Perlite, expanded:			
Armstrong World Industries, Inc	1010 Concord Lancaster, PA 17604	Plant _____	Bibb.
Sand and gravel:			
Atlanta Sand & Supply Co	Route 1 Roberta, GA 31078	Open pit mine	Crawford.
Brown Bros. Sand Co	Howard, GA 31039	Open pit mines.	Talbot.
Butler Sand Co	Box 296 Butler, GA 31006	Open pit mine	Taylor.
Colwell Construction Co	Box 6 Blairsville, GA 30512	____do ___	Union.
Howard Sand Co	Box 118 Butler, GA 31006	Open pit mines.	Talbot and Taylor.
Stone:			
Florida Rock Industries, Inc	Box 4667 Jacksonville, FL 32201	Quarries ___	Clayton, Floyd, Monroe, Spalding.
Georgia Marble Co	3460 Cumberland Pkwy., NW. Atlanta, GA 30303	____do ___	De Kalb, Douglas, Forsyth, Gilmer, Hall, Newton, Pickens.
Martin Marietta Aggregates	6901 Rockledge Dr. Bethesda, MD 20817	____do ___	Jones, Lee, Richmond, Warren.

See footnote at end of table.

Table 11.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone —Continued			
North Georgia Crushed Stone Co., a division of Koppers Co.	Box 458 Lithonia, GA 30058	Quarries	Clarke, De Kalb, Fayette, Fulton, Habersham, Hall, Stephens, Walker.
Vulcan Materials Co	Box 7324-A, 1 Office Park Birmingham, AL 35223	do	Carroll, Cobb, Coweta, Douglas, Fulton, Gwinnett, Henry, Troup.
Talc:			
Southern Talc Co	Box F Chatsworth, GA 30705	Mines and mill.	Murray.

[1]Also produced iron oxide pigments.

The Mineral Industry of Hawaii

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

By George T. Krempasky[1]

Hawaii's nonfuel mineral production totaled $59 million in 1981, 8% less than the record year of 1979. Nonmetals—cement, gem stones, lime, pumice, sand and gravel, and stone—accounted for the total value. The use of mineral commodities—cement, stone, sand and gravel, and pumice—was directly related to the construction industry, which has felt the downturn in the economy. The 1981 value of nonfuel mineral production in Hawaii was 7% greater than the average value of production for the 5-year period 1977-81.

Cement was manufactured at two plants in Honolulu County—Cyprus Hawaiian Cement Corp. and Kaiser Cement Corp. Standard Oil Co. (Indiana) wants to sell its Cyprus Hawaiian Cement plant; annual capacity is 280,000 short tons. The reasons given for seeking divestiture are the geographic separation from Standard Oil's other operations, and its deviation from the company's normal lines of business. Crushed stone was produced from quarries in Hawaii, Honolulu, Kauai, and Maui Counties. Vermiculite imported from Montana was exfoliated in Honolulu County. Gem stone material was harvested from the waters surrounding the Hawaiian Islands.

Four major manganese nodule mining companies—Kennecott Consortium, Ocean Management Inc., Ocean Minerals Co., and Ocean Mining Associates—continued to show interest in deep seabed mining. Ha-

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

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:					
Masonry	thousand short tons	13	$960	10	$807
Portland	do.	358	23,722	302	23,024
Sand and gravel	do.	1,035	2,855	p1,100	p2,900
Stone:					
Crushed	do.	rW	rW	6,036	31,403
Dimension	do.	W	11	(2)	4
Combined value of gem stones, lime, pumice, salt, and value indicated by symbol W		XX	r32,169	XX	589
Total		XX	r59,717	XX	58,727

pPreliminary. rRevised. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Less than 1/2 unit.

waii's participation as a locale for development of deep-sea mineral recovery and processing is, to some degree, assured. Industrial and technological immigration by firms with the needed expertise may result in Hawaii sharing the bounty from ocean mining. The Hawaii Department of Planning and Economic Development is conducting studies on possible processing sites, such as Keaau in the Puna district on the Big Island, Hawaii. The Office of Ocean Minerals and Energy, National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce, held hearings on April 24, 1981, related to "Proposed Deep Seabed Mining Regulations for Exploration Licenses." The Department of Commerce, NOAA, had published in the Federal Register of September 15, 1981, "Deep Seabed Mining Regulations for Exploration Licenses: Final Rules," pp. 45890-45920.

Table 2.—Value of nonfuel mineral production in Hawaii, by county

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Hawaii	$5,672	W	Stone, sand and gravel, pumice.
Honolulu	W	W	Cement, stone, sand and gravel, salt.
Kauai	W	W	Stone, sand and gravel.
Maui	r3,973	$4,427	Stone, sand and gravel, lime, gem stones, pumice.
Total	63,904	59,717	

rRevised. W Withheld to avoid disclosing company proprietary data; included in "Total."

Table 3.—Indicators of Hawaii business activity

		1980	1981p	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	401.5	418.8	+4.3
Unemployment	do	19.2	20.7	+7.8
Employment (nonagricultural):				
Mining	do	(1)	(1)	--
Manufacturing	do	24.0	23.2	-3.3
Contract construction	do	23.9	22.3	-6.7
Transportation and public utilities	do	31.2	31.3	+ .3
Wholesale and retail trade	do	105.3	105.5	+ .2
Finance, insurance, real estate	do	32.8	32.2	-1.8
Services	do	298.5	2101.1	+2.6
Government	do	89.0	89.0	--
Total nonagricultural employment	do	404.7	404.6	--
Personal income:				
Total	millions	$9,761	$10,881	+11.5
Per capita		$10,091	$11,096	+10.0
Construction activity:				
Number of private and public residential units authorized		10,323	6,478	-37.2
Value of nonresidential construction	millions	$305.9	$291.2	-4.8
Value of State road contract awards	do	$38.9	$50.5	+29.8
Shipments of portland and masonry cement to and within the State	thousand short tons	378	312	-17.5
Nonfuel mineral production value:				
Total crude mineral value	millions	$59.7	$58.7	-1.7
Value per capita, resident population		$62	$61	-1.6
Value per square mile		$9,252	$9,105	-1.6

pPreliminary.
1Included with "Services."
2Includes mining.

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

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Cement.—Cyprus Hawaiian Cement and Kaiser Cement operated cement plants in Honolulu County, Oahu Island. Production in 1981 was 80% of the average for the 5-year period 1977-81; value was 96% of the average for the 5-year period.

In the processing of cement, the companies consumed raw materials—limestone, coral, volcanic cinders, sand, and gypsum. Both fuel oil and coal were used by each plant.

The portland cement produced in 1981 was used by building materials dealers (6%), concrete product manufacturers (12%), ready-mix concrete companies (79%), and in other uses (3%).

Lime.—The Hawaiian Commercial & Sugar Co., Ltd., produced hydrated lime at Paia, Maui County. The quantity produced was constant for the 5-year period 1977-81; however, value increased 67% over the average for the 5-year period.

Pumice.—Pumice was mined and processed in Hawaii County by Puna Sugar Co. and Volcanite Ltd. Maui Pineapple Co. Ltd., in Maui County, produced pumicite (volcanic ash). The material was used for concrete aggregate, road construction, and acoustic plaster.

Sand and Gravel.—To reduce reporting burden and costs, the Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary statistics for construction sand and gravel production. The preliminary statistics for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

In view of the above, principal producers shown for sand and gravel (table 6) are based on 1980 data.

Table 4.—Hawaii: Construction sand and gravel sold or used by producers

	1980			1981[p]		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Sand	519	$1,411	$2.72	NA	NA	NA
Gravel	516	1,444	2.80	NA	NA	NA
Total or average	1,035	2,855	2.76	1,100	$2,900	$2.64

[p]Preliminary. NA Not available.

Stone.—Crushed and dimension stone and volcanic cinders (included in stone statistics formerly covered under pumice and volcanic cinders) were produced from 40 quarries in Hawaii, Honolulu, Kauai, and Maui Counties. In 1981, more than 65% of the crushed stone came from Honolulu County, compared with 70% in 1980. The decrease can be attributed to including volcanic cinders and scoria in the statistics. Quarry production ranged from less than 25,000 short tons per year to more than 1 million tons annually. More than 50% of the total production came from quarries producing in excess of 800,000 short tons per year. Twenty-six companies were engaged in producing the product for various uses (table 5). Principal producers, with more than 300,000 short tons per year, are listed in table 6.

[1]State Liaison Officer, Bureau of Mines, Spokane, Wash.

Table 5.—Hawaii: Crushed stone[1] sold or used by producers in 1981, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Poultry grit and mineral food	3	17
Concrete aggregate	1,196	7,132
Bituminous aggregate	428	2,620
Macadam aggregate	20	151
Dense-graded road base stone	1,702	6,987
Surface treatment aggregate	81	375
Other construction aggregate and road stone	1,085	4,265
Manufactured fine aggregate (stone sand)	743	7,014
Cement manufacture	696	2,394
Chemicals	10	67
Other[2]	71	381
Total	[3]6,036	31,403

[1]Includes limestone, traprock, and miscellaneous stone, and volcanic cinder and scoria.
[2]Includes stone used for agricultural limestone, riprap and jetty stone, and lime manufacture.
[3]Data do not add to total shown because of independent rounding.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Cyprus Hawaiian Cement Corp	91-055 Kaomi Loop Ewa Beach, HI 96706	Cement plant	Honolulu.
Kaiser Cement Corp	Waianae Plant 300 Lakeside Dr. Oakland, CA 94612	do	Do.
Lime:			
Hawaiian Commercial & Sugar Co., Ltd.	Box 266 Puunene, HI 96784	Rotary kiln and continuous hydrator.	Maui.
Pumice:			
Puna Sugar Co	Keaau, HI 96749	Surface mine	Hawaii.
Volcanite Ltd	Kailua Kona, HI 96740	do	Do.
Sand and gravel:			
Amelco Corp	645 Halekauwila St. Honolulu, HI 96813	Plant and pit	Maui.
Warren Corp	Ainahaina Professional Bldg. Honolulu, HI 96821	do	Honolulu.
Stone:			
Ameron Honolulu Construction & Drayage, Ltd.	Box 29968 Honolulu, HI 96820	Quarries	Honolulu and Maui.
Grove Farm Rock Co., Inc	Puhi Rural Station Puhi, HI 96766	do	Kauai.
Lone Star Industries	400 Alabama St. San Francisco, CA 94110	Quarry	Honolulu.
Pacific Concrete & Rock Co., Ltd	2344 Pahounui Dr. Honolulu, HI 96819	Quarries	Honolulu and Maui.

The Mineral Industry of Idaho

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Idaho Bureau of Mines and Geology, Idaho Department of Lands, for collecting information on all nonfuel minerals.

By D. W. Lockard,[1] E. H. Bennett,[2] and M. M. Miller[3]

Nonfuel mineral production value from Idaho declined in 1981 to $431 million, a 17% decrease from the $522 million reported for 1980. The decrease was shared by nearly all commodities produced within the State; however, the major decline was reflected mostly in precious metals. Silver again was the leading mineral commodity in terms of revenue, followed by phosphate rock, lead, and zinc. Metallic minerals accounted for more than 60% of total mineral revenue for the year.

Major developments during the year were company mergers and the announced closing of the Bunker Hill Co. operations in Kellogg. Lower metal prices slowed development of new mines, and may further curtail proposed operations.

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

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
Antimony ore and concentrate, antimony content ____ short tons	83	W	432	W
Clays ____ thousand short tons	27	$301	26	$288
Copper (recoverable content of ores, etc.) ____ metric tons	3,103	7,006	4,245	7,966
Gem stones	NA	60	NA	75
Lead (recoverable content of ores, etc.) ____ metric tons	38,607	36,139	38,397	30,923
Phosphate rock ____ thousand metric tons	4,991	100,873	5,361	108,964
Sand and gravel[2] ____ thousand short tons	5,299	14,203	p5,100	p13,200
Silver (recoverable content of ores, etc.) ____ thousand troy ounces	13,695	282,663	16,546	174,033
Stone[3] ____ thousand short tons	2,007	7,240	1,437	6,206
Zinc (recoverable content of ores, etc.) ____ metric tons	27,722	22,876	W	W
Combined value of cement, garnet (abrasives), gold, gypsum, lime, perlite, pumice, sand and gravel (industrial), stone (dimension), tungsten (1980-81), vanadium, and values indicated by symbol W ____	XX	50,734	XX	89,093
Total ____	XX	522,095	XX	430,748

pPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes industrial sand; value included in "Combined value" figure.

[3]Excludes dimension stone; value included in "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Ada	W	$3,573	Sand and gravel.
Adams	W	W	Copper, stone, silver.
Bannock	W	W	Cement, stone, sand and gravel.
Bear Lake	W	--	
Benewah	W	W	Garnet and stone.
Bingham	W	W	Phosphate rock, sand and gravel.
Blaine	W	W	Sand and gravel, gold, silver, lead.
Boise	W	W	Gold, silver, lead, stone.
Bonner	W	250	Sand and gravel.
Bonneville	$3,258	2,746	Sand and gravel, pumice, stone.
Boundary	W	W	Stone, sand and gravel.
Butte	(2)	--	
Canyon	W	W	Sand and gravel, lime.
Caribou	98,104	102,308	Phosphate rock, vanadium, stone, sand and gravel.
Cassia	W	W	Sand and gravel, stone.
Clark	84	40	Sand and gravel, clays.
Clearwater	430	688	Stone.
Custer	1,750	W	Silver, lead, zinc, copper, gold, stone.
Elmore	W	W	Stone, sand and gravel, clays.
Franklin	174	102	Stone.
Fremont	702	49	Sand and gravel.
Gem	1,918	W	Sand and gravel, stone.
Gooding	W	W	Sand and gravel.
Idaho	W	883	Stone, sand and gravel.
Jerome	--	W	Sand and gravel.
Kootenai	1,474	W	Sand and gravel, stone, silver, gold, copper, lead.
Latah	W	W	Stone and clays.
Lemhi	W	680	Silver, lead, gold, stone, copper, gypsum.
Lewis	117	45	Stone.
Lincoln	3	W	Sand and gravel.
Madison	1,639	365	Do.
Minidoka	W	W	Lime, sand and gravel.
Nez Perce	W	584	Sand and gravel, silver, stone, lead.
Oneida	W	W	Perlite, pumice, stone.
Owyhee	W	W	Silver and gold.
Payette	130	114	Sand and gravel.
Power	44	W	Do.
Shoshone	W	W	Silver, lead, zinc, copper, gold, antimony.
Twin Falls	W	W	Lime, sand and gravel.
Valley	249	W	Stone, sand and gravel, tungsten.
Washington	W	W	Gypsum.
Undistributed[3]	r327,806	409,665	
Total	r437,882	[4]522,095	

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]Camas, Jefferson, and Teton Counties are not listed because no nonfuel mineral production was reported.

[2]Less than 1/2 unit.

[3]Includes some clays (1980) that cannot be assigned to specific counties, gem stones, and values indicated by symbol W.

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

Table 3.—Indicators of Idaho business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	413.1	420.4	+1.8
Unemployment	do.	32.4	39.8	+22.8
Employment (nonagricultural):				
Mining	do.	4.7	4.9	+4.2
Manufacturing	do.	53.3	52.3	-1.9
Contract construction	do.	17.4	16.3	-6.3
Transportation and public utilities	do.	20.1	19.7	-2.0
Wholesale and retail trade	do.	80.6	79.8	-1.0
Finance, insurance, real estate	do.	23.4	23.2	-.9
Services	do.	60.0	60.0	--
Government	do.	70.5	70.1	-.6
Total nonagricultural employment	do.	330.0	326.3	-1.1
Personal income:				
Total	millions	$7,735	$8,544	+10.4
Per capita		$8,176	$8,906	+8.9
Construction activity:				
Number of private and public residential units authorized		5,795	3,056	-47.3
Value of nonresidential construction	millions	$110.1	$111.5	+1.3
Value of State road contract awards	do.	$23.5	$50.0	+112.8
Shipments of portland and masonry cement to and within the State	thousand short tons	364	313	-14.0
Nonfuel mineral production value:				
Total crude mineral value	millions	$522.1	$430.7	-17.5
Value per capita, resident population		$553	$456	-17.6
Value per square mile		$6,248	$5,155	-17.5

[p]Preliminary.

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

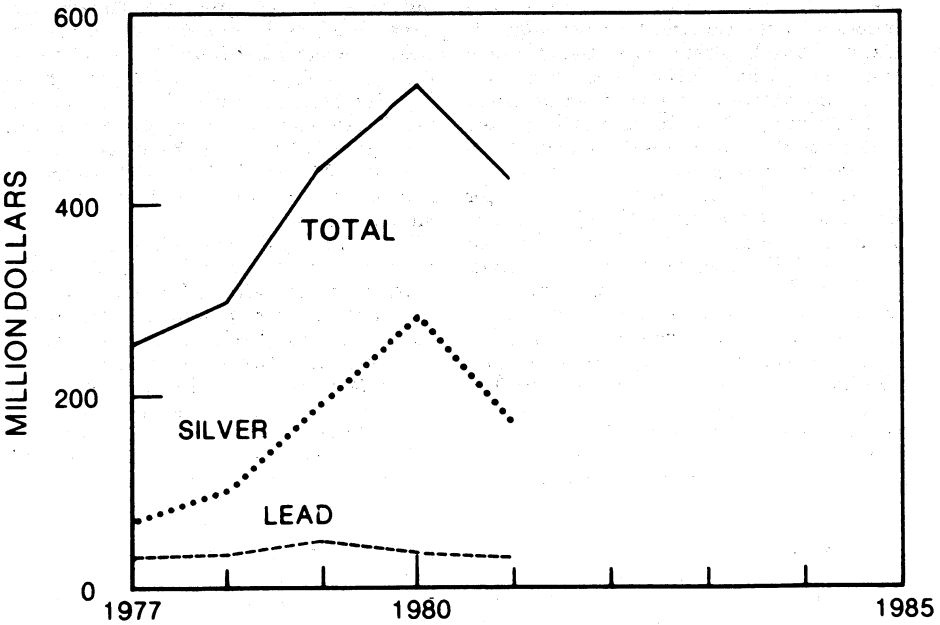

Figure 1.—Value of silver and lead, and total value of nonfuel mineral production in Idaho.

Trends and Developments.—Declining metal prices had an adverse effect on Idaho's economy, especially within the Coeur d'Alene district. On August 25, 1981, Gulf Resources and Chemical Corp. announced it was closing the Bunker Hill Co.'s Kellogg operation permanently. Closure would affect the lead smelter and refinery, zinc plant, and acid plant by the end of the year, with mining and milling operations to close in early 1982. The lead smelter and zinc plant had an annual capacity of 130,000 and 104,000 short tons, respectively. Shutdown will affect 2,100 employees and mean a loss of $50 million annual payroll. Bunker Hill was the largest single employer in northern Idaho.

The rationales behind the closure include (1) declining silver prices; (2) long-term depressed prices for lead and zinc; (3) problems in securing zinc concentrates (Bunker Hill imported nearly 70% of its zinc plant feedstock); (4) cost of installation of new antipollution equipment (estimates ranged up to $100 million); (5) problems in meeting Occupational Safety and Health Administration (OSHA), Mine Safety and Health Administration, and Environmental Protection Agency (EPA) regulations; (6) declining ore grades at the Bunker Hill Mine; (7) a proposal by the General Services Administration to sell silver from the national stockpile; (8) high labor costs; (9) maintenance problems in operating old facilities; and (10) competition for imported concentrates due to increased costs of transportation for inland shipping.

After the Gulf announcement, Governor Evans formed the Silver Valley Economic Task Force in an effort to find a buyer for the Bunker Hill complex. At the same time, the United Steel Workers local union examined the feasibility of establishing an Employees' Stock Ownership Plan; this plan was subsequently rejected as inoperable by the company in November 1981. The task force was able to obtain a 5-year postponement of OSHA regulations on lead levels, and the cooperation of EPA in specifying what the antipollution requirements would be for a buyer over the same 5-year period.

In December 1981, a local group of investors secured an option to purchase the Bunker Hill Co. for over $65 million in cash, notes, and a share in future profits. The group began seeking concessions from the craft unions, suppliers, and utilities in order to trim first-year losses from an estimated $40 million to $10 million. At yearend, no decision had been reached; however, the option had been extended into January 1982.

Shutdown of Bunker Hill will result in a loss of 26% of the Nation's refined silver output, 21% of primary refined lead production, 21% of primary slab zinc production, and 15% of its refined cadmium output. In recent years, nearly 75% of the lead and 60% of the zinc concentrates processed at the plant were obtained from other domestic and foreign sources.

A major corporate shift occurred when Sunshine Mining Co. merged with four companies that controlled mineralized ground that it was mining near the Sunshine Mine. The merged companies were Silver Dollar Mining Co.; Sunshine Consolidated, Inc.; Big Creek Apex Mining Co.; and Silver Syndicate, Inc. The agreement involved a reported $55 million stock swap. The only remaining outside interests in the Sunshine Mine Area are Hecla Mining Co., with 33.25% of the Unit Area production; Silver Surprise, Inc., with 50% of production from the "S" Area; and Metropolitan Mines Corp., with 50% from the Metropolitan Area and 16% from the Yankee Girl Area. Sunshine continued work on the No. 12 shaft, which passed the 5,000-foot level at yearend and is targeted for a depth of 5,200 feet. The building that will house the company's new silver refinery was completed, and equipment for it was purchased during the year. The price decline in silver has resulted in a delay of operation at the $15 million facility.

Hecla Mining Co. also joined the merger ranks in 1981, when it completed a stock purchase of Day Mines, Inc. The deal was valued at nearly $100 million. This combination will make Hecla the largest domestic silver producer. Hecla now owns the Lucky Friday Mine, the Knob Hill Mine (Washington), 50% of the Star Mine, and 64% of the Consolidated Silver Project. The company will also receive 60% of the profits from the Sherman Mine (Colorado), 12.5% from the Galena Mine, 5% from the Coeur Mine, and 33.25% from the Sunshine Mine. In addition to its producing properties, Hecla now controls 21,800 acres of mining claims in the Western United States, many of which are in the Coeur d'Alene mining district.

The Lucky Friday Mine was closed by a strike from March 21 to May 23. Progress

on construction of its Silver Shaft continued under budget and 44 weeks ahead of schedule, passing the 4,900-foot level at yearend; present plans call for the sinking to bottom out at the 6,100-foot level.

Shaft sinking continued also at the Caladay Project (Callahan Mining Corp.), where depth exceeded 1,600 feet at yearend. That shaft is expected to bottom out at 5,100 feet. Installation was completed of a pump station and a 27,000-horsepower Nordberg hoist.

The Consolidated Silver Project, operated by Hecla Mining Co., continued shaft sinking at the Silver Summit Mine; the shaft was extended from the 4,590-foot level to the 4,950-foot level. Exploration of the upper workings progressed throughout the year. The 5-year program cost is expected to approach $11 million.

In January, ASARCO Incorporated negotiated and signed a new 3-year contract with the United Steel Workers Union, covering workers at the Galena Mine.

Outside of the Coeur d'Alene district, major developments occurred at the Thompson Creek Mine, Custer County (molybdenum), and the Blackbird Mine, Lemhi County (cobalt).

Progress was extensive during the year at Cyprus Mining Corp.'s Thompson Creek Mine. Nearly 1,300 people were employed in removing overburden and building site facilities for the largest surface mine in the State. Overburden ranged from 50 to 600 feet thick. Excavation was completed for the crushing plant, as was site preparation for the mill. A 7,000-foot conveyor belt system will move crushed ore to the mill. Mining will be done with 4 25-yard shovels and 23 170-ton trucks. When fully operational, the mine is expected to produce 25,000 tons of ore per day and employ nearly 550 workers. Approximately 2,500 acres will be disturbed for the operation.

A 3- to 4-month gain on construction schedules, mostly due to good weather and a 20% cost overrun by primary contractors, caused Cyprus to shut down working operations at yearend. The company will renew operations in the spring after contracts have been renegotiated.

During the year, construction began on a new 95-mile, 230-kilowatt power transmission line to the mine; cost will approach $15 million. The first year budget for the $350 million venture totaled about $172 million.

Cyprus has built 262 houses in Challis, for purchase by its future employees, and a 162-unit trailer park. The company also prepaid $600,000 in 1981 property taxes to enable the community to prepare for the rapid growth.

Even though molybdenum prices declined sharply during the year, Cyprus intends to complete the Thompson Creek Mine in spite of adverse economic conditions.

At Noranda Mining Co., Inc.'s Blackbird Mine, Lemhi County, work continued during the year and the two lower levels were dewatered. Sampling and underground drilling programs continued. The work force was reduced to 90 in October 1981, and further curtailments in the work force occurred by yearend.

Exploration continued outside the immediate mine area; several new target areas were delineated. Exploration was also conducted in the Special Management Zone of the River of No Return Wilderness Area, which is adjacent to and northwest of the mine site.

Noranda announced early in the year that a $50 million cobalt refinery would be built on a 212-acre site near Blackfoot, in southeast Idaho. A 1985 completion date is planned. The facility would employ 180, and have an annual operating budget of $14 million. Noranda obtained a favorable zoning decision from the Bingham County Planning and Zoning Commission, but a suit filed by local residents sought to reverse that decision. By yearend, Noranda announced that plans for its proposed refinery were being delayed because of adverse economic conditions, and by the uncertainty of whether or not the Government will set a floor price for cobalt.

In January 1981, MAPCO Minerals Corp. completed purchase of all mining and mineral-related properties of Earth Resources Co., which included the Delamar Mine in Owyhee County. Ongoing development drilling on the property has increased reserves to a 20-year mine life. A new open pit mine named the Glen Silver was developed during the year. The deposit is northwest of the present Summer Camp Pit operation.

With an environmental impact statement completed early in the year, Canadian Superior Mining Co. began construction of production heap leach pads at its Stibnite property. Sixty people were employed on the project, which was 90% complete by yearend. The project included five 200- by

325-foot leach pads, each with the capacity to hold 25,000 to 30,000 tons of ore. The company anticipates recovering 1 ounce of gold per 10 to 20 tons of ore. The mine has a 7- to 10-year life, but will operate 6 months per year because of severe winter conditions. Preproduction costs are estimated at $10 million.

A pilot heap leach test was carried out by Yellow Jacket Mines, Inc., on 3,000 tons of gold ore at the Yellow Jacket Mine in Lemhi County. The company plans to go from start to full-scale production in 1982. Annual production of ore is estimated at 50,000 tons, with an average grade of 0.1 ounce of gold per ton.

Inspiration Development Co. dropped its option on the Rams Horn Mine (Custer County), but continued its drilling program with favorable results on the adjacent Keystone property in the Bay Horse mining district. The mine contains fluorite, silver, and lead mineralization, and has changed its status from exploration to development. The company also continued development work at the Ima Mine (Lemhi County) by driving a new adit and opening a new haulage level.

U.S. Antimony Corp. processed dump material that had been taken from the Charles Dickens Mine. Processing was done at its 300-ton-per-day mill near Preacher's Cove on the Yankee Fork of the Salmon River. The company also did development tunneling on at least two other properties in this historic mining district.

The Sunbeam Mining Corp., a subsidiary of Geo Dome Petroleum Co., Vancouver, British Columbia, Canada, started heap leaching gold material from the Sunbeam Mountain of Jordan Creek, Custer County. A trommel was installed to separate clay from the ore, and carbon towers were built to recover the gold from cyanide solution. Their operation will employ between 40 and 50 people, and approximately 7 million tons of ore will be moved during the proposed 10-year mining program.

Silver King Mines, Inc., continued copper-silver mining operations at its Copper Cliff surface mine at Cuprum (Adams County), but closed down in December 1981, because of low metal prices. The company also processed ore taken from the Iron Dyke Mine in Oregon. A potential merger between Silver King and a German company was called off at yearend.

Extensive exploration projects were underway in many of the State's counties during the year, notably Adams, Blaine, Boise, Custer, Lemhi, Shoshone, and Valley. In Custer County, Noranda Mining, Inc., drilled three holes at its Red Mountain molybdenum prospect; their exploration will continue in 1982. Noranda announced dropping of its claims on Basin Creek because of the depressed uranium market. Anaconda Mining Co. dropped claims on the Beaver Creek molybdenum prospect (Lemhi County), a few miles west of Leesburg. The company will maintain its Tango-Pioneer molybdenum claims west of Loon Creek until at least 1982. Denison Mines (U.S.) Inc. was actively exploring its Parker Mountain property north of Challis. Molycorp Inc. staked claims in the Copper Basin Area and initiated a geology, geophysic, and geochemistry program in the Star Hope Canyon and Muldoon Canyon Areas. Utah International drilled a porphyry copper molybdenum deposit near the Copper Basin Mine.

Sunshine Mining Co. drilled three holes in the Pearl district, north and west of Boise in Gem County. Monica Mines, active in the same area last year, was building a cyanide heap leach facility in early 1981. Loss of funding forced shutdown of the operation by midyear. The Golden Gate tungsten property near Yellow Pine (Valley County), another Monica venture, suffered the same fate. AMAX Inc. continued a long-standing exploration program at the CUMO molybdenum deposit near Grimes Pass, north of Idaho City (Boise County). A small drilling program was conducted during the summer. In Adams County, 12 holes were drilled on the Hercules silver prospect owned by Anglo-Bomarc. Twin Rivers Development Minerals, Inc., sold its option on the property to the Copper Lakes Co.; work ceased in midyear because of funding shortages and declining silver prices. In Kootenai County, Bear Creek Mining Co. continued exploration at the Chilco Mountain molybdenum prospect. This project is a joint venture with Union Carbide Corp. and Noranda; a deep diamond drill hole was tentatively planned for 1982. The Turtle Mining Co. examined the Big Turtle Mine near Clayton, in Custer County. The company estimates reserves of 40,000 short tons with 21 ounces of silver per ton and 8% lead. Work for the year included a geochemical survey and a detailed geologic mapping program; a drilling program was planned for 1982.

COMINCO American Inc. continued detailed geologic studies on its Bobcat Gulch prospect on Napoleon Ridge, east of Leesburg, in Lemhi County. Over 10,000 feet of new road was built on the porphyry-copper-molybdenum prospect, and a new zone of secondary copper mineralization was discovered. Molybdenite mineralization and quartz vein occurs across a 1,000- to 2,000-foot zone. This project is a joint venture with Bear Creek Mining Co.

COMINCO also continued its exploration program in the Pine Creek district. The company holds leases on the Lookout, Signal, Silver and Gold, and New Era properties through an agreement with Epic Silver Mining Co. Final agreements were reached during the year with Hypotheek Mining and Milling Co., Constitution Mining Co., Sidney Mining Co., and Mascot Mining Co. COMINCO did some surface drilling in the area during the year, and anticipates the possibility of a complete geophysical survey in 1982.

A diamond drilling program was begun by Sunshine Mining Co. on property controlled by Allied Silver-Lead Co., to explore and develop 400 acres located under the city of Mullen, near the Lucky Friday Mine. A diamond drill hole planned to reach 4,000 feet was down 3,700 feet by late October. Several siderite veins with low silver values were intersected by the hole. Sunshine is committed to spend $1.2 million on the Allied property by 1985.

Coeur d'Alene Mines Corp. continued an extensive drilling project on the Harlow property of Royal Apex Silver, in Shoshone County. Early in the year, diamond drill holes intercepted several zones of silver-bearing mineralization. The company also signed an agreement with Capital Silver Mines Inc. to expend $150,000 during the first 2 years of an exploration venture on Capital Silver's 300 claims. The company may terminate the agreement after the expenditure of $100,000. Coeur d'Alene Mines will receive 65% of any ore found on the property after recovering preproduction costs. The company also negotiated an exploration agreement with Highland Aurora Mining Co. to examine that company's 37 mining claims in the Coeur d'Alene district. A minimum of $75,000 will be spent on the property by the end of 1982.

Helena Silver Co. signed an option to lease agreement with Bear Creek Mining Co. (a subsidiary of Kennecott Corp.). Bear Creek has conducted detailed geologic and geochemical work on Helena Silver's 30-claim Wonderful Creek property, and plans to do deep diamond drilling. Shoshone Silver Mining Co. also signed option and exploration agreements with Bear Creek for its 75 claims adjacent to Helena Silver's. The option provides for expenditure of as much as $500,000 in exploration effort from 1985 to 1991. Bear Creek Mining Co. also signed option agreements with Beacon Light Mining Co., Border Silver Mines Co., Idaho Copper & Gold Inc., Idora Silver Mines Inc., Park Copper Co., Reindeer Queen Mining Co., and Silver Crest Mines Inc. This gives Bear Creek a very large land holding east of the silver belt in the Coeur d'Alene district.

In the nonmetallic mineral sector, a draft environmental statement was released in September 1981 for the J. R. Simplot Co.'s Smokey Canyon Mine. The new mine, on Federal Phosphate Lease I-012890, will eventually replace diminishing reserves at the company's Conda Mine. The lease area covers nearly 2,500 acres 25 miles east of Soda Springs, in Caribou County. Simplot plans to mine approximately 2 million tons of phosphate rock annually over a projected 30-year life. Preproduction costs are estimated at $20 million. The mine will be an open pit operation, using shovels and 170-ton haul trucks. The present proposal features a 25-mile, 8-inch pipeline for transporting slurry phosphate from the new mine site to Simplot's processing plant at Conda. The project will employ 95 people during full operation. Construction is scheduled to begin early in 1982, with the mill, slurry pipeline, and tailings dam to be completed by 1984.

The Conda Partnership, a joint venture of Beker Industries Corp. and Western Co-op Fertilizers, closed the Maybie Canyon Mine in December 1981, due to a soft market and an oversupply of phosphate.

Oneida Perlite Co. installed the largest vertical furnace manufactured for expanding perlite. A new filler plant was completed and storage facilities were expanded.

Cash Industries processed barite from a stockpile at the Bonnie Barite surface mine (Blaine County). The company processed nearly 60,000 tons of barite at its mill during the year. It is anticipated that Cash will open a new mine in 1982, when the stockpiled ore is exhausted. A drilling and exploration program was conducted on new barite claims close to the present mine. NL Industries, Inc. (Baroid Div.), which owns

the Bonnie Barite Mine, submitted a mining plan to the Idaho Department of Lands and the U.S. Forest Service, for surface mining operations to begin in 1982. The company also has plans to build a processing plant somewhere in the vicinity in 1982.

Occidental Petroleum continued with plans to produce zeolites from its claims near Sheaville, Owyhee County. A primary crushing plant is to be built at the site. The product would then be shipped to a new processing plant tentatively planned for construction in Nampa.

Legislation and Government Programs.—The 46th Idaho Legislature, first regular session, dealt with several bills that would affect Idaho's mineral industry. New laws now in effect concern provisions for exploration and lease of mineral rights on State lands, and to protect the "Good Samaritan Act" of miners in mine rescue situations. There were a number of legislative meetings and discussions over a proposal to impose a gross percent State severance tax on all minerals. The proposed bill was not reported out of committee.

The 116th Engineer Battalion of the Idaho National Guard continued rehabilitation work at the Jack Waite Mine. The Guard, as part of its summer training, is stabilizing the old mine tailings. Erosion of these has been of concern to the public and to the U.S. Forest Service, because the unstable tailings could be washed into Eagle Creek during a flood and cause metallic contamination in the North Fork of the Coeur d'Alene River.

A 3-year, $827,000 research program that began in 1981, is conducted jointly by the U.S. Geological Survey and the University of Idaho's College of Mines and Earth Resources. The program will involve surface mapping, remote sensing, and geochemical studies including isotope and fluid inclusion work. The goal is to gain further geologic knowledge of the Coeur d'Alene mining district in the search for more economic mineralization.

The Idaho Bureau of Mines and Geology (IBMG) completed the 1:250,000-scale mines and prospects map series during 1981. The 20 maps show locations and give references for over 8,000 mines and prospects in the State. The IBMG project was completed in cooperation with the U.S. Geological Survey, the Federal Bureau of Mines, the U.S. Bureau of Land Management, and the U.S. Forest Service. Third-year field work in support of the U.S. Geological Survey's Challis Conterminous U.S. Minerals Assessment Program was completed. Six 15-minute quadrangles have been mapped in the Atlanta Lobe of the Idaho Batholith, and petrologic studies are underway.

The description of a newly discovered volcanic feature in southwest Idaho, the Bruno Jarbridge Eruptive Center, was the subject of several publications during the year. The largest single publishing project ever undertaken by the IBMG was initiated during the year. The publication was a volume of more than 45 papers on the Cenozic geology of Idaho. The phosphate study in southeast Idaho, supported by the U.S. Geological Survey, continued on schedule. A contract extension increased the number from 15 to 21 of 7.5-minute quadrangles to be evaluated for phosphate; projected completion is mid-1982.

In cooperation with the Geological Survey, IBMG continued field work and compilation of its Quaternary Mapping Project. A new surficial geology map series (scale 1:250,000) was started; the first two maps are scheduled for publication in 1982. The Landsat application program for evaluating geologic hazards in the State was completed for the Pacific Northwest Regional Commission. A National Science Foundation project was completed, studying the depositional environment of Mount St. Helens ash.

The Mining and Mineral Resources and Research Institute at the University of Idaho received no new 1981 research grant money. However, the institute did receive annual allotments of $110,000 for operations and $40,000 for fellowships.

Employment.—The weakening in metal markets and construction industries caused a substantial decline in employment by yearend in the State's mineral sector. Total mining employment was down 8% from that of 1980, while primary metal products employment, reflecting the Bunker Hill Co. shutdown, plunged 45%. Layoffs in stone, clays, and concrete product areas were increased 12% over the figures reported by December 1980. Phosphate mine employment began decreasing in late November 1981, and by yearend had reached its lowest level in 8 years.

Earnings for mining workers in 1981 were the highest of all the manufacturing groups, averaging nearly $600 per week.

Table 4.—Idaho: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Lode mines producing	Material sold or treated[1] (metric tons)	Gold		Silver	
			Troy ounces	Value	Troy ounces	Value
1979, total	34	2,121,412	24,140	$7,423,057	17,144,209	$190,129,279
1980, total	21	2,198,556	W	W	13,694,902	282,662,776
1981:						
Blaine	2	21	--	--	[2]	[2]
Bonner	2	5,352	W	W	5,424	57,052
Custer	5	80,477	300	137,891	112,656	1,184,959
Kootenai	1	4,354	415	190,751	38,602	406,030
Shoshone	14	1,626,781	W	W	14,836,789	156,058,835
Undistributed[3]	9	799,960	W	W	1,552,177	16,326,374
Total[4]	33	2,516,946	W	W	16,545,648	174,033,250

County	Copper		Lead		Zinc		Total value
	Metric tons	Value	Metric tons	Value	Metric tons	Value	
1979, total	3,618	$7,420,583	42,636	$49,479,186	29,660	$24,390,724	$278,842,829
1980, total	3,103	7,005,766	38,607	36,139,250	27,722	22,876,264	W
1981:							
Blaine	[2]	[2]	1	468	1	788	5,441
Bonner	[2]	[2]	5	4,211	4	4,348	105,976
Custer	[2]	[2]	W	W	59	57,494	1,678,951
Kootenai	9	16,014	7	5,786	--	--	618,581
Shoshone	3,423	6,423,322	37,914	30,535,041	W	W	226,281,428
Undistributed[3]	814	1,526,770	469	377,989	W	W	29,778,428
Total[4]	4,245	7,966,106	38,397	30,923,495	W	W	258,468,805

W Withheld to avoid disclosing company proprietary data.
[1]Operations from which gold, silver, copper, lead, or zinc, were recovered only from tailings or cleanup are not counted as producing mines.
[2]Included in "Undistributed" to avoid disclosing company proprietary data.
[3] Ada, Adams, Boise, Camas, Idaho, Lemhi, and Owyhee and items indicated by footnote 2 combined to avoid disclosing company proprietary data.
[4]Data may not add to totals shown because of independent rounding.

Table 5.—Idaho: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1981, by class of ore or other source material

Source	Number of mines[1] [2]	Material sold or treated (thousand metric tons)	Gold (troy ounces)	Silver (thousand troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode ore:							
Gold, gold-silver, copper, lead, zinc[3]	8	801,678	W	1,541,789	[4]1,090	2	W
Silver	15	867,203	2,719	13,161,698	3,154	11,562	1,100
Lead-zinc	10	845,579	W	1,836,133	W	26,821	W
Total[5]	33	2,514,459	W	16,539,620	4,243	38,385	W
Other lode material:							
Gold tailings, silver tailings, lead-zinc cleanup	1	2,487	241	6,028	2	12	5
Total lode material[5]	33	2,516,946	W	16,545,648	4,245	38,397	W

W Withheld to avoid disclosing company proprietary data.
[1]Operations from which gold, silver, copper, lead and zinc were recovered only from tailings or cleanup are not counted as producing mines.
[2]Detail will not add to total because one mine produced more than one class of material.
[3]Combined to avoid disclosing company proprietary data.
[4]Includes copper from lead-zinc ores.
[5]Data may not add to totals shown because of independent rounding.

Table 6.—Idaho: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1981, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (thousand troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode ore:					
Cyanidation and direct smelting of ore[1]	W	1,551	14	160	36
Smelting of concentrates	3,047	14,995	4,231	38,236	W
Total	W	16,546	4,245	[2]38,397	W

W Withheld to avoid disclosing company proprietary data.
[1]Combined to avoid disclosing company proprietary data. Includes recovery from tailings and cleanup.
[2]Data do not add to total shown because of independent rounding.

REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Antimony.—Production rose five times over that reported in 1980. The Sunshine Mine, Idaho's only antimony producer, operated for the entire year. The low 1980 production was due to an 8-1/2-month strike at the Sunshine Mine.

Cadmium.—The entire State production came from the Bunker Hill Co. Because of the planned shutdown of Bunker's smelting complex, cadmium will no longer be produced in Idaho.

Cobalt.—There was no recorded production of cobalt in Idaho for 1981. Noranda Mining Inc. continued development work at its Blackbird Mine, but at a greatly reduced rate from that of 1980 owing to weak market prices. Employment was reduced 50% during the year.

Copper.—Output and value both increased in 1981. Production increase was attributable to the Sunshine Mine being operated for the full year. Eighteen mines reported copper output for the year; nearly 71% of total State production came from eight mines in the Coeur d'Alene district. Asarco's Galena and Coeur Mines were the largest producers. Copper was produced in seven counties; the only notable producer outside of Shoshone County was the Copper Cliff Mine (Adams County), operated by Silver King Mines Inc. Idaho ranked ninth in the Nation in 1981 copper output. Copper exploration projects by several companies were reported in the Seven Devils Area of Adams and Washington Counties.

Gold.—Output increased slightly in 1981. MAPCO Inc.'s Delamar Mine in Owyhee County remained the State's largest producer. The company completed a planned expansion in 1981, which resulted in increased production. Hecla's Lucky Friday Mine was the only other operation that produced over 1,000 ounces. There was gold output reported from nine counties for the year.

Canadian Superior Mining Co. should have its Stibnite project (Valley County) onstream in 1982.

There were a number of placer operations active in the State during 1981. Small operators were known to be producing in Boise, Custer, Idaho, and Lemhi Counties. The Napias Mining Co. ran a 1,000-yard-per-day operation near Leesburg (Lemhi County), and a 1,200-yard-per-day trommel was being tested at Warren Meadows (Idaho County).

Idaho ranked eighth in the Nation in gold output.

Iron Ore.—There was no reported production of iron ore in the State in 1981.

Lead.—Lead was produced from 23 mines in the State, although over 90% came from 3 mines in the Coeur d'Alene district. The Bunker Hill Mine was the largest producer, followed by Hecla's Star and Lucky Friday Mines. The only notable producers outside of the Coeur d'Alene district were the Clayton Mine (Custer County) and the Democrat Mine (Lemhi County); each produced over 200,000 pounds of lead. Idaho was the second ranked producing State, accounting for 9% of the Nation's primary lead production.

Molybdenum.—There was no reported molybdenum production from the State in 1981. Exploration for the metal continued, as did development of Cyprus Mines' Thompson Creek deposit.

Silver.—Idaho remained the Nation's top producer of silver, accounting for 41% of

the total domestic production. Eight mines in the Coeur d'Alene district accounted for approximately 90% of the total output reported from 28 mines. Sunshine Mining Co.'s Sunshine Mine was the largest producer, followed by Asarco's Galena and Coeur Mines. These mines, plus Hecla's Lucky Friday, each produced in excess of 2 million ounces of silver; the Lucky Friday output would have been greater were it not for a 9-week strike. Notable producers outside of the Coeur d'Alene district included the Clayton Mine (Custer County) and the Delamar Mine (Owyhee County); only the Delamar production exceeded 1 million ounces.

There were a number of exploration projects for silver in progress. Much of the work was occurring in Adams, Boise, Bonner, Custer, Idaho, Shoshone, and Owyhee Counties.

The building to house Sunshine Mining Co.'s new silver refinery was completed during the year. When finished, the facility will make Sunshine a totally integrated silver producer.

Tungsten.—Production was from a single operator in Valley County; output was up slightly over that reported in 1980. Inspiration Development Co.'s work at the Ima Mine, Lemhi County, passed from the exploration to the development phase as a new adit was driven and preparations were made for a new haulage level.

Vanadium.—Ferrophosphorus slag from Idaho phosphate was processed for vanadium by Kerr-McGee Chemical Corp. at Soda Springs, Idaho, and by Union Carbide Corp. at Hot Springs, Ark. Both output and value reflected a slight increase. Idaho ranked third in the Nation in 1981 in the production of elemental vanadium.

Zinc.—Zinc output was reported from 18 mines in 1981. Most of the production came from the Bunker Hill and Star Mines in the Coeur d'Alene district; Bunker Hill was the largest producer in the State. The Democrat Mine (Lemhi County) and Clayton and Phi Kappa Mines (Custer County) were the only notable producers outside of Shoshone County.

Idaho ranked fourth nationally for 1981 in the production of primary zinc.

NONMETALS

Abrasives.—*Natural.*—Emerald Creek Garnet Co. was the State's only producer of garnet sands for its operation in Benewah County. Output was down slightly, but value increased from that reported in 1980.

Cement.—Output of cement continued throughout the year from the Oregon Portland Cement Co. plant at Inkom, Bannock County.

Clays.—Output and value were both down 4% from 1980 figures. Five companies reported production from five operations. The State's largest producer was North American Refractories Co. Clays, mined in the State in order of decreasing value, were common clay, fire clay, kaolin, and bentonite (swelling).

Gem Stones.—Fire opals and Owyhee Jasper (Owyhee County), opals (Clark County), and star garnets (Benewah County) were known to have been recovered in 1981 and sold within the State.

Gypsum.—All gypsum production came from the Consumers Coop Association deposit in Washington County. Reported output was nearly equal to that of 1980.

Lime.—Amalgamated Sugar Co. accounted for all of the State's lime output from its three operations in southern Idaho. Output was nearly equal to that reported in 1980.

Perlite.—Oneida Perlite Co., Oneida County, remained the only producer of perlite in the State. Output and value remained nearly constant with those reported in 1980. The company markets all sizes of industrial grade perlite and plans to enter the precast construction business.

Phosphate Rock.—Idaho ranked second in the Nation in marketable production of phosphate rock, producing 10% of total U.S. output. Production came from six mines in Southeastern Idaho (Bingham and Caribou Counties). The J. R. Simplot Co. was the largest producer from its two mines.

The Conda Partnership (Beker Industries Corp. and Western Cooperative Fertilizers, Ltd.) laid off 350 workers at its operations, citing bad winter conditions and high inventories; market conditions will determine when operations will resume in 1982. In a related move, Beker closed its ammonia plant at Soda Springs because of higher rates for natural gas. The company was looking for a new 1982 supplier.

Wet-process phosphoric acid (WPPA) plants were operated by both Simplot and Beker. The Bunker Hill Co. also operated a WPPA plant at its Kellog lead-zinc smelter; the company received its phosphate from Stauffer Chemical Co. and shipped sulfuric acid to Beker.

Pumice and Pumicite.—Pumice output

came from Bonneville and Oneida Counties. Production and value declined 40% and 21%, respectively, from that of 1980. Amcor Inc. was the State's largest producer from its operation near Idaho Falls. Nearly 95% of State output was utilized as lightweight concrete aggregate.

Sand and Gravel.—To reduce the burdens and costs of reporting, the Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only estimates for construction sand and gravel production, but complete data on industrial sand and gravel. The estimates for production of construction sand and gravel for odd years will be revised and finalized the following year.

Martin Marietta Corp. was the State's only industrial sand producer; output was from an operation in Gem County. Production was down slightly from that reported in 1980.

Table 7.—Idaho: Sand and gravel sold or used by producers, by use

Use	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	1,690	$4,745	$2.81	NA	NA	NA
Gravel	3,609	9,458	2.62	NA	NA	NA
Total or average	5,299	14,203	2.68	p5,100	p$13,200	p$2.59
Industrial sand	W	W	14.22	W	W	17.58
Grand total or average	W	W	2.95	W	W	p2.90

pPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.

Stone.—Output and value of stone declined further in 1981 from the levels reported in 1980 and 1979. Decreased construction activity resulted in a declining demand for crushed stone. Three counties (Bannock, Caribou, and Idaho) accounted for 78% of the total State output. The Oregon Portland Cement Co. (Bannock County) and the Monsanto Co. (Caribou County) were the leading producers.

[1]State Liaison Officer, Bureau of Mines, Spokane, Wash.
[2]Associate chief, Idaho Bureau of Mines and Geology, Moscow, Idaho.
[3]Chief, Idaho Bureau of Mines and Geology, Moscow, Idaho.

Table 8.—Idaho: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	29	86	35	104
Poultry grit and mineral food	5	16	6	17
Bituminous aggregate	W	W	5	W
Dense-graded road base stone	41	123	318	1,106
Surface-treatment aggregate	365	1,062	W	W
Other construction aggregate and road stone	408	1,050	225	740
Riprap and jetty stone	419	1,673	49	164
Railroad ballast	55	104	20	38
Paper manufacture	17	45	--	--
Other[2]	668	3,082	780	4,037
Total[3]	2,007	7,240	1,437	6,206

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, granite, sandstone, traprock, and miscellaneous stone.
[2]Includes cement manufacture, flux stone, roofing granules, and other uses not specified.
[3]Data may not add to totals shown because of independent rounding.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasives:			
Emerald Creek Garnet Co	Box 176 Fernwood, ID 83830	Placer mine	Benewah.
Antimony:			
Sunshine Mining Co	Box 1080 Kellogg, ID 83837	Mine, mill, plant	Shoshone.
Cement:			
Oregon Portland Cement Co	Old National Bank, Rm 622 Inkom, ID 83245	Surface mine and plant.	Bannock.
Clays:			
A. P. Green Refractories (U.S. Gypsum)	Box 158 Troy, ID 83871	do	Latah.
North American Refractories Co	3502 Breakwater Ct. Harwood, CA 94545	Surface mine	Various.
Copper:			
ASARCO Incorporated	Box 440 Wallace, ID 83873	Mine and mill	Shoshone.
Hecla Mining Co	Box 320 Wallace, ID 83873	Mine, mill, plant	Do.
Silver King Mines Inc	1204 Deseret Bldg. Salt Lake City, UT 84111	Surface mine and mill.	Adams.
Sunshine Mining Co	Box 1080 Kellogg, ID 83837	Mine and mill	Shoshone.
Gold:			
Hecla Mining Co	Box 320 Wallace, ID 83873	do	Do.
MAPCO Inc	Box 52 Jordan Valley, OR 97910	Surface mine and mill.	Owyhee.
Gypsum:			
Consumers Coop Association	502 Pioneer Rd. Weiser, ID 83672	Surface mine	Washington.
Lead:			
The Bunker Hill Co	Box 29 Kellogg, ID 83837	Mine, mill, plant	Shoshone.
Clayton Silver Mines	Box 890 Wallace, ID 83873	Mine and mill	Custer.
Hecla Mining Co	Box 320 Wallace, ID 83873	do	Shoshone.
Lime:			
Amalgamated Sugar Co	First Security Bank Bldg. Ogden, UT 84402	Plant	Various.
Perlite:			
Oneida Perlite Corp	Box 162 Malad City, ID 83252	Surface mine and plant.	Oneida.
Phosphate rock:			
Conda Partnership	Box 37 Conda, ID 83230	do	Caribou.
Monsanto Co	800 North Lindbergh Blvd. St. Louis, MO 63166	Surface mine	Do.
J. R. Simplot Co	Box 912 Pocatello, ID 83201	Surface mine and plant.	Various.
Pumice:			
Amcor, Inc	Box 1141 Idaho Falls, ID 83401	Quarry	Bonneville.
Hess Pumice Products	Box 209 Malad City, ID 83252	do	Oneida.
Sand and gravel (industrial):			
Martin Marietta Corp	Emmet, ID 83617	Pit	Gem.
Silver:			
ASARCO Incorporated	Box 440 Wallace, ID 83873	Mine and mill	Shoshone.
The Bunker Hill Co	Box 29 Kellogg, ID 83837	Mine, mill, plant	Do.
Hecla Mining Co	Box 320 Wallace, ID 83873	Mine and mill	Do.
MAPCO Inc	Box 52 Jordan Valley, OR 97910	Surface mine and mill.	Owyhee.
Sunshine Mining Co	Box 1080 Kellogg, ID 83837	Mine and mill	Shoshone.
Stone:			
FMC Corp	1356 North Main Pocatello, ID 83201	Quarry	Bannock.
Monsanto Co	800 North Lindbergh Blvd. St. Louis, MO 63166	do	Caribou.
Oregon Portland Cement Co	Old National Bank, Rm. 622 Inkom, ID 83245	Quarry and plant	Bannock.
Seubert Excavation Inc	Grangeville, ID 83530	Quarry	Idaho.
Vanadium:			
Kerr-McGee Chemical Corp	Box 478 Soda Springs, ID 83276	Plant	Caribou.
Zinc:			
The Bunker Hill Co	Box 29 Kellogg, ID 83837	Mine, mill, plant	Shoshone.
Hecla Mining Co	Box 320 Wallace, ID 83873	Mine and mill	Do.

The Mineral Industry of Illinois

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

By James J. Hill[1] and Robert J. Tuchman[2]

The value of nonfuel mineral production in Illinois dropped to $428.3 million in 1981. Value was $15 million below that of 1980 and $48.2 million below that of 1979, the record year. Nationally, Illinois ranked 19th in value of total nonfuel mineral output and led in production of fluorspar, industrial sand, and tripoli. The State ranked fourth in the production of peat, fuller's earth, and crushed stone. As in 1980, stone, sand and gravel, cement, and lime contributed the greatest value to the State's nonfuel mineral production.

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

Mineral	1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement, portland thousand short tons	1,649	$75,315	1,574	$61,536
Clays[2] do	459	1,919	322	1,540
Gem stones	NA	15	NA	15
Peat thousand short tons	79	1,505	46	1,502
Sand and gravel do	31,725	122,332	p28,546	p118,986
Stone:				
Crushed do	53,309	180,656	44,159	165,218
Dimension do	2	103	2	85
Combined value of barite, cement (masonry), clays (fuller's earth), fluorspar, lead, lime, silver, tripoli, and zinc	XX	61,436	XX	79,434
Total	XX	443,281	XX	428,316

pPreliminary. 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.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Adams	W	W	Stone, sand and gravel.
Alexander	W	W	Tripoli, sand and gravel.
Bond	$1,075	$1,050	Sand and gravel, clays.
Boone	W	W	Sand and gravel, stone.
Brown	W	738	Stone.
Bureau	1,269	1,535	Sand and gravel, stone.
Calhoun	45	87	Stone.
Carroll	1,064	970	Do.
Champaign	1,563	1,266	Sand and gravel.
Christian	1,379	W	Stone.
Clark	W	W	Stone, sand and gravel.
Clay	757	1,078	Stone.
Clinton	W	W	Stone, sand and gravel.
Coles	W	W	Do.
Cook	95,024	87,340	Stone, lime, sand and gravel, clays, peat.
Crawford	W	W	Sand and gravel.
Cumberland	542	705	Do.
De Kalb	W	W	Stone, sand and gravel.
De Witt	262	11	Sand and gravel.
Douglas	W	W	Stone.
Du Page	4,489	5,371	Sand and gravel, stone.
Effingham	W	W	Sand and gravel.
Fayette	W	W	Stone, sand and gravel.
Ford	940	918	Sand and gravel.
Fulton	W	W	Do.
Gallatin	W	W	Do.
Greene	W	W	Stone.
Grundy	W	W	Sand and gravel, clays.
Hancock	W	W	Stone, sand and gravel.
Hardin	21,204	20,853	Fluorspar, stone, zinc, barite, lead, silver.
Henderson	1,205	W	Stone, sand and gravel.
Henry	1,449	1,877	Stone.
Jackson	W	W	Do.
Jersey	333	W	Do.
Jo Daviess	W	W	Stone, sand and gravel.
Johnson	2,990	W	Stone.
Kane	16,705	14,508	Sand and gravel, stone.
Kankakee	W	W	Stone, clays, sand and gravel.
Kendall	W	W	Stone, sand and gravel.
Lake	W	W	Sand and gravel, peat.
La Salle	W	W	Sand and gravel, cement, stone, clays.
Lawrence	W	W	Sand and gravel.
Lee	W	W	Cement, stone.
Livingston	7,714	W	Stone, clays.
Logan	W	W	Stone, sand and gravel.
McDonough	W	W	Stone, clays.
McHenry	19,238	14,365	Sand and gravel.
McLean	2,918	1,991	Do.
Macon	2,027	W	Do.
Madison	4,873	4,780	Stone, sand and gravel.
Marion	W	--	
Marshall	W	W	Sand and gravel.
Mason	28	39	Do.
Massac	W	W	Cement, sand and gravel.
Menard	W	W	Stone.
Mercer	236	296	Do.
Monroe	W	W	Do.
Montgomery	5,444	4,058	Do.
Moultrie	W	W	Sand and gravel.
Ogle	W	W	Sand and gravel, stone.
Peoria	1,866	1,304	Do.
Piatt	319	415	Sand and gravel.
Pike	W	W	Stone, sand and gravel.
Pulaski	W	W	Clays, stone, sand and gravel.
Putnam	W	W	Sand and gravel.
Randolph	W	W	Stone, sand and gravel.
Rock Island	W	W	Do.
St. Clair	W	W	Do.
Sangamon	2,896	2,772	Sand and gravel.
Schuyler	W	W	Sand and gravel, stone.
Scott	W	W	Stone.
Shelby	803	539	Sand and gravel, stone.
Stephenson	1,101	1,216	Stone, sand and gravel.
Tazewell	3,165	W	Sand and gravel, clays.
Union	W	W	Stone, sand and gravel.
Vermilion	W	W	Do.
Wabash	301	291	Sand and gravel.
Warren	3,122	W	Stone.
Washington	W	W	Do.
White	W	W	Sand and gravel.

See footnotes at end of table.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Whiteside	W	W	Peat, stone, sand and gravel.
Will	$21,976	$17,854	Stone, sand and gravel.
Williamson	27	--	
Winnebago	3,380	3,876	Stone, sand and gravel.
Woodford	3,573	3,248	Sand and gravel.
Undistributed[2]	239,233	247,935	
Total[3]	476,530	443,281	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Cass, Edgar, Edwards, Franklin, Hamilton, Iroquois, Jasper, Jefferson, Knox, Macoupin, Morgan, Perry, Pope, Richland, Saline, Stark, and Wayne Counties are not listed because no nonfuel mineral production was reported.
[2]Includes stone (1979) that cannot be assigned to specific counties, gem stones, and values indicated by symbol W.
[3]Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Illinois business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	5,517.0	5,431.6	-1.6
Unemployment	do	505.0	453.9	-10.1
Employment (nonagricultural):				
Mining[1]	do	31.3	26.7	-14.7
Manufacturing	do	1,208.2	1,134.9	-6.1
Contract construction	do	188.4	168.9	-10.4
Transportation and public utilities	do	285.7	284.4	-.5
Wholesale and retail trade	do	1,130.7	1,096.6	-3.0
Finance, insurance, real estate	do	314.3	316.7	+.1
Services	do	942.3	957.2	+1.6
Government	do	766.3	767.2	+.1
Total nonagricultural employment[1 2]	do	4,867.1	4,752.5	-2.4
Personal income:				
Total	millions	$119,954	$131,565	+9.7
Per capita		$10,479	$11,479	+9.5
Construction activity:				
Number of private and public residential units authorized		26,659	15,466	-42.0
Value of nonresidential construction	millions	$1,596.0	$1,543.9	-3.3
Value of State road contract awards	do	$769.0	$386.0	-49.8
Shipments of portland and masonry cement to and within the State	thousand short tons	2,754	2,393	-13.1
Nonfuel mineral production value:				
Total crude mineral value	millions	$443.3	$428.3	-3.4
Value per capita, resident population		$39	$38	-2.6
Value per square mile		$7,860	$7,594	-3.4

[p]Preliminary.
[1]Includes bituminous coal and oil and gas extraction.
[2]Data may not add to totals shown because of independent rounding.

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

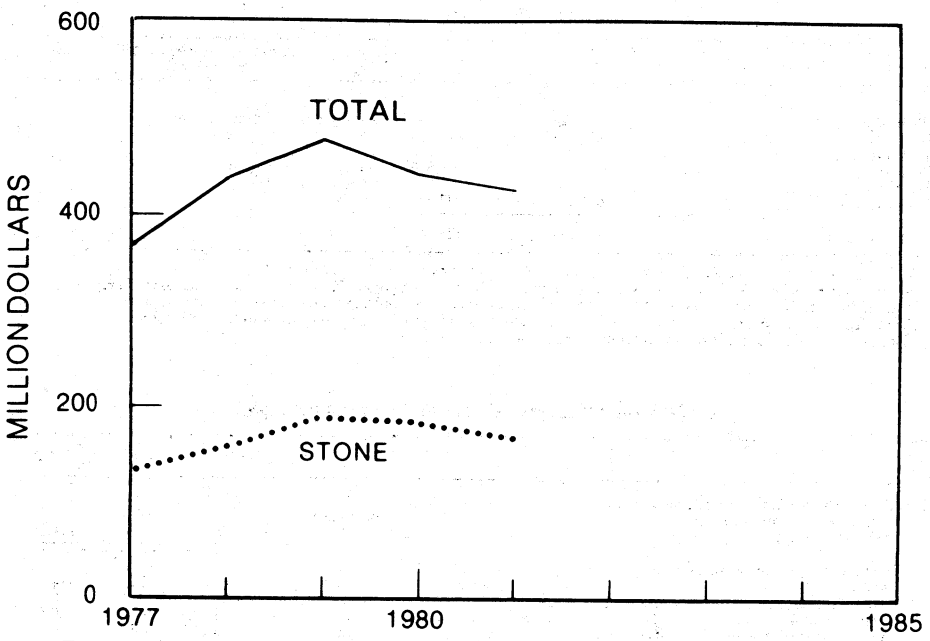

Figure 1.—Value of stone and total value of nonfuel mineral production in Illinois

Trends and Developments.—For the second consecutive year, nonfuel mineral production in Illinois declined because of the faltering economy and the depressed state of the construction industry. Output of mineral commodities used in construction (stone, sand and gravel, cement, and clays) dropped below that of 1980. The U.S. Department of Commerce reported a 42% drop, compared with 1980 levels, in the number of residential units (public and private) for which construction permits were issued, and a 78.6% drop compared with 1978 levels. Also, the value of private nonresidential construction dropped 3.2% below 1980 figures.

Illinois' manufacturing sector was also affected significantly by the recession. Steel mills operated below capacity for most of the year because of reduced demand for steel by the automotive industry and other durable goods manufacturers. Although most steel firms reported a slight gain in shipments from 1980 to 1981, steel production in the latter half of the year plummeted, resulting in many employee layoffs. According to the American Iron and Steel Institute, foreign imports accounted for a record 19.1% of all steel sold in the United States in 1981.

Early in the year, the U.S. Economic Development Administration (EDA) became the owner of Wisconsin Steel Co., South Chicago, at auction proceedings of a Federal bankruptcy court. Wisconsin Steel closed in March 1980, idling 3,500 workers, when the company and its corporate parent, Envirodyne Industries, Inc., filed for protection from creditors under chapter 11 of the Federal bankruptcy laws.

In February, Inspiration Mines, Inc., an affiliate of Inspiration Consolidated Copper Co., acquired the holdings of Eagle-Picher Industries, Inc., in the Upper Mississippi Valley zinc-lead district. The purchase included four inactive mines in Wisconsin and about 10,000 acres of mining leases in Illinois and Wisconsin. The firm drilled nine exploration holes in Jo Daviess County in 1981.

In April, Ball Corp. of Muncie, Ind., closed its glass container plant at Mundelein, north of Chicago, in an effort to streamline operations and improve profitability. Approximately 475 employees were affected by the closure.

Also in April, Ray E. Friedman & Co., a Chicago-based commodity brokerage firm, purchased Simmons Refining Co. of Chicago. Simmons, a precious metals refiner,

had one plant in Chicago and scrap collection facilities throughout the United States.

In June, United Refining & Smelting Co., a subsidiary of Diversified Industries, Inc., completed expansion of its precious metals recycling facility in Franklin Park, a suburb of Chicago. New furnaces were added, increasing capacity of the operation by about 50%. Gold, silver, and other precious metals are recycled from industrial scrap.

Alcan Aluminum Corp. began production at its new aluminum powders plant at Joliet in June. The plant is part of a $10 million expansion program at the Joliet site under which the existing secondary smelter was also expanded.

In July, Gulf + Western Industries, Inc., announced the sale of its zinc dust plant in Depue to a group of private investors. The property was one of the firm's New Jersey Zinc Co. assets.

The U.S. Army Corps of Engineers began construction on lock and dam No. 26, near Alton, on the Mississippi River. Scheduled for completion in 1989, the facility is expected to improve shipments of mineral commodities on the river. Also, at Cora, south of St. Louis, a new rail-to-barge mineral transshipment facility came onstream that is capable of moving 15 million tons per year.

Three railway companies—Seaboard Coastline Railroad, Louisville & Nashville Railroad, and Illinois Central Gulf Railroad—signed a 5-year contract with Olin Corp. to transport Florida phosphate to the Olin chemical plant in Joliet. Fertilizer additives and other chemicals are manufactured at the plant.

Late in the year, American Shipbuilding Co. shut down its drydock repair facility in southeast Chicago on the Calumet River. The facility was closed because of the lack of repair orders and the firm's inability to handle the larger Great Lakes vessels that transport iron ore.

Legislation and Government Programs.—Several Illinois Senate and House bills related to mining and mineral resources were enacted into law in 1981. House bill 0134 amended the State's Surface-Mined Land Conservation and Reclamation Act and the Environmental Protection Act to provide for exclusive State control over reclamation standards and procedures, but does not preempt local control over the commencement, location, and operation of surface mining operation. Senate bill 0899 amended an existing act to allow the Board of Natural Resources and Conservation to consider and decide all matters pertaining to natural history, geology, water and water resources, forestry, and allied research, investigations, and scientific work. Senate bill 0900 changed the name of the State's Institute of Natural Resources to the Department of Energy and Natural Resources.

Two laws were enacted that could affect the taxes paid by mining companies. Senate bill 0477 amended the Income Tax Law to provide an investment tax credit for mining and manufacturing firms. Senate bill 0486 amended the Revenue Act of 1939 to allow local taxing districts the right to abate property taxes of industrial firms locating within a county from another State or country or for expanding existing facilities.

The Governor also created by executive order the Illinois Energy Review Board to streamline the permit process for private industries interested in building facilities that will expand the Illinois coal market.

During the year, Southern Illinois University at Carbondale, the State's Mining and Mineral Resources and Research Institute, was awarded approximately $365,000 in grants by the U.S. Office of Surface Mining Reclamation and Enforcement (OSM) for new and continued research projects. The projects included studies of the recovery and utilization of coal fines, reclamation of prime farmlands, and environmental impacts of coal mine and waste.

The State Geological Survey Division continued its research function in basic geology, geochemistry, hydrology, mineral resources, mineral economics, and environmental geology. Several reports were published during the year on Illinois' mineral resources. In October, the State Survey dedicated its newly remodeled Applied Research Laboratory for Illinois coal and minerals.

OSM awarded Illinois a $1.1 million grant to support the State's interim surface coal mining reclamation program. The grant, effective March 1 through September 30, was administered by the Land Reclamation Division of the Illinois Department of Mines and Minerals.

The U.S. Bureau of Mines had several active contracts and grants with industrial firms, educational institutions, and consulting firms during the year. Research was conducted on various types of mining equipment, mine health and safety, mineral re-

sources, and environmental impacts of mining. Funding for these projects totaled approximately $1.8 million. In conjunction with the U.S. Forest Service's Roadless Area Review and Evaluation (RARE II) program, the Bureau of Mines released an open file report (MLA 32-81) on the Burden Falls RARE II Further Planning Area. Field investigations and analytical studies found mineral potential to be low in the area.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Abrasives.—Illinois ranked first of four States in the production of tripoli, a natural abrasive. Two underground mines operated by Illinois Minerals Co. and Tammsco, Inc., in Alexander County accounted for the State's production. Compared with 1980 figures, production declined about 18% in quantity and 11% in value, mainly because of the slowdown in the general economy. Tripoli was used as a soft abrasive in buffing and polishing compounds and as a filler. Most of the tripoli was processed in the State.

ESK Corp., a subsidiary of Wacker Chemical Co., produced silicon carbide, an artificial abrasive, at its plant near Hennepin, Putnam County. The product was used as an abrasive, as a refractory material, and in metallurgical applications.

During the year, Universal Grinding Wheel Co. of Horsham, Pa., began expanding its bonded abrasive plant at Salem, in south-central Illinois. The firm, which makes grinding wheels, invested in new presses and finishing equipment, increased capacity of oven and kiln facilities, and enlarged the plant building.

Barite.—Inverness Mining Co., a subsidiary of Seaforth Mineral & Ore Co., Cleveland, Ohio, and Ozark-Mahoning Co. recovered barite as a byproduct at their fluorspar operations in Hardin County. Production and value increased approximately 33% and 27%, respectively, compared with those of 1980. Some of the increased production can be attributed to the new Ozark-Mahoning Denton Mine, which came onstream in August; in addition, Inverness Mining did not produce barite during part of 1980. Barite was used as a weighting agent in drilling muds and in the manufacture of paint, rubber, glass, and barium chemicals.

Cement.—Gray portland cement was manufactured by four companies in 1981. Illinois Cement Co., a subsidiary of Centex Corp., and Marquette Co., a division of Gulf + Western, operated plants in La Salle County, in north-central Illinois. Lone Star Industries, Inc., operated a plant at Dixon in adjoining Lee County; Missouri Portland Cement Co., a plant at Joppa in Massac County, in southeastern Illinois. Lone Star was the only producer of white portland and masonry cement during the year.

Total shipments of cement declined because of the continued depressed construction industry. All Illinois cement producers reported some downtime for their kilns during the year owing to either maintenance and repairs or high inventories. Cement was shipped to ready-mix concrete companies, concrete products manufacturers, highway contractors, building material dealers, and miscellaneous customers. Cement was transported to consumers mainly by truck.

Table 4.—Illinois: Portland cement salient statistics

(Short tons)

	1980	1981
Number of active plants	4	4
Production	1,767,582	1,701,207
Shipments from mills:		
Quantity	1,648,674	1,573,750
Value	$75,315,222	$61,536,383
Stocks at mills, Dec. 31	254,703	360,618

Lone Star's rehabilitation of the Dixon plant was nearly completed at yearend. The improvements included modernizing the homogenizing and feeder systems, installing new kiln shell sections, and upgrading coal-grinding equipment.

During the year, Gulf + Western's Natural Resources group donated 16.7 acres of land to the Nature Conservancy on behalf of Marquette Co. The land was at the company's Marquette plant site near Oglesby and will be used to further the conservancy's goals of protecting natural areas and wildlife.

In another action, Medusa Cement Co., Cleveland, Ohio, began construction on a $6 million cement distribution facility on a 10-acre site leased from the Port of Chicago at Lake Calumet. Scheduled for completion in 1982, the facility will receive cement shipped by lake freighter from Medusa's Charlevoix, Mich., plant.

Clays.—In 1981, 13 companies produced clay in 9 Illinois counties. Common clay accounted for most of the State's production, followed by fuller's earth (absorbent clay) and fire (refractory) clay. Total clay production was down for the year owing to the depressed economy and decrease in construction.

Of the seven counties in which common clay was mined, Livingston County led in production. Common clay was used in the manufacture of cement, common brick, face brick, sewer pipe, and drain tile.

As in 1980, Illinois ranked fourth of nine States in the production of fuller's earth. Two companies mined fuller's earth in Pulaski County, in the southernmost part of the State. Fuller's earth was used as an oil and grease absorbent, for animal litter, and as a paper filler.

Fire clay was mined by one company in Grundy County in north-central Illinois. Major uses were for firebrick and other refractory products.

Fluorspar.—Illinois led the Nation in fluorspar shipments, followed by Nevada and Texas. Production and value increased 23% and 45%, respectively, over those of 1980. Three companies mined in the southeastern Illinois fluorspar district during the year. Hastie Mining Co. operated a surface mine near Cave In Rock in Hardin County and produced a metallurgical-grade gravel spar. Inverness Mining, a subsidiary of Seaforth Mineral & Ore Co. of Cleveland, Ohio, and Ozark-Mahoning operated underground mines near Cave In Rock and produced both acid- and metallurgical-grade fluorspar.

Ozark-Mahoning completed developmental work at its Denton Mine and began production in August; work continued on the development of the Henson Mine in Pope County. Inverness Mining cut back production late in the year to reduce inventories.

Gem Stones.—Value of gem stones and mineral specimens collected by mineral dealers and amateur collectors was estimated at $15,000 in 1981.

Gypsum.—Crude gypsum, imported from Michigan, was calcined by National Gypsum Co. at its plant in Waukegan, just north of Chicago, for use in wallboard. Production decreased about 8% from 1980 to 1981 mainly because of the depressed housing industry.

Iron and Steel Slag.—Illinois ranked ninth of 20 States in the production of processed iron and steel slag. Sales declined in both quantity and value from 1980 to 1981. A byproduct of steelmaking, slag was processed for use as construction aggregate.

Lime.—Illinois ranked seventh in output among the 39 lime-producing States. Marblehead Lime Co., an operating unit of General Dynamics Corp., produced quicklime and hydrated lime at plants in South Chicago and Thornton in Cook County; Vulcan Materials Co. also produced quicklime at a plant in Cook County. Output and value increased about 20% and 29%, respectively, compared with those of 1980, partly because of Marblehead's new rotary kiln, which went onstream at the South Chicago plant. Lime was used in steelmaking and for industrial sewage and waste treatment, water purification, and road stabilization.

Peat.—Nationally, Illinois continued to rank fourth, behind Michigan, Florida, and Indiana, in peat production. Peat was mined by five companies in Cook, Lake, and Whiteside Counties; the latter, in northwestern Illinois, led in production. Sales declined in both quantity and value from 1980 to 1981, reflecting the general decline in the economy. Types of peat produced were reed sedge, humus, and hypnum and sphagnum moss. Peat was sold in bulk and packaged form for general soil improvement purposes, earthworm culture, as an ingredient in potting soil, and to golf courses and nurseries.

Perlite.—Illinois ranked third of 32

States in sales of expanded perlite, after leading the Nation in 1980. Quantity and value dropped 16% and 11%, respectively, because of the continued decline in the construction industry. Crude perlite, imported from other States, was expanded by five companies in four counties in the northeastern corner of the State. Will County led the State in sales of expanded perlite. Perlite was used in concrete and plaster aggregate, for insulation, as a filter aid, and for horticultural purposes.

Sand and Gravel.—In late 1980, the U.S. Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but complete data on industrial sand and gravel. Estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

In 1981, Illinois was estimated to rank seventh nationally in the production of construction sand and gravel, and ranked first in industrial sand production. Total production and value declined for the second consecutive year because of the depressed economy and reduced construction activity. About 84% of the State's sand and gravel output was used in construction, accounting for about 59% of the value. The remainder was used in industrial applications. Most sand and gravel was shipped to consumers by truck.

Industrial sand was produced by five companies in La Salle and Ogle Counties. Both output and value increased from 1980 to 1981. Major sales were for foundry use, glass container manufacture, flat glass manufacture, hydraulic fracturing, refractory use, and chemicals.

During the year, the Chamber of Commerce of Ottawa, La Salle County, began promoting the town as the industrial sand capital of the world. The town and its environs historically have supported a thriving industrial sand industry.

Table 5.—Illinois: Sand and gravel sold or used by producers

Use	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	12,939	$34,891	$2.70	NA	NA	NA
Gravel	14,155	43,619	3.08	NA	NA	NA
Total or average	27,094	78,510	2.90	[p]23,900	[p]$69,800	[p]$2.92
Industrial sand	4,631	43,822	9.46	4,646	49,186	10.59
Grand total or average	31,725	122,332	3.86	[p]28,546	[p]118,986	[p]4.17

[p]Preliminary. NA Not available.

Stone.—In 1981, Illinois ranked fourth, behind Texas, Florida, and Pennsylvania, in stone production. Stone was the leading nonfuel mineral commodity produced in the State in terms of value, although sales dropped for the second consecutive year mainly because of the decline in construction. Limestone continued to be the only type of stone mined.

Crushed stone was mined in 57 counties at 196 quarries. Cook County led the State in production. Six operations, each producing more than 1 million tons, accounted for about 35% of the State's output. Most crushed stone produced in Illinois was shipped to market by truck, followed by rail and barge.

A small amount of dimension stone was produced by one company in Kane County, in northeastern Illinois. Sales were for rubble, flagging, and house veneer.

During the year, Vulcan Materials Lemont operation on the outskirts of Chicago received a certificate of merit from the National Crushed Stone Association for its efforts in site improvement under the association's About Face Program. Quarry operators are recognized under the program for improvements to the appearance of their property.

Table 6.—Illinois: Crushed limestone sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	5,158	17,647	4,351	16,207
Agricultural marl and soil conditioners	2	6	5	W
Poultry grit and mineral food	175	1,824	167	1,960
Concrete aggregate	7,233	24,520	5,535	20,348
Bituminous aggregate	5,728	19,972	4,362	16,814
Macadam aggregate	2,109	6,802	1,717	5,956
Dense-graded road base stone	16,605	53,446	13,658	47,844
Surface treatment aggregate	3,550	11,649	2,888	10,149
Other construction aggregate and road stone	6,022	18,177	4,638	15,791
Riprap and jetty stone	631	1,974	388	1,403
Railroad ballast	857	2,634	943	4,768
Filter stone	W	W	9	30
Manufactured fine aggregate (stone sand)	259	1,241	337	1,026
Cement manufacture	2,597	6,453	2,759	6,093
Flux stone	586	1,994	619	2,869
Asphalt filler	65	526	40	226
Other fillers or extenders	599	8,143	645	10,044
Fill	15	46	W	W
Other[1]	1,118	3,602	1,098	3,684
Total	53,309	180,656	44,159	[2]165,218

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes stone used for filter stone (1980), lime manufacture, mine dusting, whiting or whiting substitutes (1981), roofing granules (1981), sulfur removal from stack gases (1981), and other uses not specified.
[2]Data do not add to total shown because of independent rounding.

Table 7.—Illinois: Crushed limestone sold or used by producers, by county

(Thousand short tons and thousand dollars)

County	1980		1981	
	Quantity	Value	Quantity	Value
Adams	985	10,340	1,040	12,410
Brown	182	738	100	441
Bureau	40	109	32	93
Calhoun	37	87	30	86
Carroll	336	970	241	748
Cass	—	—	78	228
Clay	264	1,078	W	W
Clinton	99	230	7	17
Du Page	427	1,495	W	W
Hancock	615	1,733	454	1,417
Hardin	2,308	5,850	2,205	5,746
Henry	460	1,877	412	1,818
Jersey	95	W	W	W
Jo Daviess	375	775	304	784
Kane	1,083	3,352	743	3,036
La Salle	2,265	6,668	2,152	6,450
Lee	1,165	3,787	1,076	2,962
Madison	830	2,828	770	2,819
Mercer	183	296	62	109
Montgomery	1,221	4,058	663	2,250
Ogle	859	2,604	627	1,862
Peoria	169	633	173	657
Pike	618	2,151	518	1,962
Rock Island	1,405	5,527	1,030	4,296
St. Clair	2,412	7,112	1,722	5,363
Shelby	35	117	35	128
Stephenson	354	1,001	252	751
Whiteside	439	1,233	120	370
Will	4,960	15,645	3,917	14,337
Winnebago	799	1,881	429	1,620
Undistributed[1]	28,286	96,482	24,964	92,458
Total[2]	53,309	180,656	44,159	165,218

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Includes Boone, Christian, Clark, Coles, Cook, De Kalb, Douglas, Fayette, Greene, Henderson, Jackson, Johnson, Kankakee, Kendall, Livingston, Logan, McDonough, Menard, Monroe, Pulaski, Randolph, Schuyler, Scott, Union, Vermilion, Warren, and Washington Counties.
[2]Data may not add to totals shown because of independent rounding.

Sulfur.—Elemental sulfur was recovered as a byproduct by six companies in seven counties. Shipments amounted to 216,000 metric tons valued at $19.7 million in 1981.

Vermiculite.—Crude vermiculite imported from out of State was exfoliated by W. R. Grace & Co., Du Page County; Mica Pellets, Inc., De Kalb County; and International Vermiculite Co., Macoupin County. Shipments increased about 6% in quantity and about 9% in value from 1980 to 1981. Sales were for loosefill and block insulation, concrete and plaster aggregate, fireproofing, and horticultural applications.

METALS

Iron Oxide Pigments.—Shipments of finished iron oxide pigments originated from Adams, Kane, St. Clair, and Sangamon Counties and were used mainly in paints and coatings. In 1981, Pfizer, Inc., announced a $50 million program to increase production capacity that includes its plant at East St. Louis.

Iron and Steel.—Illinois ranked fifth of 14 States in quantity and value of pig iron shipments. Shipments totaled 4.5 million tons valued at $929 million, reflecting a slight increase in quantity and a 9% increase in value compared with 1980 levels. Declining sales, however, during the last quarter of 1981 forced cutbacks in production and personnel layoffs.

During the year, several steel companies made plans to upgrade plants and facilities. United States Steel Corp., the Nation's largest steelmaker, announced a new multimillion-dollar rail mill at its South Works in Chicago, scheduled for startup in late 1983. When in full operation, the mill is expected to produce more than 700,000 tons of rail annually and employ about 1,000 workers. The program will mark the first major investment in South Works in a decade.

Republic Steel Corp., the fifth largest steel producer in the Nation, announced at yearend a $112 million capital improvement program, with $77 million allotted for its Chicago plant. The company plans to modernize its seamless tube mill to improve pipe quality and increase capacity.

Northwestern Steel & Wire Co., the Nation's 12th largest steelmaker, announced it will spend $25 to $30 million to add two continuous casters at its mill in Sterling, Whiteside County. The casters were expected to reduce energy costs by about $20 per ton.

Early in 1981, EDA took title to Wisconsin Steel, South Chicago, at a Federal bankruptcy court auction. Wisconsin Steel was shut down in March 1980, idling 3,500 hourly workers, when the company and its corporate parent, Envirodyne Industries, Inc., filed for protection from creditors under chapter 11 bankruptcy proceedings. EDA later sold the firm's cold-finishing mill to La Salle Steel Co., Hammond, Ind., for $1.4 million. The mill will be dismantled, rebuilt, and relocated, and was expected to be operational by the latter half of 1982.

Lead, Silver, and Zinc.—Inverness Mining and Ozark-Mahoning recovered minor amounts of lead, silver, and zinc as coproducts at their fluorspar operations in Hardin County, in southern Illinois. Output and value of all three metals increased from 1980 to 1981.

Gould, Inc., Rolling Meadows, shut down its secondary lead smelter at Savanna, Carroll County, in July while new battery-breaking equipment was being installed. The plant has an annual capacity of 60,000 tons.

AMAX Inc.'s wholly owned refinery in Sauget, south of East St. Louis, produced a record 74,600 tons of refined zinc in 1981, as well as 930,000 pounds of byproduct cadmium. The electrolytic zinc plant treats zinc concentrates produced by the company's mine at Buick, Mo., as well as concentrates purchased from others. During 1981, the refinery was the successful bidder for about 6,000 tons of refined zinc and alloy to be used by the U.S. Mint for its initial zinc-alloy penny coin production in 1982.[3]

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[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]Liaison program assistant, Bureau of Mines, Pittsburgh, Pa.
[3]AMAX Inc. 1981 Annual Report. P. 20.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasives, tripoli:			
Illinois Minerals Co	2035 Washington Ave. Cairo, IL 62914	Underground mine.	Alexander.
Tammsco, Inc	Box J Tamms, IL 62988	____do ____	Do.
Cement:			
Illinois Cement Co., a subsidiary of Centex Corp.	Box 442 La Salle, IL 61301	Plant	La Salle.
Lone Star Industries, Inc	East River Rd. Dixon, IL 61021	____do ____	Lee.
Marquette Co., a division of Gulf + Western Industries, Inc.	Portland Ave. Oglesby, IL 61348	____do ____	La Salle.
Missouri Portland Cement Co	Box 147 Joppa, IL 62953	____do ____	Massac.
Clay and shale:			
Absorbent Clay Products Co	Box 120 Anna, IL 62906	Pits and plant	Pulaski.
American Brick Co	6558 West Fullerton Ave. Chicago, IL 60635	Pit and plant	Cook.
Lowe's, Inc	Box 68 Olmsted, IL 62970	____do ____	Pulaski.
Valley View Dirt & Gravel Co	R.F.D. 1 Cornell, IL 61319	____do ____	Livingston.
Fluorspar:			
Hastie Mining Co	Cave In Rock, IL 62919	Open pit	Hardin.
Inverness Mining Co., a subsidiary of Seaforth Mineral & Ore Co.[1]	____do	Underground mines, mill, plant.	Do.
Ozark-Mahoning Co.[1]	Box 57 Rosiclare, IL 62982	____do ____	Hardin and Pope.
Gypsum:			
National Gypsum Co	515 Sea Horse Dr. Box 139 Waukegan, IL 60085	Plant	Lake.
Iron oxide pigments, finished:			
Pfizer, Inc	2001 Lynch Ave. East St. Louis, IL 62201	____do ____	St. Clair.
Prince Manufacturing Co., Inc	700 Lehigh St. Bowmanstown, PA 18030	____do ____	Adams.
Iron and steel:			
Granite City Steel Div. of National Steel Corp.	20th and State Sts. Granite City, IL 62040	Iron and steel furnaces.	Madison.
Interlake, Inc	13500 South Perry Ave. Riverdale, IL 60627	Iron furnaces	Cook.
Republic Steel Corp	Suite 550, Commerce Plaza Oak Brook, IL 60521	Iron and steel furnaces.	Do.
United States Steel Corp	3426 East 89th St. Chicago, IL 60617	____do ____	Do.
Lime:			
Marblehead Lime Co	300 West Washington St. Chicago, IL 60606	Plants	Do.
Vulcan Materials Co	Joliet Rd. and 53d St. McCook, IL 60525	Plant	Do.
Peat:			
Anderson Peat Co. of Illinois	R.R. 3 Morrison, IL 61270	Bog and processing plant.	Whiteside.
Markman Peat Co	Route 3 Morrison, IL 61270	____do ____	Do.
Perlite, expanded:			
Johns-Manville Perlite Corp	Route 6, Box 864 Joliet, IL 60434	Plant	Will.
Silbrico Corp	6300 South River Rd. Hodgkins, IL 60525	____do ____	Cook.
Sand and gravel:			
Elmhurst-Chicago Stone Co	400 West 1st St. Box 57 Elmhurst, IL 60126	Pits and plants	Du Page, Kane, Will.
Material Service Corp., a subsidiary of General Dynamics Corp.	300 West Washington St. Chicago, IL 60606	____do ____	Grundy, Kane, McHenry.
Meyer Aggregate	Box 56, Route 2 Algonquin, IL 60102	____do ____	Kane and McHenry.
Thelen Sand & Gravel	28955 West Rt. 173 Antioch, IL 60002	Pit and plant	Lake.
Vulcan Materials Co	500 Plainfield Rd. Box 6 Countryside, IL 60525	Pits and plants	Cook and McHenry.
Stone:			
Anna Quarries, Inc	Box 180 Anna, IL 62906	Quarry and plant	Union.
Columbia Quarry Co	Box 128 Columbia, IL 62236	Quarries and plants.	Monroe and Pulaski.
Material Service Corp., a subsidiary of General Dynamics Corp.	300 West Washington St. Chicago, IL 60606	Underground mine, quarries, plants.	Cook, Vermilion, Will.

See footnotes at end of table.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone —Continued			
Medusa Aggregates Co., a subsidiary of Crane Co.	Box 5529 Lafayette, IN 47903	Quarries and plants.	Clark, Henderson, Kankakee, Livingston.
Moline Consumers Co	313 16th St. Moline, IL 61255	____do	Rock Island.
Vulcan Materials Co	500 Plainfield Rd. Box 6 Countryside, IL 60525	____do	Cook and Will.
Sulfur, recovered elemental:			
Marathon Oil Co	Robinson, IL 62454	Plant	Crawford.
Mobil Oil Corp	Box 874 Joliet, IL 60434	____do	Will.
Union Oil Co. of California	1650 East Golf Rd. Schaumburg, IL 60196	____do	Cook.
Vermiculite, exfoliated:			
W. R. Grace & Co	6051 West 65th St. Bedford Park, IL 60638	____do	Du Page.
International Vermiculite Co	1st and Mound Sts. Girard, IL 62640	____do	Macoupin.
Mica Pellets, Inc	1120 Oak St. De Kalb, IL 60115	____do	De Kalb.

[1]Also barite, lead, silver, and zinc.

The Mineral Industry of Indiana

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

By James J. Hill[1] and Robert J. Tuchman[2]

The value of Indiana's nonfuel mineral production was $259 million in 1981. For the second consecutive year, value dropped below the record $317 million set in 1979. Nationally, Indiana ranked 26th in value of total nonfuel mineral output and led in pig iron shipments. The State ranked third in the production of masonry cement and peat and fourth in iron and steel slag. Other commodities produced were natural abrasives, portland cement, clays, gypsum, lime, sand and gravel, and stone. The State is a major producer of steel and has one primary aluminum smelter. Sulfur was recovered as a byproduct at oil refining operations. Fluorspar and perlite were among the mineral commodities brought into the State for processing.

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

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:					
Masonry	thousand short tons	W	W	252	$10,972
Portland	do.	1,769	$73,049	1,538	59,344
Clays	do.	932	1,930	691	1,602
Gem stones		--	--	NA	1
Peat	do.	84	1,414	105	3,140
Sand and gravel	do.	22,031	52,939	p20,457	p49,979
Stone:					
Crushed	do.	30,910	92,106	25,349	79,910
Dimension	do.	161	14,046	145	13,672
Combined value of abrasives (natural), gypsum, lime, and value indicated by symbol W		XX	52,986	XX	40,212
Total		XX	288,470	XX	258,832

pPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Adams	W	W	Stone, sand and gravel.
Allen	W	W	Stone, sand and gravel, peat.
Bartholomew	W	W	Stone, sand and gravel.
Blackford	W	W	Stone.
Boone	W	W	Sand and gravel.
Carroll	W	W	Stone, sand and gravel.
Cass	W	W	Cement, stone, sand and gravel, clays.
Clark	W	W	Do.
Clay	W	$619	Clays.
Clinton	W	W	Sand and gravel.
Crawford	$8,148	7,789	Stone.
Daviess	263	W	Sand and gravel.
Dearborn	W	W	Do.
Decatur	W	W	Stone.
De Kalb	942	768	Sand and gravel.
Delaware	W	W	Stone, sand and gravel.
Dubois	7	W	Clays.
Elkhart	795	1,007	Sand and gravel, stone.
Fayette	528	W	Sand and gravel.
Floyd	W	W	Do.
Fountain	W	1,470	Sand and gravel, clays.
Franklin	W	W	Stone, sand and gravel.
Fulton	255	W	Sand and gravel, peat.
Gibson	W	W	Sand and gravel.
Grant	W	W	Stone, sand and gravel.
Greene	W	W	Sand and gravel.
Hamilton	W	W	Stone, sand and gravel, peat.
Hancock	W	W	Sand and gravel.
Harrison	W	W	Stone, sand and gravel.
Henry	W	W	Sand and gravel.
Howard	W	987	Do.
Huntington	W	W	Stone, sand and gravel, clays.
Jackson	W	W	Sand and gravel, clays.
Jasper	1,938	W	Sand and gravel, stone, peat.
Jay	W	W	Stone, sand and gravel.
Jennings	W	W	Stone.
Johnson	183	168	Sand and gravel.
Knox	1,240	1,089	Do.
Kosciusko	1,559	W	Sand and gravel, peat.
Lagrange	384	W	Sand and gravel.
Lake	47,146	W	Lime, cement.
La Porte	W	W	Sand and gravel, peat.
Lawrence	W	W	Cement, stone.
Madison	W	W	Stone, sand and gravel.
Marion	W	9,403	Sand and gravel, stone.
Marshall	W	W	Sand and gravel.
Martin	W	W	Gypsum.
Miami	W	W	Stone, sand and gravel.
Monroe	W	9,959	Stone.
Montgomery	W	W	Sand and gravel, clays.
Morgan	W	W	Sand and gravel, clays, stone.
Newton	W	3,160	Stone.
Noble	W	W	Sand and gravel, stone.
Ohio	W	8	Sand and gravel.
Orange	W	W	Stone, abrasives.
Owen	W	W	Stone, sand and gravel.
Parke	W	W	Sand and gravel, clays.
Perry	W	2,419	Stone.
Porter	W	W	Sand and gravel, clays.
Posey	15	--	
Pulaski	W	W	Stone.
Putnam	36,214	31,434	Cement, stone, clays, sand and gravel.
Randolph	W	W	Stone, sand and gravel.
Ripley	1,626	W	Stone.
Rush	725	W	Stone, sand and gravel.
St. Joseph	2,778	2,847	Sand and gravel, stone, peat.
Scott	W	W	Stone.
Shelby	2,620	W	Stone, sand and gravel.
Steuben	775	803	Sand and gravel, stone.
Sullivan	W	W	Do.
Switzerland	W	W	Do.
Tippecanoe	W	W	Sand and gravel.
Tipton	W	W	Stone.
Union	--	W	Sand and gravel.
Vanderburgh	191	175	Do.
Vermillion	W	W	Sand and gravel, clays.
Vigo	878	W	Sand and gravel.
Wabash	W	W	Do.
Warren	2,360	1,623	Do.
Washington	W	443	Stone.
Wayne	W	W	Sand and gravel, stone.
Wells	W	W	Stone, peat.

See footnotes at end of table.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
White	W	W	Stone.
Whitley	W	W	Sand and gravel.
Undistributed[2]	$205,574	$212,299	
Total	317,144	288,470	

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: Benton, Brown, Hendricks, Jefferson, Pike, Spencer, Starke, and Warrick.

[2]Includes sand and gravel that cannot be assigned to specific counties and values indicated by symbol W.

Table 3.—Indicators of Indiana business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	2,599.2	2,668.4	+2.7
Unemployment	do	235.9	331.9	+40.7
Employment (nonagricultural):				
Mining[1]	do	10.1	9.0	-10.9
Manufacturing	do	658.0	656.9	-.2
Contract construction	do	91.6	86.7	-5.4
Transportation and public utilities	do	105.0	103.5	-1.4
Wholesale and retail trade	do	478.2	469.0	-1.9
Finance, insurance, real estate	do	101.9	101.3	-.6
Services	do	337.1	341.0	+1.2
Government	do	355.2	347.4	-2.2
Total nonagricultural employment[1]	do	2,137.1	2,114.8	-1.0
Personal income:				
Total	millions	$49,112	$52,798	+7.5
Per capita		$8,924	$9,656	+8.2
Construction activity:				
Number of private and public residential units authorized		21,116	14,725	-30.3
Value of nonresidential construction	millions	$718.0	$528.1	-26.4
Value of State road contract awards	do	$93.0	$84.0	-9.7
Shipments of portland and masonry cement to and within the State	thousand short tons	1,408	1,217	-13.6
Nonfuel mineral production value:				
Total crude mineral value	millions	$288.5	$258.8	-10.3
Value per capita, resident population		$53	$47	-11.3
Value per square mile		$7,949	$7,132	-10.3

[p]Preliminary.

[1]Includes bituminous coal and oil and gas extraction.

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

Trends and Developments.—The faltering State and national economies continued to impact Indiana's nonfuel mineral industries during 1981. High interest rates hindered the construction industry, reducing demand for cement, clays, gypsum, sand and gravel, and stone. The U.S. Department of Commerce reported a 30.3% drop in the number of construction permits issued for residential units (public and private) compared with 1980 levels. Also, the value of private nonresidential construction dropped 26.4% below 1980 figures.

Indiana's manufacturing sector also suffered setbacks during the year. Most steel mills operated below capacity, and depressed sales in the last quarter of 1981 forced several mills to reduce production and lay off personnel. However, several producers announced plans for modernization or continued ongoing expansion programs during the year.

Although an 11-day strike in April by employees on Great Lakes vessels slowed deliveries of mineral commodities to Indiana steel mills, the Indiana Port Commission reported that record amounts of cargo passed through the State's two ports during the year. Compared with 1980 levels, cargo handled at Burns Waterway Harbor on Lake Michigan increased 11.6%. The Southwind Maritime Center, a partially completed port on the Ohio River near Mount Vernon, recorded a 56% increase in cargo.

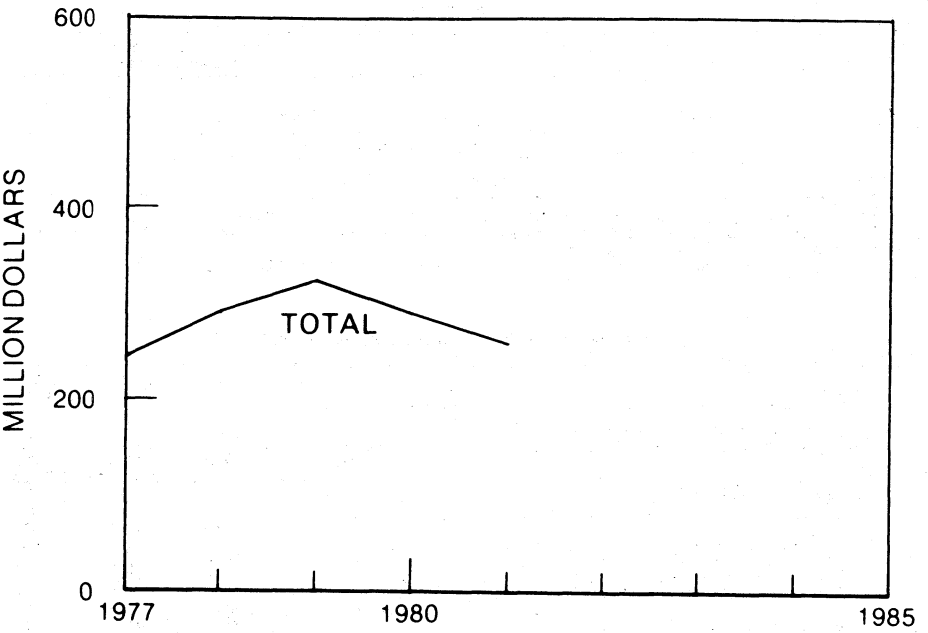

Figure 1.—Total value of nonfuel mineral production in Indiana.

In October, Indiana and Kentucky settled their Ohio River boundary dispute and reestablished the border as it existed in 1792. The agreement was expected to bring millions of dollars in tax revenue to Indiana and allow for construction of the Clark Maritime Center, a new port proposed near Jeffersonville. A permit for work on the port was issued in 1979 by the U.S. Army Corps of Engineers.

Early in the year, Exmin Corp., a U.S. subsidiary of the Belgian diamond mining company Sibeka, of the Société Générale de Belgique Group, established offices and began construction of a geological laboratory in Bloomington. The firm was conducting exploration programs in several States for diamonds and other minerals.

In Jay County, near Portland, Wulfrath Resources, Inc., began investigating the feasibility of establishing a refractory brick plant because of the availability of high-quality dolomite and accessibility to area glass industries. The Jay County Council approved a $10 million inducement resolution for low-interest-rate economic development bonds for the firm's purchase of a quarry and construction of the refractory plant.

Legislation and Government Programs.—Several laws were enacted during the year that relate to the mineral industry.

Public Law 54 removed Lake George in Whiting, Lake County, from the jurisdiction of the Indiana Department of Natural Resources, which could lead to the authorization of a sand mining operation at the lake.

Public Law 59 amended an existing law concerning steel procurement for public works projects. State agencies are allowed to use a price differential of 25% rather than 15% if an agency determines that the use of domestic steel will benefit the local or State economy.

Public Law 66 raised the gross weight limit of trucks operating on highways to 80,000 pounds, increased registration fees, and extended criminal liability to shippers for overweight trucks.

Public Law 153 amended Indiana's law regulating coal, clay, and shale surface mining to conform more closely to the Federal Surface Mining Control and Reclamation Act of 1977.

Public Law 331 authorized the Indiana Department of Natural Resources to enforce section 502 of the Federal Surface Mining Control and Reclamation Act of 1977 until June 30, 1983.

On a Federal level, the U.S. Supreme Court upheld the Federal Government's strip mining law, which had been challenged by Indiana and Virginia. Two rulings by lower courts that had invalidated major portions of the act were overturned by a unanimous decision. In another action, the U.S. Supreme Court heard arguments over whether an Indiana law, the Dormant Mineral Interests Act, was unconstitutional. The act cancels severed mineral interests to a property after 20 years unless a claim is recorded during a 2-year grace period. The Court was expected to rule on the case in early 1982.

At Purdue University in West Lafayette, the State's Mining and Mineral Resources and Research Institute was awarded $380,000 in grants for fiscal year 1981 by the U.S. Office of Surface Mining Reclamation and Enforcement (OSM) for two continuing studies on mined land reclamation. Also, OSM awarded the Indiana Department of Natural Resources a $740,000 grant to plan for reclamation of abandoned coal mines in the State.

The Indiana Geological Survey, Department of Natural Resources, continued to provide information to the public, industry, and government agencies on Indiana's mineral resources. Three mineral producer directories were published during the year covering dimension stone, sand and gravel, and clay, shale, and ceramic plant operations.

In fiscal year 1981, the Federal Government returned approximately $115,200 to the State for its share of funds generated by activities on national forest lands (timbering, minerals leasing, and recreation fees). To comply with a State law enacted in 1980, the area within the Hoosier National Forest purchase boundary was reduced to 429,908 acres during the year. The forest was established in 1935 and consists of 188,013 acres of national forest land. No action was taken by the U.S. Congress in 1981 on two areas in the forest nominated for wilderness status under the U.S. Forest Service's Roadless Area Review and Evaluation (RARE II) program.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Abrasives.—Hindostan Whetstone Co., Indiana's only producer of natural abrasives, continued to quarry sandstone near Orleans, Orange County, for shaping into cuticle removers and sharpening stones.

Two companies reported production of metallic abrasives in 1981. Wheelabrator-Frye, Inc., manufactured aluminum shot, chilled iron shot and grit, annealed iron shot and grit, and steel shot and grit in St. Joseph County. Jumbo Manufacturing Co. produced chilled iron shot and grit in Marshall County.

Cement.—Nationally, Indiana ranked 15th in portland cement shipments and 3d, behind Pennsylvania and Florida, in masonry cement shipments. Lehigh Portland Cement Co., a subsidiary of Heidelberger Zement AG of the Federal Republic of Germany, operated a plant at Mitchell, Lawrence County, and a distribution terminal at Buffington, Lake County. Lone Star Industries, Inc., operated a plant at Greencastle, Putnam County, and Louisville Cement Co. operated plants at Logansport, Cass County, and Speed, Clark County.

For the second consecutive year, cement shipments in Indiana declined because of the drop in construction activity. All three cement producers in the State reported some downtime for their kilns during the year owing to either maintenance and repairs or high inventories. Most of the cement sold was used by ready-mix concrete companies and concrete-products manufacturers; other sales were to building-material dealers and highway contractors.

Clays.—Nationally, Indiana ranked 18th in the production of common clay and shale in 1981. Production and value declined approximately 26% and 17%, respectively, compared with those of 1980. The drop in output was attributable to the closure of several clay operations and the overall decline in construction activity. Clay was produced by 11 companies in 10 counties; Morgan County led the State in production. Most of the clay was used in cement manufacture and as a lightweight aggregate in concrete block. Other uses included common brick, face brick, sewer pipe, drain tile, flue linings, pottery, and electrical porcelain.

Table 4.—Indiana: Clays sold or used by producers

(Thousand short tons and thousand dollars)

Year	Fire clay		Common clay		Total[1]	
	Quantity	Value	Quantity	Value	Quantity	Value
1977	1	20	1,266	2,216	1,268	2,237
1978	1	15	1,276	2,480	1,277	2,495
1979	1	15	1,184	2,325	1,185	2,341
1980	(2)	3	932	1,927	932	1,930
1981	--	--	691	1,602	691	1,602

[1]Data may not add to totals shown because of independent rounding.
[2]Less than 1/2 unit.

Fluorspar.—Fluorspar was imported from out of State and fabricated into briquets by National Briquet Corp. at its facility in East Chicago, Lake County, for use as flux by the steel industry.

Gypsum.—Nationally, Indiana ranked sixth in the production of both crude and calcined gypsum in 1981. Output and value of crude gypsum declined approximately 16% and 20%, respectively, compared with those of 1980. Production of calcined gypsum dropped 9%, but value increased about 20%. National Gypsum Co. and United States Gypsum Co. mined crude gypsum from underground mines at Shoals, Martin County, in the south-central part of the State. Both firms calcined gypsum at mine-plant sites, and United States Gypsum also calcined gypsum at a plant in Lake County in northwestern Indiana. Most gypsum was used in manufacturing wallboard, with lesser amounts used in the manufacture of cement and plaster products.

Iron and Steel Slag.—Indiana ranked fourth of 20 States in the production of processed iron and steel slag in 1981. One company in Lake County and one in Porter County processed iron and steel slag obtained from area steelmaking centers. Both production and value declined from 1980 to 1981 because of the drop in construction activity. Slag was used mainly as road base, fill, mineral wool, asphalt, and concrete aggregate.

Lime.—Indiana continued to rank eighth among the States in lime production. Production and value increased approximately 5% and 9%, respectively, from 1980 to 1981. Two firms, both in Lake County, produced lime during the year. Marblehead Lime Co. operated a plant at Buffington; Inland Steel Co., a plant at Indiana Harbor. Lime was used mainly in steelmaking and for water treatment.

Peat.—Indiana ranked third, behind Michigan and Florida, in peat production in 1981. Sales increased in both quantity and value over those of 1980. Peat was mined by nine companies in eight counties. La Porte, Hamilton, and Jasper Counties led in production. Peat was sold in bulk and packaged form for general soil improvement, earthworm culture, plant packing, and as an ingredient in potting soil. Bulk sales were also made to nurseries and golf courses.

During the year, Anderson Peat Co. acquired the Organic Products Co. operation in Hamilton County.

Perlite.—Indiana ranked 11th nationally in sales of expanded perlite in 1981. Four companies expanded crude perlite imported from out-of-State sources. United States Gypsum operated plants in Lake and Martin Counties; National Gypsum, a plant in Martin County. Grefco, Inc., and Chemrock Corp. operated plants in Montgomery and Tippecanoe Counties, respectively. Expanded perlite was used mainly as a filter aid, as a paint extender, and for horticultural aggregate. Other uses were as cavity fill insulation and in plaster aggregate.

Sand and Gravel.—In late 1980, the U.S. Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but complete data on industrial sand and gravel. Estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

In 1981, Indiana ranked 11th nationally in the production of construction sand and gravel, based on preliminary data, with output and value decreasing about 7% and 6%, respectively, from 1980 levels. In terms of value, construction sand and gravel was the State's third leading nonfuel mineral

commodity, behind stone and cement.

Indiana ranked 22d of 38 States in industrial sand production in 1981. Output and value decreased slightly compared with those of 1980. Industrial sand was mined by three companies from operations located in La Porte, Porter, and Warren Counties. Major uses were for foundry sand and refractories.

During the year, Martin Marietta Corp. received permission from a local zoning board to establish a mine for foundry sand near Michigan City in northwestern Indiana. Mining was expected to be completed in 6 years, after which the minesite would be reclaimed for housing development around a 32-acre lake.

Table 5.—Indiana: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	11,056	$24,750	$2.24	NA	NA	NA
Gravel	10,716	26,988	2.52	NA	NA	NA
Total or average	21,772	51,738	2.38	p20,200	p$48,800	p$2.42
Industrial sand	259	1,201	4.64	257	1,179	4.59
Grand total or average	22,031	52,939	2.40	p20,457	p49,979	p2.44

pPreliminary. NA Not available.

Stone.—Nationally, Indiana ranked 15th in value of total stone production and 5th in value of dimension stone production in 1981. Stone continued to be the leading nonfuel mineral commodity extracted in the State in terms of value. Limestone was the leading rock-type mined, followed by marl and sandstone.

Crushed limestone was produced in 42 counties at 92 quarries; crushed marl, in 3 counties at 3 quarries. Crawford County led the State in value of crushed stone production; Putnam County had the largest number of operating quarries.

Dimension stone was quarried in 4 counties at 18 operations. Lawrence and Monroe Counties led the State in value of production. One company in Lawrence County quarried dimension sandstone; the remaining dimension stone producers quarried limestone.

Table 6.—Indiana: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	2,446	7,881	1,975	6,929
Agricultural marl	38	317	29	308
Concrete aggregate	6,334	18,128	4,747	14,447
Bituminous aggregate	2,653	8,695	1,676	5,946
Macadam aggregate	1,299	3,989	967	3,203
Dense-graded road base stone	6,593	20,169	5,476	18,295
Surface-treatment aggregate	1,050	3,260	633	2,163
Other construction aggregate and road stone	6,148	17,666	5,939	17,236
Riprap and jetty stone	295	1,021	285	1,067
Railroad ballast	791	2,313	738	2,304
Manufactured fine aggregate (stone sand)	46	141	40	91
Cement manufacture	2,769	5,936	2,461	5,472
Dead-burned dolomite	22	78	--	--
Fill	1	2	W	W
Other[2]	426	2,511	384	2,449
Total[3]	30,910	92,106	25,349	79,910

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

[1]Includes limestone and marl.

[2]Includes stone used for poultry grit and mineral food, filter stone, flux stone, mine dusting, asphalt filler, glass manufacture, other uses not specified, and items indicated by symbol W.

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

Table 7.—Indiana: Crushed stone sold or used by producers, by county

(Thousand short tons and thousand dollars)

County	1980		1981	
	Quantity	Value	Quantity	Value
Allen	1,320	3,793	908	2,624
Bartholomew	754	2,484	480	1,687
Blackford	W	W	--	--
Clark	2,429	6,599	1,736	4,550
Crawford	3,088	7,789	3,325	9,224
Delaware	W	W	244	693
Dubois	--	--	16	46
Elkhart	8	16	W	W
Grant	608	W	W	W
Hamilton	2,576	6,952	2,063	6,039
Harrison	385	1,106	285	941
Howard	--	--	W	W
Lawrence	2,137	6,259	1,568	4,937
Marion	1,373	4,019	W	W
Monroe	1,016	3,271	1,179	3,984
Newton	890	3,160	W	W
Noble	3	8	--	--
Orange	519	1,485	W	W
Perry	904	2,419	W	W
Putnam	2,870	9,229	2,473	8,701
St. Joseph	W	3	1	W
Steuben	W	W	(1)	(1)
Sullivan	17	105	11	66
Switzerland	45	W	W	159
Tipton	W	W	--	--
Washington	176	443	251	809
Wayne	265	996	W	W
Undistributed[2]	9,525	31,970	10,811	35,451
Total[3]	30,910	92,106	25,349	79,910

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Less than 1/2 unit.
[2]Includes Adams, Carroll, Cass, Decatur, Franklin, Huntington, Jasper, Jay, Jennings, Madison, Miami, Morgan, Owen, Pulaski, Randolph, Ripley, Rush, Scott, Shelby, Wells, and White Counties and items indicated by symbol W.
[3]Data may not add to totals shown because of independent rounding.

Table 8.—Indiana: Dimension stone[1] sold or used by producers, by use

Use	1980			1981		
	Short tons	Cubic feet (thousands)	Value (thousands)	Short tons	Cubic feet (thousands)	Value (thousands)
Rough stone:						
Rough blocks	71,853	949	$3,002	71,126	945	$3,056
Irregular-shaped stone	1,818	25	74	3,086	43	144
Rubble	W	W	W	1,800	25	5
Flagging	W	W	W	11,173	154	132
Dressed stone:						
Cut stone	19,827	273	5,236	18,699	258	6,075
Sawed stone	44,152	603	4,784	32,025	442	3,755
House stone veneer	10,623	149	807	6,950	98	503
Flagging	W	W	W	17	(2)	2
Other[3]	12,518	173	144	--	--	--
Total[4]	160,791	2,173	14,046	144,876	1,965	13,672

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone and sandstone.
[2]Less than 1/2 unit.
[3]Includes items indicated by symbol W.
[4]Data may not add to totals shown because of independent rounding.

Table 9.—Indiana: Crushed calcareous marl sold or used by producers

Year	Number of producers	Short tons	Value
1977	7	16,581	$25,901
1978	5	15,029	18,762
1979	4	12,728	19,424
1980	4	13,437	26,764
1981	3	6,087	13,076

During the year, American Aggregates Corp. received a zoning variance on property near Stinesville, northwest of Bloomington, for a quarry to supply high-calcium limestone to Indiana power companies. In return, the firm agreed to rebuild about a mile of county road and maintain it for the life of the quarry.

The Martin Marietta Aggregates underground limestone mine at Kentucky Avenue in Indianapolis began production on November 1, 1981. The mine had been under development since January 1980. Eventually, the mine will have the capacity to produce more than 1 million tons per year of decorative architectural stone and aggregate for asphalt and concrete.

Construction began during the year on a Limestone Tourism Center at Bedford. The center, scheduled for completion in late 1982, will include a 100-foot-high replica of the Great Pyramid of Cheops constructed from waste blocks of limestone. Federal grants totaling $700,000 were obtained from the U.S. Economic Development Administration to aid in building the center, which will serve to memoralize the dimension limestone industry.

Sulfur (Recovered).—Elemental sulfur was recovered as a byproduct by Amoco Oil Co., Energy Cooperative, Inc., and Northern Indiana Public Service Co., all in Lake County. Shipments decreased in quantity but increased in value from 1980 to 1981. Stauffer Chemical Co. continued to produce liquid sulfur dioxide at its plant in Hammond, Lake County.

METALS

Aluminum.—Indiana was 1 of 17 States in which primary aluminum was produced in 1981. Output and value decreased compared with those of 1980 owing to the depressed national economy.

Aluminum Co. of America (Alcoa) continued to operate a smelter and fabricating plant near Evansville, in southwestern Indiana, along with finishing mills at Fort Wayne, Lafayette, and Richmond. Rea Magnet Wire Co., a wholly owned subsidiary, operated a research laboratory at Fort Wayne.

During the year, the Alcoa Lafayette Works began supplying extrusions of a stronger, more corrosion-resistant aluminum alloy to reconstruct the wings of the 77 U.S. Air Force C5A's, the world's largest aircraft. The project was expected to last 5 years.[3]

Kaiser Aluminum & Chemical Corp. completed a $15 million conversion of its Bedford plant into an aluminum scrap reclamation facility. The plant can remelt beverage cans into approximately 30,000 tons of aluminum per year for use as can stock at its Ravenswood, W. Va., plant.[4]

Iron and Steel.—Indiana continued to rank first among the States in pig iron shipments, accounting for almost 25% of the national output. Shipments totaled 18.3 million tons valued at nearly $3.7 billion, reflecting an increase of about 16% in quantity and about 20% in value from 1980 to 1981. A dropoff in demand, however, during the last quarter of 1981 resulted in cutbacks in production and personnel layoffs.

During the year, several steel companies made plans to upgrade facilities or continued ongoing projects. United States Steel Corp., the Nation's leading steelmaker, completed installation of a computerized heat-treating facility for tubular products and planned to upgrade the continuous caster at its Gary Works.

Bethlehem Steel Corp., the second largest steelmaker in the Nation, announced it will install a second continuous slab caster at its Burns Harbor Works in Porter County as part of a $750 million modernization program. The firm also planned to construct a new continuous heat-treating line designed to produce stronger and more lightweight steel products.

Jones & Laughlin Steel Corp., a subsidiary of LTV Corp. and the Nation's third largest steelmaker, ordered a two-strand, $165 million slab caster for its Indiana Harbor plant in East Chicago. The caster, the first of its kind in the Nation, will be capable of manufacturing two kinds of steel simultaneously and was expected to increase the plant's shipping capacity by 12%.

Inland Steel had a continuous annealing line under construction at Indiana Harbor, which was expected to be completed in 1983 to process high-strength sheet steel for use by the automotive and appliance industries.

Allegheny Ludlum Steel Corp. had a $3.5 million improvement program underway at its plant in New Castle, Henry County. The improvements were expected to provide additional stainless sheet capacity and result in a 20% increase in mill productivity. The firm was purchased by private investors early in the year from Allegheny Ludlum Industries, Inc.

In another development, National Steel Corp. started up a process line to galvanize sheet steel products coated with an aluminum-zinc alloy at its Midwest Steel Div. in Portage for use by the preengineered building industry. The Galvalume process was obtained under a licensing arrangement with Bethlehem Steel.

Other Metals.—Federated Metals Corp., a wholly owned subsidiary of ASARCO Incorporated, recycled scrap materials containing copper, lead, zinc, aluminum, and magnesium at its facility in Lake County. The finished products were used by the automotive, housing, and electronic industries.

Cabot Corp. continued construction on a new $58 million hot-rolling mill at its operation in Kokomo, Howard County, where the firm processed titanium sheet and plate. Also during the year, the Cabot Berylco Div. opened a beryllium copper and beryllium nickel service center in Elkhart, Elkhart County.

[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]Liaison program assistant, Bureau of Mines, Pittsburgh, Pa.
[3]Aluminum Co. of America. 1981 Annual Report. P. 8.
[4]Kaiser Aluminum & Chemical Corp. 1981 Annual Report. P. 15.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasive stone:			
Hindostan Whetstone Co	Box 432 Bedford, IN 47421	Quarry and plant	Orange.
Abrasives, metallic:			
Wheelabrator-Frye, Inc	400 South Byrkit St. Mishawaka, IN 46544	Plant	St. Joseph.
Aluminum:			
Aluminum Co. of America	Newburgh, IN 47530	Smelter	Warrick.
Cement:			
Lehigh Portland Cement Co.[1]	718 Hamilton Mall Allentown, PA 18105	Plants	Lawrence.
Lone Star Industries, Inc.[1 2]	2511 East 46th St. Indianapolis, IN 46205	Plant	Putnam.
Louisville Cement Co.[1 2]	Box 35750 Louisville, KY 40232	Plants	Cass and Clark.
Clays:			
C & F Shale Co	203 South Walnut St. Brazil, IN 47834	Pit	Clay.
General Shale Products Corp	Box 86 Mooresville, IN 46158	Pits and plant	Morgan.
Hydraulic-Press Brick Co	705 Olive St. St. Louis, MO 63101	Pit and plant	Do.
Log Cabin Coal Co	304 South Depot St. Brazil, IN 47834	Pits and plant	Clay.
Gypsum:			
National Gypsum Co.[3]	4100 1st International Bldg. Dallas, TX 75270	Underground mine and plant.	Martin.
United States Gypsum Co.[3]	101 South Wacker Dr. Chicago, IL 60606	do	Do.
Iron and steel:			
Bethlehem Steel Corp	Box 248 Chesterton, IN 46304	Blast furnaces	Porter.
Inland Steel Co	3210 Watling St. East Chicago, IN 46312	do	Lake.
Jones & Laughlin Steel Corp	3001 Dickey Rd. East Chicago, IN 46312	do	Do.
United States Steel Corp	1 North Broadway Gary, IN 46402	do	Do.
Lime:			
Inland Steel Co	3210 Watling St. East Chicago, IN 46312	Plant	Do.
Marblehead Lime Co	300 West Washington St. Chicago, IL 60606	do	Do.
Peat:			
Anderson Peat Organic Compost	Route 19 Noblesville, IN 46060	Bog and plant	Hamilton.
Michigan Peat Co	Box 66388 Houston, TX 77006	do	Jasper.
Millburn Peat Co., Inc	Box 236 La Porte, IN 46350	do	La Porte.

See footnotes at end of table.

Table 10.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Perlite, expanded:			
Chemrock Corp	Box 7151 Nashville, TN 37210	Plant	Tippecanoe.
Grefco, Inc	3450 Wilshire Blvd. Los Angeles, CA 90010	do	Montgomery.
Sand and gravel:			
American Aggregates Corp	Drawer 160 Greenville, OH 45331	Pits and plants	Hamilton, Marion, Wayne.
Hilltop Basic Resources, Inc	Box 11056 Cincinnati, OH 45211	Pit and plant	Switzerland.
Martin Marietta Aggregates	Box 789 Cedar Rapids, IA 52406	Pits and plants	Various.
Western Materials Co.[1]	Box 5529 Lafayette, IN 47903	do	Do.
Stone:			
American Aggregates Corp	Garst Ave. at Ave. B Greenville, OH 45331	Quarries and plants	Hamilton, Marion, Owen.
France Stone Co	Box 1928 Toledo, OH 43603	do	Allen, Cass, Putnam.
Irving Bros. Gravel Co., Inc.[4]	6377 West 600 South St. Swayzee, IN 46986	do	Delaware, Grant, Huntington.
Martin Marietta Aggregates	Box 789 Cedar Rapids, IA 52406	do	Clark, Howard, Madison, Marion, Putnam, Vigo.
Mulzer Crushed Stone Co	Box 248 Tell City, IN 47586	Quarries, mines, plants	Crawford and Perry.
Ralph Rogers & Co., Inc.[2 4]	Box 849 Bloomington, IN 47402	Quarries and plants	Crawford, Lawrence, Monroe, Newton, Putnam.
Sulfur:			
Amoco Oil Co	2815 Indianapolis Blvd. Indianapolis, IN 46204	Refinery	Lake.
Energy Cooperative, Inc	3500 Indianapolis Blvd. East Chicago, IN 46312	do	Do.

[1]Also stone.
[2]Also clays.
[3]Also expanded perlite.
[4]Also sand and gravel.

The Mineral Industry of Iowa

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Iowa Geological Survey for collecting information on all nonfuel minerals.

By James H. Aase[1]

The value of nonfuel mineral production in Iowa during 1981 was $232.3 million, an 8% decrease from that of 1980 and 16% below the record high value set in 1979. Of the eight mineral commodities produced, all except gem stones and lime declined in output from the 1980 level, reflecting the construction industry's continuing downturn in demand for industrial minerals.

Cement, the leading commodity produced in terms of value, was followed by stone, sand and gravel, and gypsum. Continuing inflation was a principal cause for the record high unit prices received for all commodities produced.

Nationally, Iowa ranked third among the States in the value of gypsum produced and 29th in total nonfuel mineral output value.

United States Gypsum Co. announced plans for a major expansion of the gypsum board manufacturing facilities at its Sperry Mine and plant. The expansion, scheduled to be completed by mid-1982, will increase the plant's capacity by approximately 27%.

For the second consecutive year, United States Gypsum Co.'s underground gypsum mine near Sperry received the Sentinels of Safety Award as the safest nonmetal underground mine in the Nation. The American Mining Congress and the Federal Mine Safety and Health Administration jointly presented the award.

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

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
Cement:				
Masonry thousand short tons	48	$3,340	41	$3,227
Portland do	1,998	101,008	1,779	92,099
Clays do	754	2,555	476	2,375
Gem stones	--	--	NA	1
Gypsum thousand short tons	1,468	13,136	1,383	12,706
Peat do	11	276	10	453
Sand and gravel[2] do	12,683	32,722	p12,100	p32,000
Stone:				
Crushed do	26,542	92,603	22,424	82,891
Dimension do	10	509	W	W
Combined value of other nonmetals and value indicated by symbol W	XX	5,727	XX	6,559
Total	XX	251,876	XX	232,311

pPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes industrial sand; value included in "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Adair	W	W	Stone.
Adams	W	W	Do.
Allamakee	$1,241	W	Stone, sand and gravel.
Appanoose	3,243	$2,638	Stone, clays, sand and gravel.
Audubon	W	W	Sand and gravel.
Benton	W	W	Stone, sand and gravel.
Black Hawk	W	W	Do.
Boone	686	724	Sand and gravel.
Bremer	706	W	Stone, sand and gravel.
Buchanan	W	W	Do.
Buena Vista	217	109	Sand and gravel.
Butler	W	W	Stone, sand and gravel.
Calhoun	71	W	Sand and gravel.
Carroll	398	329	Do.
Cass	W	W	Stone.
Cedar	W	W	Stone, sand and gravel.
Cerro Gordo	W	65,146	Cement, stone, clays, sand and gravel.
Cherokee	612	856	Sand and gravel.
Chickasaw	W	582	Stone.
Clarke	1,101	1,037	Do.
Clay	220	320	Sand and gravel.
Clayton	3,180	4,509	Sand and gravel, stone.
Clinton	2,092	2,002	Stone, sand and gravel.
Crawford	W	W	Sand and gravel.
Dallas	W	W	Sand and gravel, clays.
Davis	W	W	Stone.
Decatur	1,176	809	Do.
Delaware	W	W	Stone, sand and gravel.
Des Moines	6,194	5,054	Gypsum, stone, sand and gravel.
Dickinson	289	617	Sand and gravel.
Dubuque	W	W	Stone, sand and gravel.
Emmet	531	381	Sand and gravel.
Fayette	1,611	2,503	Stone, sand and gravel.
Floyd	W	W	Do.
Franklin	W	W	Stone, sand and gravel, clays.
Fremont	496	423	Stone.
Greene	453	W	Sand and gravel.
Grundy	38	30	Do.
Guthrie	W	304	Do.
Hamilton	W	677	Stone, sand and gravel.
Hancock	1,421	W	Sand and gravel, stone, peat.
Hardin	5,464	6,293	Stone, sand and gravel.
Harrison	W	W	Do.
Henry	125	W	Stone.
Howard	507	524	Stone, sand and gravel.
Humboldt	W	W	Do.
Ida	W	W	Sand and gravel.
Iowa	W	--	
Jackson	W	W	Stone, sand and gravel.
Jasper	W	W	Sand and gravel, stone.
Jefferson	W	W	Stone.
Johnson	3,336	3,076	Stone, sand and gravel.
Jones	2,898	2,952	Do.
Keokuk	W	W	Stone.
Kossuth	93	73	Sand and gravel.
Lee	1,589	W	Stone, sand and gravel.
Linn	6,207	W	Stone, sand and gravel, peat.
Louisa	1,525	W	Stone, sand and gravel.
Lucas	--	41	Stone.
Lyon	W	W	Sand and gravel.
Madison	W	W	Stone, clays.
Mahaska	W	W	Stone.
Marion	W	W	Stone, sand and gravel, gypsum.
Marshall	4,332	3,138	Stone, sand and gravel.
Mills	W	349	Stone.
Mitchell	1,409	W	Stone, sand and gravel.
Monona	W	W	Sand and gravel.
Monroe	W	1,383	Stone.
Montgomery	1,372	W	Stone, sand and gravel.
Muscatine	W	W	Do.
O'Brien	338	467	Sand and gravel.
Osceola	W	402	Do.
Page	W	W	Stone, sand and gravel.
Palo Alto	W	W	Sand and gravel.
Plymouth	W	W	Do.
Pocahontas	W	W	Stone.
Polk	W	W	Cement, sand and gravel, clays.
Pottawattamie	W	W	Stone, sand and gravel.
Poweshiek	W	W	Stone.
Sac	W	W	Sand and gravel.

See footnotes at end of table.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Scott	$40,162	$38,865	Cement, stone, lime, sand and gravel, clays.
Shelby	W	W	Sand and gravel.
Sioux	1,876	1,521	Do.
Story	W	W	Sand and gravel, stone, clays.
Tama	W	W	Stone, sand and gravel.
Taylor	3	181	Stone.
Union	W	W	Do.
Van Buren	W	W	Stone, sand and gravel.
Wapello	W	1,105	Sand and gravel, clays.
Warren	W	W	Clays.
Washington	W	W	Stone.
Webster	12,922	12,027	Gypsum, stone, sand and gravel.
Winnebago	186	W	Sand and gravel, peat.
Winneshiek	1,325	1,446	Stone, sand and gravel.
Woodbury	W	W	Sand and gravel, clays.
Worth	W	W	Stone, sand and gravel, peat.
Wright	400	440	Sand and gravel.
Undistributed[2]	165,856	88,544	
Total	277,901	[3]251,876	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Ringgold and Wayne Counties are not listed because no nonfuel mineral production was reported.
[2]Includes sand and gravel that cannot be assigned to specific counties (1979) and values indicated by symbol W.
[3]Data do not add to total shown because of independent rounding.

Table 3.—Indicators of Iowa business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	1,399.4	1,443.7	+3.2
Unemployment	do	80.3	128.1	+60.0
Employment (nonagricultural):				
Mining[1]	do	2.2	1.9	-13.6
Manufacturing	do	244.8	235.9	-3.6
Contract construction	do	50.9	45.3	-11.0
Transportation and public utilities	do	56.3	54.0	-4.1
Wholesale and retail trade	do	280.7	274.6	-2.2
Finance, insurance, real estate	do	58.3	59.2	+1.5
Services	do	209.3	209.2	--
Government	do	207.4	209.9	+1.2
Total nonagricultural employment[1]	do	1,109.9	[2]1,090.1	-1.8
Personal income:				
Total	millions	$27,188	$29,420	+8.2
Per capita		$9,310	$10,149	+9.0
Construction activity:				
Number of private and public residential units authorized		8,917	5,564	-37.6
Value of nonresidential construction	millions	$291.9	$219.4	-24.8
Value of State road contract awards	do	$122.8	$132.6	+8.0
Shipments of portland and masonry cement to and within the State	thousand short tons	1,313	1,163	-11.4
Nonfuel mineral production value:				
Total crude mineral value	millions	$251.9	$232.3	-7.8
Value per capita, resident population		$86	$80	-7.0
Value per square mile		$4,475	$4,127	-7.8

[p]Preliminary.
[1]Includes bituminous coal.
[2]Data do not add to total shown because of independent rounding.

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

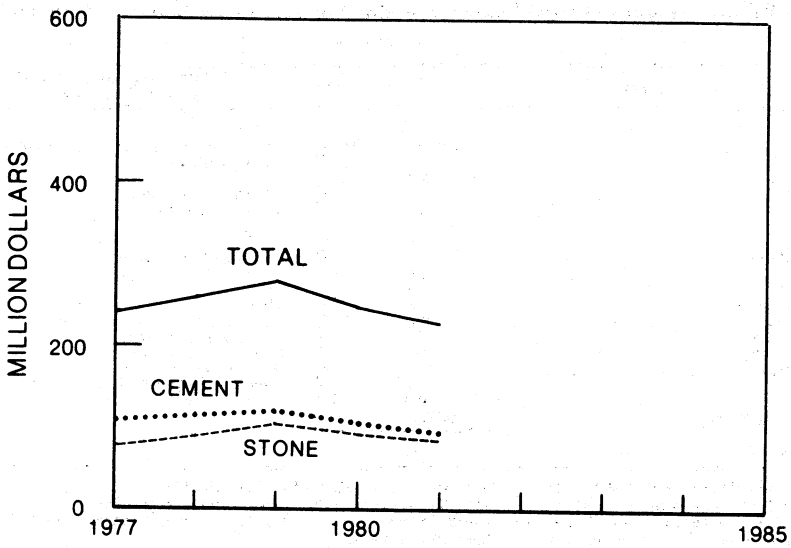

Figure 1.—Value of cement, stone, and total value of nonfuel mineral production in Iowa.

Martin Marietta Corp. acquired the Penn-Dixie Industries West Des Moines cement plant and inventories. The Penn-Dixie Industries sale was in accordance with reorganization proceedings under Chapter 11 of the Federal Bankruptcy Act. Martin Marietta planned to use the West Des Moines facility mainly as a terminal for serving construction markets in the metropolitan Des Moines area and western Iowa. The plant kiln and processing facilities were not to be used; however, the grinding mill and associated finishing works were to be used as the market expanded. In late 1981, Martin Marietta placed onstream a new $80 million dry-process cement plant in Davenport, replacing the original wet-process facility at the same location. The new plant increases annual production capabilities by 350,000 tons and consumes 45% less coal and 10% less electricity than the wet-process facility.

The Monarch Cement Co. stopped production at its Des Moines cement manufacturing facility for a brief period during the year. The shutdown and layoff of workers was due to high inventories and low cement demand. The Des Moines plant usually produces approximately 300,000 tons of cement annually.[2]

The Pella plant of Van Dusseldorp Sand & Gravel, Inc., Colfax, Iowa, won the National Sand & Gravel Association's 1980 safety contest for operations producing less than 60,000 tons annually.

A new geology center and museum were dedicated and opened to the public in June at Cornell College in Mt. Vernon. The geology center houses offices, map and drafting rooms, a library, document repositories, a laboratory, and classrooms. The three-floor museum is a central part of the geology center. Its many exhibits include Iowa minerals and fossils; and rocks representing a core of the Earth's crust from the Iowa region.

Employment.—Iowa Department of Job Service statistics indicated that, at midyear, employment in the mining industry was 2,200, compared with 2,500 for the same period in 1980. The average hourly earnings of mining production and related nonsupervisory workers was $7.48 in July 1981, an increase of approximately 7% compared with the same month of 1980.

Legislation and Government Programs.—During 1981, the Iowa Legislature enacted a bill bringing metallic mineral exploration under the same statutes governing exploration for oil and gas. The law

requires a permit from the State geologist, under rules prescribed by the Iowa Natural Resources Council, for the exploration of metallic minerals. In addition, the bill's provisions allow the leasing of public lands for metallic mineral exploration.

The Iowa Geological Survey (IGS), an independent State agency reporting directly to the Governor, actively pursued its responsibility for applied research in geology and water resources. Various IGS activities during the year included (1) completing a study of the Devonian-Silurian carbonate aquifer in Iowa, (2) launching a project to evaluate systematically the alluvial aquifers associated with the State's major interior rivers, (3) completing a regional evaluation of the Dakota sandstone aquifer in northwestern Iowa, (4) beginning operations in remote sensing and image processing, (5) completing a project to acquire high-altitude, color-infrared photography for the entire State, and (6) continuing work toward its goal of having complete 7-1/2-minute topographic quadrangle coverage, currently at 88% published coverage, 8.1% in preliminary publication stages, and the remainder with mapping in progress.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Cement.—The quantity and value of Iowa's cement shipments in 1981 were at their lowest levels since 1953 and 1976, respectively. The State's cement output during the year was from 4 companies that collectively operated 10 kilns at 2 wet-process and 2 dry-process plants located at Mason City, Des Moines, and Davenport.

Iowa was ranked 9th among the States in producing portland cement and 20th in masonry cement output.

The average value of portland cement sold by the Iowa producers during the year was $51.77 per ton, the highest unit price on record. The largest users of the State's portland cement output in 1981 were ready-mix companies, consuming about two-thirds of the production, followed, in descending order, by concrete products, highway contractors, building-material dealers, and minor amounts to Government agencies and other customers.

Most of the cement shipments were in bulk form, with only minor amounts shipped in containers. Truck transportation was the principal mode for handling most shipments, and rail accounted for the remaining minor quantities.

Approximately 3.2 million tons of nonfuel minerals and related raw materials was consumed in producing 1.8 million tons of finished cement in Iowa during 1981.

The State's reduced level of cement output in 1981, compared with that of 1980, mirrored the trend in the cement industry nationally, an effect caused primarily by high interest rates.

Clays.—Clay production during 1981 came from 13 mines operated by 9 companies in 10 counties. Tonnage for the year decreased 37% from that in 1980, registering the lowest yearly production level since 1945. The average unit price for the total 1981 output was $4.99 per ton, a $1.60-per-ton advance over that of 1980, setting a record high price that was partly attributed to continuing nationwide inflation.

Cerro Gordo County was the leading county in the State in clay production, followed by Dallas County and Woodbury County, which collectively produced approximately one-half of the State's output during the year. Of the total clay mined, nearly two-thirds was from the operations of three firms.

Face-brick manufacturing was the largest consumer of the clay produced during 1981, using 49% of the output. Other clay uses, in descending order of amounts consumed, included the manufacturing of cement, concrete block, structural concrete products, and drain tile.

Gypsum.—The 1981 production of crude gypsum, obtained from six mines operated by five companies at locations in three counties, decreased 6% in quantity and 3% in value compared with that of 1980. The average unit price of the crude gypsum produced during the year was $9.19 per ton, a $0.24-per-ton advance over that received in 1980.

Nationally, Iowa ranked third among the States in value of crude gypsum produced during 1981, surpassed by Texas and California. Webster County produced approximately three-fourths of Iowa's total output.

Active operations during the year included underground mines operated by United States Gypsum Co. near Sperry in Des Moines County and by Kaser Corp. near Harvey in Marion County and surface mines operated by United States Gypsum

Co., National Gypsum Co., Georgia-Pacific Corp., and Jim Walter Corp. at sites near Fort Dodge in Webster County. All companies, except Kaser Corp., calcined their crude gypsum output at plants near their minesites for the production of gypsum wallboard.

Lime.—Production of lime in 1981 increased in quantity and value over that of 1980. Linwood Stone Products Co., Inc., in Scott County was the State's only producer of quicklime and hydrated lime. Output was used mainly for water purification and softening and in steel-furnace operations.

Iowa lime consumption from all domestic sources during 1981 totaled 117,000 tons.

Peat.—Four companies produced either moss, humus, or reed-sedge peats from bogs in Hancock, Linn, Winnebago, and Worth Counties. Reed-sedge, the principal type of peat produced, was sold principally in bulk form for use on golf courses. Peat was also used for packing flowers, plants, and shrubs, fertilizers, general soil improvement, nurseries, vegetable growing, and earthworm culture.

Perlite.—Crude perlite mined in other States was expanded by National Gypsum Co. and United States Gypsum Co. at their Fort Dodge gypsum calcining plants in Webster County. The entire output was used for plaster aggregate.

Sand and Gravel.—To reduce reporting burden and costs, the Bureau of Mines implemented new canvassing procedures for its 1981 surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even years only; however, the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for 1981 production of construction sand and gravel but contains complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd years will be revised and made final the following year.

Martin Marietta Aggregates, Central Div., produced industrial sand from an underground mine in Clayton County. Output was used primarily by the foundry industry. A decline in production from that of 1980 was reported.

Table 4.—Iowa: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	7,272	$17,917	$2.46	NA	NA	NA
Gravel	5,412	14,805	2.74	NA	NA	NA
Total or average	[1]12,683	32,722	2.58	[p]12,100	[p]$32,000	[p]$2.64
Industrial sand	W	W	10.38	W	W	11.86
Grand total or average	W	W	2.67	W	W	2.72

[p]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Data do not add to total shown because of independent rounding.

Stone.—Crushed and dimension limestone, the only type of stone produced in the State during 1981, was from 291 quarries operated by 68 firms in 65 counties. Scott County led in crushed stone output during the year, followed by Cerro Gordo, Black Hawk, Hardin, and Madison Counties, which collectively accounted for approximately one-fourth of the total State production.

More than one-third of the State's crushed stone output was from the operations of five firms, each producing in excess of 1 million tons during 1981. Output from individual quarry operations varied widely. During the year, 43% of the quarries produced less than 25,000 tons each; 35%, between 25,000 and 100,000 tons; 21%, between 100,000 and 500,000 tons; and the remainder, more than 500,000 tons.

Crushed stone was used mainly for surface-treatment aggregate, unspecified aggregate, dense-graded road base stone, concrete aggregate, and cement manufac-

turing, cumulatively accounting for 77% of the State's 1981 output. Most of the crushed stone shipments were handled by truck, with about 2% shipped by rail, waterway, or other means.

W. Becker & Sons Stone Co. in Dubuque County and W. C. Weber Stone Co. in Jones County produced dimension limestone in 1981. Output was used for dressed construction stone, house stone veneer, rubble, flagging, sawed stone, and other purposes.

[1]State Liaison Officer, Bureau of Mines, Minneapolis, Minn.
[2]Des Moines Register. July 21, 1981.

Table 5.—Iowa: Crushed limestone sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	3,074	11,041	2,323	8,757
Poultry grit and mineral food	266	3,849	259	3,660
Concrete aggregate	3,196	13,753	3,103	13,547
Bituminous aggregate	1,190	4,605	1,032	4,151
Macadam aggregate	355	1,048	168	527
Dense-graded road base stone	4,930	16,116	3,751	12,483
Surface-treatment aggregate	4,903	17,482	4,098	15,676
Other construction aggregate and road stone	3,883	13,326	3,760	13,678
Riprap and jetty stone	278	1,128	232	1,221
Railroad ballast	659	1,881	639	2,231
Filter stone	89	270	77	373
Cement manufacture	2,864	4,944	2,631	5,168
Lime manufacture	W	W	204	686
Fill	W	W	60	116
Roofing granules	W	W	19	283
Other[1]	855	3,160	69	335
Total[2]	26,542	92,603	22,424	82,891

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes stone used for manufactured fine aggregate (stone sand), flux stone, asphalt filler, sulfur removal from stack gases (1980), other uses not specified, and uses indicated by symbol W.
[2]Data may not add to totals shown because of independent rounding.

Table 6.—Iowa: Crushed limestone sold or used by producers, by county

County	1980			1981		
	Number of quarries	Quantity (thousand short tons)	Value (thousands)	Number of quarries	Quantity (thousand short tons)	Value (thousands)
Allamakee	14	262	$888	15	87	$311
Buchanan	11	330	1,017	14	359	1,247
Butler	5	188	565	5	173	520
Cedar	5	154	447	4	W	W
Cerro Gordo	4	1,992	4,651	4	1,671	3,428
Chickasaw	6	209	582	5	125	377
Clarke	1	336	1,037	1	140	466
Clayton	23	421	1,124	17	320	1,021
Clinton	12	570	1,728	9	512	1,752
Decatur	2	262	809	3	183	610
Delaware	13	388	1,026	12	328	1,048
Des Moines	3	332	W	4	380	1,604
Dubuque	15	825	1,971	14	524	1,595
Fayette	16	911	2,402	14	431	1,223
Franklin	4	121	367	4	67	220
Fremont	2	117	423	2	69	284
Hamilton	1	135	574	1	122	518
Hardin	4	752	5,826	4	978	6,527
Harrison	2	304	994	2	335	1,084
Howard	5	157	465	6	108	392
Humboldt	1	206	718	4	302	952
Jackson	9	420	1,412	9	272	1,016
Jasper	1	W	W	1	73	322
Jones	8	493	1,680	8	511	1,868
Linn	12	1,061	3,650	8	940	3,392
Lucas	1	19	41	--	--	--
Madison	10	1,191	3,671	10	975	3,203
Mahaska	2	W	W	1	37	151
Marion	2	W	W	3	276	1,199

See footnotes at end of table.

Table 6.—Iowa: Crushed limestone sold or used by producers, by county —Continued

County	1980			1981		
	Number of quarries	Quantity (thousand short tons)	Value (thousands)	Number of quarries	Quantity (thousand short tons)	Value (thousands)
Mills	2	76	$349	2	53	$240
Monroe	1	306	1,383	1	191	863
Montgomery	1	260	1,381	1	264	1,404
Page	1	240	886	1	114	420
Scott	4	3,002	9,333	2	W	W
Story	1	124	440	1	276	1,058
Taylor	1	50	181	1	60	216
Van Buren	5	529	2,162	4	356	1,465
Webster	3	W	W	2	W	1,953
Winneshiek	17	418	1,281	16	644	2,150
Worth	4	211	670	5	176	629
Undistributed[1]	r66	9,167	36,470	70	9,990	36,160
Total[2]	300	26,542	92,603	290	22,424	82,891

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Includes Adair, Adams, Appanoose, Benton, Black Hawk, Bremer, Cass, Davis, Floyd, Hancock, Henry, Jefferson, Johnson, Keokuk, Lee, Louisa, Marshall, Mitchell, Muscatine, Pocahontas, Polk (1981), Pottawattamie, Poweshiek, Tama, Union, and Washington Counties and data indicated by symbol W.
[2]Data may not add to totals shown because of independent rounding.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Lehigh Portland Cement Co	Box 1882 Allentown, PA 18105	Plant	Cerro Gordo.
Martin Marietta Corp	Box 4288 Davenport, IA 52808	do	Polk and Scott.
The Monarch Cement Co	Humboldt, KS 66748	do	Polk.
Northwestern States Portland Cement Co.	Box 1008 Mason City, IA 50401	do	Cerro Gordo.
Clays and shale:			
Can-Tex Industries, Div. of Harsco Corp.	101 Ashworth Rd. Des Moines, IA 50265	Pits and plants	Dallas, Polk, Wapello.
Carter-Waters Corp	Box 19676 Kansas City, MO 64141	Pit and plant	Appanoose.
Martin Marietta Corp	Box 4288 Davenport, IA 52808	do	Scott.
Northwestern States Portland Cement Co.	Box 1008 Mason City, IA 50401	do	Cerro Gordo.
Sioux City Brick & Tile	Box 56 Sergeant Bluff, IA 51054	Pits and plants	Dallas and Woodbury.
Gypsum:			
Celotex Div., Jim Walter Corp.	1500 North Dale Mabry Tampa, FL 33607	Mine and plant	Webster.
Georgia-Pacific Corp	900 SW 5th Ave. Portland, OR 97204	do	Do.
National Gypsum Co	2001 Rexford Rd. Charlotte, NC 28211	do	Do.
United States Gypsum Co	101 South Wacker Dr. Chicago, IL 60606	Mines and plant	Des Moines and Webster.
Lime:			
Linwood Stone Products Co., Inc.	Route 2 Davenport, IA 52804	Plant	Scott.
Peat:			
C-IT-GRO	Route 2 Garner, IA 50438	Bog and plant	Hancock.
Eli Colby Co	Box 248 Lake Mills, IA 50450	do	Winnebago.
Colby Pioneer Peat Co	Box 8 Hanlontown, IA 50444	do	Worth.
Hughes Peat Co	Route 2 Marion, IA 52302	do	Linn.
Perlite, expanded:			
National Gypsum Co	2001 Rexford Rd. Charlotte, NC 28211	Plant	Webster.
United States Gypsum Co	101 South Wacker Dr. Chicago, IL 60606	do	Do.
Sand and gravel (1980):			
Acme Fuel & Material Co	Box 34 Muscatine, IA 52761	Pit and plant	Muscatine.
B. L. Anderson, Inc	327 Guaranty Bldg. Cedar Rapids, IA 52401	do	Jones.

See footnotes at end of table.

Table 7.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel (1980) — Continued			
G. A. Finley, Inc	Box 465 Harlan, IA 51537	Pits and plants	Audubon, Crawford, Dallas, Montgomery, Page, Pottawattamie, Shelby.
Hallett Construction Co	Box 13 Boone, IA 50036	do	Boone, Buena Vista, Calhoun, Carroll, Cherokee, Clay, Crawford, Franklin, Hamilton, Marshall, Montgomery, Polk, Sac, Story, Wright.
Kaser Corp	7200 Hickman Rd. Des Moines, IA 50322	do	Marion.
Martin Marietta Aggregates, Central Div.	Box 789 Cedar Rapids, IA 52406	Pits, underground mine, plants. Industrial sand and construction sand and gravel.	Black Hawk, Clayton, Linn, Marshall, Polk, Wapello, Worth.
Maudlin Construction Co	Box 634 Webster City, IA 50595	Pits and plants	Boone, Buena Vista, Dickinson, Franklin, Hamilton, Hardin, O'Brien, Osceola, Webster.
Peters Construction Co	Route 1 Cumming, IA 50061	do	Ida, Monona, Polk, Woodbury.
Stevens Sand & Gravel Co., Inc.	2525 Highway 218 South Iowa City, IA 52240	Pit and plant	Johnson.
Van Dusseldorp Sand & Gravel, Inc.	Box 156 Colfax, IA 50054	Pits and plants	Jasper and Marion.
Stone:			
Alpha Crushed Stone, Inc	Box 267 Marion, IA 52302	Quarries and plants	Cedar, Clinton, Jones, Linn.
B. L. Anderson, Inc	327 Guaranty Bldg. Cedar Rapids, IA 52401	do	Benton, Jackson, Jones, Linn, Tama.
Kaser Corp	7200 Hickman Rd. Des Moines, IA 50322	Underground mines, quarries, plants.	Des Moines, Fremont, Jasper, Keokuk, Marion, Mills, Monroe, Montgomery, Poweshiek, Washington.
McCarthy Improvement Co., Linwood Stone Products Co., Inc.	Route 2 Davenport, IA 52804	Underground mine and plant.	Scott.
Martin Marietta Aggregates, Central Div.	Box 789 Cedar Rapids, IA 52406	Underground mines, quarries, plants.	Black Hawk, Bremer, Chickasaw, Hancock, Johnson, Keokuk, Linn, Madison, Marshall, Polk, Scott, Worth.
Northwestern States Portland Cement Co.	Box 1008 Mason City, IA 50401	Quarry and plant	Cerro Gordo.
River Products Co	220 Savings & Loan Bldg. Iowa City, IA 52240	Quarries and plants	Johnson, Louisa, Washington.
Schildberg Construction Co., Inc.	Box 358 Greenfield, IA 50849	do	Adair, Adams, Cass, Madison, Pottawattamie, Union.
Weaver Construction Co	Box 817 Iowa Falls, IA 50126	Underground mine, quarries, plants	Cerro Gordo, Franklin, Hamilton, Hardin, Humboldt.
Welp & McCarten, Inc	Box W Fort Dodge, IA 50501	Quarries and plants	Black Hawk, Howard, Humboldt, Webster, Worth.

The Mineral Industry of Kansas

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the State Geological Survey of Kansas, for collecting information on all nonfuel minerals.

By Jane P. Ohl[1]

The value of nonfuel minerals produced in Kansas was $249.1 million in 1981, a 4.8% decrease from the 1980 value. The slight decline was due mainly to nationwide recession and inflation that again forestalled some housing and highway construction. Quantities of every important mineral commodity produced in Kansas, except clays, high-purity helium, and industrial sand and gravel, declined from the 1980 output. Total values, however, of clays, gypsum, high-purity helium, lime, salt (brine), and industrial sand and gravel increased over those of 1980.

Kansas Department of Human Resources 1981 data showed an erratic but overall decline in employment in the nonfuel mining and quarrying industries. Peak employment was 1,354 persons in June; the lowest employment occurred in December (1,169), a 9% decline from the November figure.

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

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
Cement:				
Masonry thousand short tons	60	$3,310	51	$2,835
Portland do	1,835	86,103	1,641	81,792
Clays do	886	2,325	915	4,756
Gem stones	--	--	NA	1
Pumice thousand short tons	rW	W	W	W
Salt[2] do	1,572	64,276	1,410	60,148
Sand and gravel[3] do	12,124	23,817	p10,600	p21,000
Stone:				
Crushed do	17,398	54,731	14,143	45,738
Dimension do	18	937	14	605
Combined value of gypsum, helium (crude and high-purity), lime, salt (brine), sand and gravel (industrial), and values of items indicated by symbol W	XX	26,094	XX	32,185
Total	XX	261,593	XX	249,060

pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes salt in brines; value included with "Combined value" figure.

[3]Excludes industrial sand; value included with "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Allen	W	W	Cement, stone, clays.
Anderson	W	$419	Stone.
Atchison	W	W	Do.
Barber	W	W	Gypsum, sand and gravel.
Barton	W	W	Sand and gravel, clays.
Bourbon	W	W	Stone.
Brown	--	9	Sand and gravel.
Butler	$2,037	3,519	Stone.
Chase	109	231	Do.
Chautauqua	--	29	Do.
Cherokee	W	W	Sand and gravel, stone, clays.
Cheyenne	128	W	Sand and gravel.
Clark	40	30	Do.
Clay	W	W	Stone, sand and gravel.
Cloud	W	W	Sand and gravel, clays.
Coffey	W	W	Stone, sand and gravel.
Comanche	6	5	Sand and gravel.
Cowley	2,687	3,051	Stone, sand and gravel.
Crawford	W	W	Stone, clays.
Decatur	93	100	Sand and gravel.
Dickinson	2,024	W	Stone, sand and gravel.
Doniphan	W	W	Do.
Douglas	W	W	Do.
Edwards	W	W	Sand and gravel.
Elk	W	W	Stone.
Ellis	603	W	Sand and gravel, stone.
Ellsworth	W	W	Helium, salt, sand and gravel, clays.
Finney	W	W	Sand and gravel, stone.
Ford	719	741	Sand and gravel.
Franklin	W	W	Stone, clays.
Geary	W	W	Sand and gravel, stone.
Gove	57	--	
Graham	W	W	Stone.
Grant	W	W	Helium, sand and gravel.
Gray	W	W	Sand and gravel.
Greeley	18	17	Do.
Greenwood	290	148	Stone.
Hamilton	143	W	Sand and gravel.
Harper	32	48	Do.
Harvey	W	W	Do.
Haskell	W	W	Do.
Hodgeman	W	42	Do.
Jackson	107	73	Stone.
Jefferson	2,129	1,887	Do.
Jewell	W	W	Do.
Johnson	W	W	Stone, sand and gravel.
Kearny	W	W	Sand and gravel.
Kingman	48	--	
Kiowa	W	W	Sand and gravel.
Labette	1,076	1,098	Stone.
Leavenworth	1,854	1,690	Do.
Lincoln	W	W	Stone, sand and gravel.
Linn	847	564	Stone.
Lyon	W	W	Stone, sand and gravel.
McPherson	W	W	Clays, sand and gravel.
Marion	W	W	Stone.
Marshall	W	W	Gypsum, sand and gravel, stone.
Meade	W	W	Sand and gravel.
Miami	1,169	960	Stone.
Montgomery	W	W	Cement, stone, clays.
Morris	45	2	Stone.
Morton	W	W	Helium.
Nemaha	218	55	Stone.
Neosho	W	W	Cement, stone, clays, sand and gravel.
Ness	728	227	Sand and gravel.
Norton	W	W	Pumice, sand and gravel.
Osage	W	148	Stone.
Ottawa	27	85	Sand and gravel.
Pawnee	181	166	Do.
Phillips	367	50	Do.
Pottawatomie	W	W	Stone, sand and gravel.
Pratt	W	W	Sand and gravel.
Rawlins	36	33	Do.
Reno	41,754	46,961	Salt, sand and gravel.
Republic	W	W	Sand and gravel.
Rice	17,231	W	Salt, stone, sand and gravel.
Riley	W	W	Stone, sand and gravel.
Rooks	14	13	Sand and gravel.
Rush	W	W	Helium.
Russell	W	53	Sand and gravel.

See footnotes at end of table.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Saline	$779	W	Sand and gravel.
Sedgwick	W	W	Sand and gravel, salt.
Seward	330	$242	Sand and gravel.
Shawnee	3,641	W	Stone, sand and gravel.
Sheridan	W	W	Sand and gravel.
Sherman	W	W	Lime, sand and gravel.
Smith	W	W	Stone.
Stafford	W	W	Sand and gravel.
Stevens	22	46	Do.
Sumner	W	W	Do.
Thomas	239	W	Do.
Trego	115	140	Sand and gravel, stone.
Wabaunsee	485	W	Stone.
Wallace	13	11	Sand and gravel.
Washington	W	W	Sand and gravel, stone.
Wichita	33	--	
Wilson	W	W	Cement, stone, clays.
Woodson	W	31	Stone, clays.
Wyandotte	W	W	Cement, sand and gravel, stone.
Undistributed[2]	182,088	198,677	
Total[3]	264,566	261,593	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]Lane, Logan, Mitchell, Osborne, Scott, and Stanton Counties are not listed because no nonfuel mineral production was reported.

[2]Includes 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 Kansas business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	1,190.2	1,209.7	+1.6
Unemployment	do.	52.3	52.4	+.2
Employment (nonagricultural):				
Mining[1]	do.	16.1	19.1	+18.6
Manufacturing	do.	190.5	187.9	-1.4
Contract construction	do.	46.5	42.5	-8.6
Transportation and public utilities	do.	63.7	63.0	-1.1
Wholesale and retail trade	do.	226.4	228.2	+.8
Finance, insurance, real estate	do.	47.2	47.9	+1.5
Services	do.	166.8	173.7	+4.1
Government	do.	187.4	186.8	-.3
Total nonagricultural employment[1]	do.	[2]944.7	949.1	+.5
Personal income:				
Total	millions	$23,367	$25,899	+10.8
Per capita		$9,864	$10,870	+10.2
Construction activity:				
Number of private and public residential units authorized		10,930	8,366	-23.5
Value of nonresidential construction	millions	$231.5	$252.1	+8.9
Value of State road contract awards	do.	$118.0	$105.7	-10.4
Shipments of portland and masonry cement to and within the State	thousand short tons	1,231	1,108	-10.0
Nonfuel mineral production value:				
Total crude mineral value	millions	$261.6	$249.1	-4.8
Value per capita, resident population		$111	$105	-5.4
Value per square mile		$3,180	$3,028	-4.8

[p]Preliminary.

[1]Includes bituminous coal and oil and gas extraction.

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

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

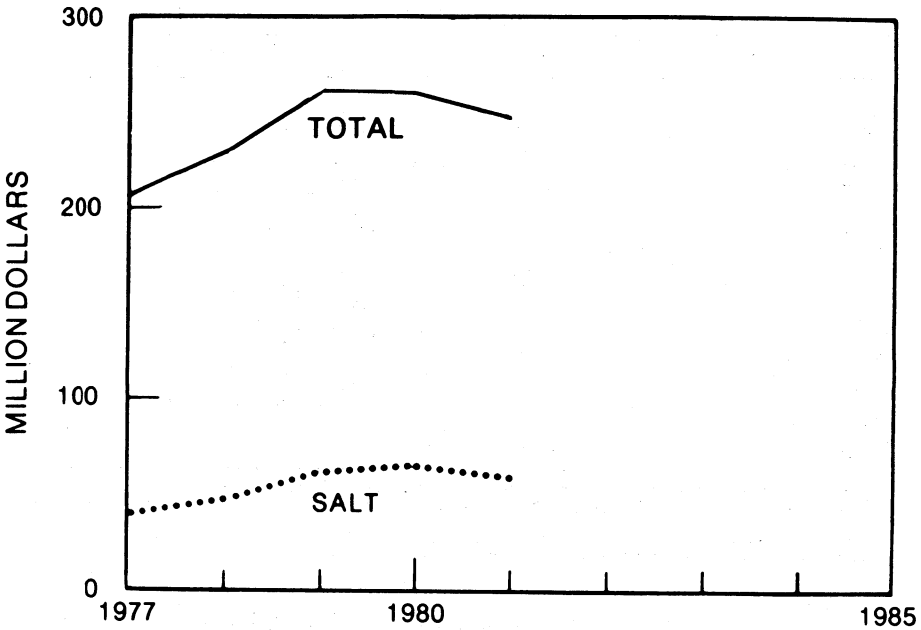

Figure 1.—Value of salt and total value of nonfuel mineral production in Kansas.

Trends and Developments.—Kimberlite pipes and the surrounding alluvial or washed and weathered areas were drilled as part of preliminary investigations near the towns of Bala, Leonardville, Randolph, Stockdale, and Winkler, in Riley County. The results indicated the presence of diopside, garnet, ilmenite, magnetite, and vermiculite in varying degrees of geologic abundance. In similar geologic settings and similar association elsewhere in the world, diamonds are found, not uncommonly, with ilmenite and garnet. Rock excavated from these lands was evaluated at Cominco American Incorporated's mineral-extraction plant in Fort Collins, Colo.

The Kansas Geological Survey studied the stratigraphy and ore mineralogy of copper-bearing formations in lower Permian redbeds. Several mineralized zones were found in the Ninnescah and Wellington Formations in Harper, Sedgwick, and Sumner Counties.[2]

As an example of mined land being converted to a public purpose, Gulf Oil Corp. and its subsidiary, Pittsburgh & Midway Coal Mining Co., donated about 8,200 acres of surface-mined land in Cherokee County to the State for a wildlife area. The company agreed also to give the State $250,000 to develop the lands.

Underground industrial parks, factories, offices, warehouses, wine cellars, trout farms, and tennis courts were developed in mined-out limestone beds near Kansas City and in nearby States. More than 180 million square feet of mined-out space, as of 1981, was providing cheaper costs, less noise, no weather, and no distractions. Rents were often one-half as much as those aboveground; energy bills were 90% less; construction costs were lower because interior walls are the only usual structural needs; temperature stays at a steady 58 degrees; and humidity is about 50%. Inland Storage Distribution Center, a unit of Beatrice Foods Co., managed the space left by extracting the limestone near Kansas City.

Environment.—In the fall of 1980, the Bureau of Mines awarded a contract to the Kansas Geological Survey to study the hazards of abandoned open shafts, collapsed ground, and ground suspected of further collapse over mines in the now-inactive Tri-State lead-zinc area of southeastern Kansas. Working within a budget of $89,481, the Kansas Geological Survey was to complete the contracted work by September 19, 1982. Field investigations were completed by the end of 1981; the investigators worked with

maps and aerial photographs, inspected sites on foot, and identified about 3,500 shafts and prospects. More than 880 hazards were tallied; of about 530 collapsed shafts, 350 were within a few miles of Galena; 50 more shafts were found to be open and unprotected, though timbering was in place. The contract also called for recommendations to minimize or alleviate these hazards. Some of the techniques considered were capping, backfilling, or using hydroflushing to fill shafts and adits with a water and sludge mixture to support the walls and back. A final report was to be issued in September 1982.[3]

In an effort to bring unwanted kiln fines under control, The Monarch Cement Co. applied a dust retardant on 6 miles of roads at its plant and quarry near Humboldt. Lone Star Industries, Inc., conducted a project to improve its spoil pile on Highway K-32 near Bonner Springs. Grass was planted, and 150 seedling trees were to be added later.

Legislation and Government Programs.—Several environmental laws were enacted by the Kansas Legislature during the 1981 session.

Air Quality.—H.B. 2184 amended K.S.A. 65-3008 giving the secretary of the Department of Health and Environment authority to deny a permit to any proposed stationary source that may cause or contribute to pollution if the owner or operator cannot demonstrate that its other properties are in, or will be in, compliance with the Federal Clean Air Act.

Disposal of Salt Water.—A substitute for H.B. 2040 made it unlawful for anyone to dispose of salt water or brines produced in conjunction with the production of oil and gas except in the manner and location authorized, etc.

Hazardous Waste.—Senate substitute for House substitute for H.B. 2181 established, among other things, a Hazardous Waste Disposal Facility Approval Board. Members of the board are the secretary of the Department of Health and Environment, the secretary of the Department of Transportation, the State geologist, and two members of the general public appointed by the Governor. The board cannot approve an application for a radioactive hazardous waste disposal facility unless the State enters into an interstate compact to regulate the transportation, storage, and disposal of low-level radioactive waste. A former salt mine at Lyons was being considered as a possible site for such a disposal facility.

Mined-Land Conservation and Reclamation.—H.B. 2182 amended sections of the Kansas act to provide for compliance with provisions of the National Surface Mining Control and Reclamation Act of 1977. Also, a Mined-Land Reclamation Fund was created to replace an already-existing fund.

Governor John Carlin's proposed severance tax on oil, natural gas, coal, cement, and salt was modified and then successfully thwarted by opponents. At yearend 1981, the Governor planned to continue his effort for a severance tax enacted in Kansas; however, cement, coal, and salt were dropped from his proposed list of taxable mineral commodities.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Cement.—Kansas ranked 13th in value out of 40 portland cement-producing States, and 19th out of 38 masonry cement-producing States. Five plants were in operation. Late in 1981, General Portland, Inc., sold its outstanding shares of common stock for $47 (U.S.) per share to Canada Cement LaFarge, Ltd., of Montreal, thereby transferring the operation of its cement plant at Fredonia, Wilson County, to the foreign investor.

Canada Cement was the second foreign investor in Kansas cement plants; the other was Heidelberger Zement A.G. of the Federal Republic of Germany (Lehigh Portland Cement Co.).

At Chanute, Neosho County, a new cement terminal consolidated four terminals that had operated in Chanute, Fredonia, Humboldt, and Independence, serving, respectively, Ash Grove Cement Co., General Portland, Lehigh Portland, and Monarch Cement. Opened on January 5, 1981, the new terminal had a new central dispatch system to provide 24-hour service. Ruan Transport Corp., Des Moines, Iowa, employed about 75 persons at the new terminal and served the cement industry in Arkansas, Missouri, Oklahoma, and Texas, as well as Kansas.

Finished portland cements are classified as white or gray. The gray was used to make types I and II general-purpose, moderate-

heat portland cements, comprising about 92% of the total quantity and about 91% of the total value of finished portland cements in 1981.

In decreasing order of quantity used, gray and white finished portland cements were distributed as follows: 73.4% to ready-mix concrete companies, 9.2% to other contractors, 6.1% to concrete product manufacturers, 4.8% to building material dealers, 4.7% to miscellaneous customers, 1.7% to highway contractors (down 60% from that of 1980), and 0.1% to Federal, State, and other governmental agencies.

About 60% of finished portland cement was shipped to consumers by truck, approximately 35% by rail, and the remainder by other means.

During the year, the industry operated 15 kilns having a total production capacity of 7,416 tons of cement per 24 hours. Ash Grove Cement, General Portland, and Lone Star Industries, all used the wet process; Monarch Cement and Lehigh Portland used the dry process.

The industry consumed 2.8 million short tons of cement rock and limestone, 275,000 tons of clay and shale, nearly 119,000 tons of sand and sandstone, more than 5,700 tons of ferriferous materials, and about 76,600 tons of gypsum. Small amounts of various acids, resins, and other materials also were consumed.

Energy requirements for the industry in 1981 were less than those in 1980. Natural gas consumption was 1.02 billion cubic feet, 70% less than in 1980; fuel oil, bituminous coal, electricity, and petroleum consumption also declined.

The average value of all types of portland cement rose to $49.86 per short ton, a 6% increase over that of 1980. The average value of prepared masonry cement was $55.78 per short ton, 26 cents higher than that of 1980.

Table 4.—Kansas: Portland cement salient statistics

(Short tons unless otherwise specified)

	1980	1981
Number of active plants	5	5
Production	1,968,341	1,842,861
Shipments from mills:		
Quantity	1,834,580	1,640,572
Value	$86,103,446	$81,791,554
Stocks at mills, Dec. 31	190,813	293,953

Table 5.—Kansas: Masonry cement salient statistics

(Short tons unless otherwise specified)

	1980	1981
Number of active plants	5	5
Production	62,832	71,691
Shipments from mills:		
Quantity	59,616	50,831
Value	$3,309,604	$2,835,185
Stocks at mills, Dec. 31	17,047	32,691

Clays.—Common clay and shale and a comparatively small amount of bentonitic clay were mined in Kansas. During 1981, the quantity of clay (excluding bentonite) and shale increased 3.7%.

Eleven companies extracted common clay and shale from 19 mines in 11 counties: Allen, Barton, Cherokee, Cloud, Crawford, Ellsworth, Franklin, McPherson, Montgomery, Neosho, and Wilson. Micro-Lite, Inc., of Chanute, mined swelling bentonitic clay from its property in Woodson County. The bentonitic clay amounted to 27,000 short tons valued at $12.29 per ton. Common clay and shale brought a much lower average price per ton ($4.98); the total average value for all clays was $5.20.

Almost 36% of the common clay was used in manufacturing portland cement. Nearly 35% was used to produce concrete blocks and structural concrete products, up from 25% in 1980. More than 17% was used for common and face brick, down from 22% in 1980. Clay also was used in ceramic floor and wall tiles, highway surfacing, roof tile, manufacturing sewer pipe, and other items. Animal feeds were manufactured from the bentonitic clay.

The sagging economy and sluggish sales were blamed for the laying off in June of 75 workers at the W. S. Dickey Clay Manufacturing Co. in Pittsburg. At yearend, the company had 122 employees, down from a peak employment of more than 250 workers in the mid-1970's; the employee count included sales agents and the secretarial and clerical staff at the company's corporate office in Pittsburg.

In June, workers lost their jobs at the tunnel kiln, a facet of W. S. Dickey's operation that remained idle through yearend. Because of the size of the tunnel kiln and the time it takes to fire it—2 to 3 weeks—the company decided to reduce its stock of 4- to 15-inch sewerline pipe used for business

buildings, residences, and water treatment plants. Although the housing industry was slow, the company sold more pipe than it produced during the year, thus intentionally reducing its large inventory.

Elsewhere on the 100-acre W. S. Dickey site, 26 old brick beehive kilns stood idle; gradually they were being replaced by new circular kilns with steel exteriors. Five circular kilns, each equivalent to three of the older types, had been completed by the end of 1981; work on a sixth was halted because of a net reduction in sales. W. S. Dickey planned to build 12 new steel-sided kilns to replace the older, less efficient brick kilns, but company plans depended on a resurgence in the housing industry and orders associated with new waste-water treatment plants.

Excelsior Brick Corp.'s plant in Fredonia closed down for about 30 days in July. During the closedown, most employees took vacation time, but the plant manager and a small maintenance crew continued working. Operations resumed in early August.

Acme Brick Co. (a subsidiary of Justin Industries, Inc.) laid off more than a dozen employees during 1981, reducing its work force to 38 people by July, then 22 as of December 11. Recession, inflation, and high interest rates were major reasons for the cutback. In July, the company had a 15-million brick stockpile compared with a normal stockpile of only 1 to 2 million brick and was shipping about 60,000, or 40%, fewer brick per day than "during good times." The Acme plant was built in Kanopolis because of Ellsworth County's many colored-clay deposits. The clays were hauled to the plant from five different pits, located from 3 to 15 miles from the Acme plant. Equipped to manufacture 40 or 50 kinds of brick, the plant produced only 10 kinds in 1981. The brick, used locally or shipped to Oklahoma and Texas, was used for architectural, business, or residential construction.

Gypsum.—Although 1981 was the second year of a nationwide depression in housing construction, gypsum production in Kansas declined less than 1%; value, however, increased about 23%. Georgia-Pacific Corp., Gypsum Div., mined its number one grade gypsum and processed it into wallboard and plaster in the plant at Blue Rapids, Marshall County. At the far southern border of the State, National Gypsum Co.'s facilities in Barber County, near Medicine Lodge and Sun City, produced crude and calcined gypsum for wallboard manufacture.

Helium.—In the first quarter of 1981, a breach of contract lawsuit the Northern Helex Co. had brought against the Federal Government was settled. The helium company had contracted in 1961 to provide helium to the Government for 22 years, but the contract was considered broken in 1970. Other suits brought by Cities Service Helex, Inc., and National Helium Corp., which also have helium extraction plants in Kansas, were settled later in 1981.

The U.S. Bureau of Mines operates and maintains a high-pressure helium pipeline, which starts at Bushton and connects five of the six helium plants in Kansas to the Cliffside, Tex., helium storage reservoir. During 1981, about 453 million cubic feet of helium was put in the pipeline and about 385 million cubic feet was withdrawn for purification. The Bureau's pipeline maintenance station is near Satanta. Kansas ranked first in the Nation among the four high-purity helium-producing States.

Lime.—Great Western Sugar Co. produced quicklime for use in manufacturing and refining sugar at its beet sugar plant near Goodland, Sherman County. Value increased 16%, but quantity decreased 6% compared with that of 1980. The 1981 unit price, however, improved 20% over that of 1980, yet it was still a third lower than that of 1979.

Perlite.—Lite-Weight Products, Inc., expanded perlite obtained from out-of-State sources at its plant in Wyandotte County. The product was sold for filter aids, horticultural aggregates, and other uses.

Pumice.—Kansas was one of only eight pumice-producing States. Calvert Mines, Inc., owned mineral rights under 250 acres in Norton County, northwestern Kansas, where pumice (pumicite) has been mined for many years. Widely distributed in Kansas and nearby States, pumicite is a very finely divided volcanic ash interstratified with clays and sandstones of the Tertiary Period. The 18-foot-thick ash bed at Calvert is believed to have originated from volcanic eruptions in States southwest of Kansas and to contain about 5 million tons of ash.

In 1981, Calvert operated at 20% of capacity, employing three to six part-time workers. The pumicite was mined from an average depth of 16 feet, although at the 10-foot depth the ash is very fine and, upon the removal of moisture, could be used for sandblasting. Pumicite was accumulated at the mine, graded into seven categories, dried, and bagged by processors in St. Louis or Chicago. Pumicite, a natural pozzolan, was used as a substitute for as much as 40% of portland cement to produce a less porous

and lighter concrete. Pumicite also was used in abrasive cleansers; absorbents; acoustical and insulating plasters or tiles; bar, paste, and powdered hand soaps; ceramic bodies and glazes; chinchilla baths; concrete water proofing; construction blocks and slabs; insecticide carriers; lightweight aggregates; metal polishes; and paint products. Calvert acquired the mine in 1977 from a large national manufacturer of abrasive cleansers.

Salt.—Salt production from evaporated brines was approximately the same as that of 1980, but rock salt production decreased 6.4% from that of 1980.

American Salt Co. continued capital improvements at its Lyons plant. Three doors added to the warehouse and dock area enlarged the truck-loading capacity from six to nine trucks. A new 10- by 70-foot scale, which doubled loading capability, was installed at a cost of $100,000 in the new bulk-loading area. According to a company spokesperson, the company tentatively planned to expand the warehouse an additional 7,500 square feet to provide more storage for packaged products. Mining rock salt at American Salt resumed on a 5-day-per-week basis in mid-September, after a 2-day-per-week pace following the mild 1980-81 winter. Besides its use in deicing during the winter, rock salt was used to cure hides and has a variety of agricultural purposes.

Cargill Inc., Salt Div., used solution mining to extract a maximum of 650 tons per day from its 6 million tons of proven reserves in Reno County; the company estimated that there is an additional 15 million tons of probable reserves.[4]

Sand and Gravel.—To reduce the burdens and costs of reporting, the Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. This chapter, therefore, contains only preliminary estimates for construction sand and gravel production but contains complete data on industrial sand and gravel. The preliminary estimates of construction sand and gravel production for odd-numbered years will be revised and completed the following year.

In 1981, industrial sand was 1.4% of the estimated total quantity of sand and gravel produced in Kansas, and its value was 6.7% of the estimated total value. Quantity and value of construction sand and gravel were estimated to have decreased 13% and 12%, respectively; but quantity and value of industrial sand and gravel increased 2% and 7.8%, respectively.

Industrial sand was dredged from streams in the Kansas River valley near Kansas City by Builders Sand Co. in Johnson County and by HUB Materials, Inc., in Wyandotte County. In decreasing order of quantity, industrial sands were used for fiberglass, blasting, traction, roofing granules, and other uses; their average value per ton was $9.95, about 55 cents more than the 1980 average value. All industrial sand was shipped by either truck (92%) or railroad (8%).

An automated slag-processing plant, designed to produce annually 80,000 tons of granules for asphalt shingles and sandblasting abrasive, began production at La Cygne in April 1981. The plant was the newest of the Lone Star Industries' slag-processing facilities.[5]

Table 6.—Kansas: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	8,220	$15,990	$1.95	NA	NA	NA
Gravel	3,904	7,828	2.00	NA	NA	NA
Total or average	12,124	[1] r23,817	1.96	p10,600	p$21,000	p$1.98
Industrial sand	W	W	9.41	W	W	9.95
Grand total or average	W	W	2.05	W	W	p2.09

pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Data do not add to total shown because of independent rounding.

In the spring of 1981, the City of Pittsburg spent $30,000 to rejuvenate its municipal asphalt plant, which it has owned since 1969. Sand and chat in 200-pound batches are dumped into a pug mill and mixed with oil to create asphalt for road repairs. The asphalt can be produced at the rate of 40 tons per hour if the sand and chat are dry. Owning its own plant saved the city thousands of dollars in making street repairs, according to Pittsburg's Public Works director.

Stone.—Kansas stone quarries produced more than 14.1 million short tons of limestone and sandstone from 175 quarries during 1981, mostly as crushed stone. No stone operation in Kansas produced more than 800,000 tons per year; more than 169 quarries yielded less than 400,000 tons each per year. Only 14,067 tons of limestone, for use as dimension stone, was quarried from five sites in Chase, Cowley, Pottawatomie, and Riley Counties; the remainder of the limestone (13.8 million tons) and all of the sandstone(0.4 million tons) was crushed. In descending order of quantity quarried, the crushed sandstone was produced from Lincoln, Neosho, Graham, and Smith Counties.

Fifty-four private firms and seven county highway departments provided Kansas stone to consumers. Values ranged from a low of $1.00 per ton for crushed limestone produced by the Norton County Highway Department to about $121.00 per ton for dimension limestone produced by Bayer Stone, Inc., for rock from its quarry in Pottawatomie County. The average unit value of dimension limestone was $43.04; the average value for all stone was $3.27, although crushed sandstone averaged $5.00 per ton.

Counties having the greatest number of quarries were Miami (10) and adjacent Johnson (9), both near to or enclosing parts of the large metropolitan Kansas City area, where much of this mineral commodity was marketed. Counties producing the greatest tonnage of stone were Johnson (1.5 million tons) and Wyandotte (1.1 million tons), which also bordered the growing Kansas City area.

Martin-Marietta Aggregates, Central Div., the State's largest producer, operated 15 quarries in 10 counties (Coffey, Doniphan, Douglas, Elk, Franklin, Jefferson, Johnson, Leavenworth, Riley, and Shawnee). In decreasing order of output, each of the following produced more than 500,000 tons, mainly limestone, from the combined 72 quarries: Ash Grove Cement; Monarch Cement; N. R. Hamm Quarry Inc.; Midwest Minerals, Inc.; McAdam Limestone Products, Inc.; General Portland, Trinity Div.; Lone Star Industries, Central Region; and Ashland Oil, Inc., Reno Construction.

Dimension limestone was used for cut stone, house stone veneer, and rubble.

The Kansas Geological Survey is to publish in early 1982 the second part of a four-part series on Kansas building limestones.[6]

Table 7.—Kansas: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	719	1,828	385	1,167
Agricultural marl and other soil conditioners	3	13	W	W
Concrete aggregate (coarse)	2,949	12,414	2,326	10,211
Bituminous aggregate	1,820	7,253	1,487	6,006
Macadam aggregate	467	1,162	333	890
Dense-graded road base stone	2,834	8,715	1,865	6,023
Surface-treatment aggregate	790	2,860	677	2,290
Other construction aggregate and road stone	3,464	10,066	3,266	10,241
Riprap and jetty stone	394	1,365	159	543
Railroad ballast	126	687	89	451
Filter stone	226	650	178	544
Manufactured fine aggregate (stone sand)	133	450	20	51
Cement manufacture	3,372	6,982	3,206	7,024
Asphalt filler	W	W	61	131
Other[2]	99	288	92	165
Total[3]	17,398	54,731	14,143	45,738

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

[1]Includes limestone and sandstone.

[2]Includes stone used in terrazzo and exposed aggregate, fill, other uses not specified, and uses indicated by symbol W.

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

Crushed limestone was used, in descending order of quantity, for unspecified aggregate, cement manufacture, concrete aggregate, dense-graded road base stone, bituminous aggregate, surface treatment, and other products. Crushed sandstone was used, in descending order of quantity, for bituminous and concrete aggregates, railroad ballast, dense-graded road base stone, riprap and jetty stone, and other products.

About 97% of crushed stone was shipped by truck; the rest was shipped by railroad.

Sulfur (Recovered Elemental).—Refinery operations in Kansas produced 20,000 metric tons valued at $1.7 million in 1981, a 5% decline in tons but a 3% increase in value from that of 1980.

Vermiculite.—Shelter Shield Products, a division of Insulation Sales Co., produced exfoliated vermiculite at its plant in Wellsville, Franklin County. The company imported beneficiated vermiculite from Libby, Mont., and Africa.

Vermiculite has the unique property of exfoliating upon heating to produce a low-density, bulky material. The British thermal units required to expand a ton of vermiculite depend on the grade and quality of the material. The exfoliated material was used extensively and sold by Shelter Shield as lightweight aggregate and thermal insulation (block and loose fill) in the construction industry, as a fertilizer carrier and soil conditioner in horticulture and the agricultural industry, and for many other commercial and industrial applications.

[1]State Liaison Officer, Bureau of Mines, Denver, Colo.

[2]Berendsen, P., and M. W. Lambert. Copper Sulfides in the Lower Permian Redbeds of South-Central Kansas: Stratigraphy and Host Rock Lithology. Kansas Geol. Survey Bull. 223, pt. 1, 1981, 86 pp.

Lambert, M. W., P. Berendsen, and E. M. Ripley. Copper Sulfides in the Lower Permian Redbeds of South-Central Kansas: Ore Mineralogy. Kansas Geol. Survey Bull. 223, pt. 2, 1981, 15 pp.

[3]McCauley, J. Kansas Geological Survey, Lawrence, Kans., oral communication.

[4]1981 E&MJ International Directory of Mining, p. 198.

[5]Steel, C. Automated Slag Plant Goes Into Production. Pit & Quarry, August 1981, pp. 52-56.

[6]Aber, S. W., and D. A. Grisafe. Petrographic Characteristics of Kansas Building Limestones. Kansas Geol. Survey Bull. 224, 1982, 37 pp.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Ash Grove Cement Co.[1 2]	8900 Indian Creek Pkwy. Suite 600 Overland Park, KS 66225	Plant and quarry	Neosho.
General Portland, Inc., Victor Div.[2]	7701 East Kellogg St. Wichita, KS 67207	do	Wilson.
Lehigh Portland Cement Co	Box 428 Independence, KS 67301	do	Montgomery.
Lone Star Industries, Inc.[2]	Box 12449 Dallas, TX 75225	do	Wyandotte.
The Monarch Cement Co.[1 2]	Box 187 Humboldt, KS 66748	do	Allen.
Clays:			
Builder, Inc., a division of Clemens Coal Co.	Box 62299 Pittsburg, KS 66762	Pit, mine, mill, plant	Franklin and McPherson.
Cloud Ceramics, a division of General Finance, Inc.	Box 369 Concordia, KS 66901	Pits and plant	Cloud.
W. S. Dickey Clay Manufacturing Co	Box 6 Pittsburg, KS 66762	Mines and plant	Cherokee and Crawford.
Justin Industries, Inc., Acme Brick Co.	Box 425 Fort Worth, TX 76101	Pits and plant	Cherokee and Ellsworth.
Lehigh Portland Cement Co	718 Hamilton Mall Allentown, PA 18105	Mine	Montgomery.
Micro-Lite, Inc	1100 South Katy St. Chanute, KS 66720	do	Woodson.
Gypsum:			
Gypsum Div. of Georgia-Pacific Corp	900 SW. 5th Ave. Portland, OR 97204	Mine and plant	Marshall.
National Gypsum Co	2001 Rexford Rd. Charlotte, NC 28211	do	Barber.
Helium:			
Alamo Chemical Co	Richfield, KS 67953	Plant	Morton.
Kansas Refined Helium Co	Otis, KS 67565	do	Rush.
Northern Helex Co	Bushton, KS 67427	do	Ellsworth and Rice.
Union Carbide Corp., Linde Div.	do	do	Do.
Lime:			
Great Western Sugar Co	Box 5308 Denver, CO 80217	do	Sherman.

See footnotes at end of table.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Perlite, expanded:			
Lite-Weight Products, Inc	1706 Kansas Ave. Kansas City, KS 66105	Plant	Wyandotte.
Pumice:			
Calvert Mines, Inc	Box 97 Norton, KS 67654	Pit and plant	Norton.
Salt:			
American Salt Co	3142 Broadway Kansas City, MO 64111	Wells and underground mine.	Rice.
Carey Salt Co	1800 Carey Blvd. Hutchinson, KS 67501	Underground mine	Reno.
Cargill, Inc., Salt Div	Box 1403 Hutchinson, KS 67501	Mine	Do.
Independent Salt Co	Box 36 Kanopolis, KS 67454	Underground mine	Ellsworth.
Morton Salt Div. of Morton-Norwich Products, Inc.	Box 1547 Hutchinson, KS 67501	Evaporation pond	Do.
Vulcan Materials Co., Chemical Div	Box 7689 Birmingham, AL 35223	Wells	Sedgwick.
Sand and gravel (industrial):			
Builders Sand Co	78th & Holliday Dr. Kansas City, KS 66106	Dredges and plant	Johnson.
HUB Materials, Inc	Box 11126 Kansas City, KS 66111	Plant	Wyandotte.
Stone:			
N. R. Hamm Quarry Inc	Box 17 Perry, KS 66073	Quarries and plants	Various (12 counties).
Martin-Marietta Aggregates, Central Div.	Box 789 Cedar Rapids, IA 52406	do	Various (10 counties).
McAdam Limestone Products, Inc	Moran, KS 66755	do	Anderson and Cowley.
Midwest Minerals, Inc	Box 412 Pittsburg, KS 66762	do	Cherokee, Crawford, Labette, Montgomery, Neosho, Wilson.
Sulfur (byproduct):			
CRA, Inc	North Linden St. Coffeyville, KS 67337	Secondary recovery plant.	Montgomery.
Getty Refining & Marketing Co	Box 1121 El Dorado, KS 67042	do	Butler.
Phillips Petroleum Co	Bartlesville, OK 74004	do	Wyandotte.

[1]Also clays.
[2]Also stone.

The Mineral Industry of Kentucky

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Kentucky Geological Survey for collecting information on all nonfuel minerals.

By Donald K. Harrison[1] and Preston McGrain[2]

The value of Kentucky's nonfuel mineral production in 1981 was $207.8 million, $3.5 million more than that of 1980. Crushed stone was the leading nonfuel mineral produced, accounting for more than 50% of the total value. Other commodities produced included cement, clays, lime, sand and gravel, and zinc.

Kentucky ranked second in the Nation in the production of ball clay and primary aluminum and fourth in lime output. Commodities processed or manufactured in the State included perlite, vermiculite, synthetic graphite, pig iron, regenerator iron oxides, and synthetic mullite.

Trends and Developments.—The depressed economy continued to affect the State's construction mineral output. Decreases were reported for cement, crushed stone, clay and shale, and sand and gravel. Although output dropped in 1981, total State mineral value rose, reflecting higher unit values and an increase in lime production.

Depressed construction activity resulted in the temporary shutdown of several stone quarries in 1981 because of excessive inventories and exhausted stockpile space. Also, several operations changed ownership during the year. These ownership changes, which have become a trend in recent years, are usually the result of larger companies acquiring smaller ones, leaving only the most cost-efficient operations active. Increasing costs for larger and more mobile equipment, together with required safety

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

Mineral	1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2] thousand short tons	748	$3,692	490	$2,395
Gem stones	NA	1	NA	1
Sand and gravel thousand short tons	[3]7,767	[3]17,637	[p][3]7,000	[p]15,547
Stone (crushed) do	W	W	32,433	108,257
Combined value of cement, clays (ball clay), lime, sand and gravel (industrial), zinc (1981), and value indicated by symbol W	XX	182,970	XX	81,559
Total	XX	204,300	XX	207,759

[p]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes ball clay; value included with "Combined value" figure.

[3]Excludes industrial sand; value included with "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Adair	W	W	Stone.
Allen	W	W	Do.
Anderson	W	W	Do.
Barren	$848	$765	Do.
Bell	W	W	Sand and gravel.
Boone	3,755	3,229	Do.
Bourbon	W	W	Stone.
Boyle	W	W	Do.
Breckinridge	W	W	Sand and gravel, stone.
Bullitt	W	W	Stone, clays.
Butler	W	--	
Caldwell	W	W	Stone.
Calloway	W	W	Sand and gravel.
Carlisle	W	W	Clays, sand and gravel.
Carroll	2,363	1,640	Sand and gravel.
Carter	W	W	Stone, clays.
Casey	546	342	Stone.
Christian	4,749	3,338	Do.
Clinton	W	W	Stone, sand and gravel.
Crittenden	W	W	Stone.
Cumberland	W	W	Do.
Daviess	2,025	2,125	Sand and gravel.
Edmonson	W	W	Stone.
Estill	634	552	Do.
Fayette	W	W	Do.
Fleming	W	W	Do.
Floyd	W	W	Stone, sand and gravel.
Franklin	W	W	Stone.
Fulton	140	--	
Gallatin	W	W	Sand and gravel.
Garrard	W	382	Stone.
Graves	W	W	Clays, sand and gravel.
Grayson	W	W	Stone.
Green	W	W	Do.
Hancock	251	223	Clays.
Hardin	3,247	3,397	Stone.
Harlan	975	645	Do.
Harrison	W	W	Do.
Hart	W	W	Stone, sand and gravel.
Henderson	--	W	Sand and gravel.
Henry	W	W	Stone.
Hickman	W	W	Sand and gravel.
Jackson	327	437	Stone.
Jefferson	34,154	30,159	Cement, stone, sand and gravel, clays.
Jessamine	W	2,003	Stone.
Knott	--	W	Do.
Laurel	--	247	Do.
Lee	W	W	Do.
Letcher	3,872	2,879	Do.
Lewis	W	W	Sand and gravel.
Livingston	W	W	Stone, sand and gravel.
Logan	W	W	Stone.
McCracken	W	W	Sand and gravel.
McCreary	W	--	
Madison	W	W	Stone.
Marion	256	293	Do.
Martin	W	W	Sand and gravel.
Mason	W	W	Lime, stone, sand and gravel.
Meade	4,393	3,925	Stone.
Menifee	W	W	Do.
Mercer	W	W	Do.
Metcalfe	258	341	Do.
Monroe	W	W	Do.
Montgomery	W	W	Do.
Morgan	W	1,252	Do.
Muhlenberg	2,710	1,955	Do.
Nelson	W	W	Do.
Nicholas	155	138	Do.
Ohio	W	W	Do.
Oldham	4,390	3,144	Stone, sand and gravel.
Pendleton	W	W	Lime, stone.
Pike	1,834	W	Stone.
Powell	2,274	1,989	Stone, clays.
Pulaski	4,007	2,398	Stone.
Rockcastle	W	W	Do.
Scott	W	W	Do.
Simpson	W	W	Do.
Taylor	W	W	Do.
Todd	W	W	Do.
Trigg	W	W	Do.

See footnotes at end of table.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Union	W	W	Sand and gravel.
Warren	W	W	Stone.
Washington	W	W	Do.
Wayne	W	$600	Do.
Whitley	W	W	Clays.
Wolfe	$666	475	Stone.
Undistributed[2]	129,101	135,426	
Total[3]	207,927	204,300	

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: Ballard, Bath, Boyd, Bracken, Breathitt, Campbell, Clark, Clay, Elliott, Grant, Greenup, Hopkins, Johnson, Kenton, Knox, Larue, Lawrence, Leslie, Lincoln, Lyon, McLean, Magoffin, Marshall, Owen, Owsley, Perry, Robertson, Rowan, Russell, Shelby, Spencer, Trimble, Webster, and Woodford.

[2]Includes gem stones and values indicated by symbol W.

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

Table 3.—Indicators of Kentucky business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	1,609.0	1,627.1	+1.1
Unemployment	do.	121.8	168.9	+38.7
Employment (nonagricultural):				
Mining[1]	do.	52.8	50.5	-4.4
Manufacturing	do.	276.2	272.1	-1.5
Contract construction	do.	58.0	51.4	-11.4
Transportation and public utilities	do.	68.5	67.1	-2.0
Wholesale and retail trade	do.	260.8	258.3	-1.0
Finance, insurance, real estate	do.	52.3	52.0	-.6
Services	do.	210.5	214.7	+2.0
Government	do.	230.9	227.1	-1.6
Total nonagricultural employment	do.	1,210.0	1,193.2	-1.4
Personal income:				
Total	millions	$28,118	$30,966	+10.1
Per capita		$7,622	$8,455	+10.9
Construction activity:				
Number of private and public residential units authorized		10,360	7,562	-27.0
Value of nonresidential construction	millions	$246.2	$344.1	+39.8
Value of State road contract awards	do.	$180.0	$102.0	-43.3
Shipments of portland and masonry cement to and within the State	thousand short tons	1,034	990	-4.3
Nonfuel mineral production value:				
Total crude mineral value	millions	$204.3	$207.8	+1.7
Value per capita, resident population		$56	$57	+1.8
Value per square mile		$5,058	$5,143	+1.7

[p]Preliminary.

[1]Includes bituminous coal and oil and gas extraction.

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

programs and environmental protection equipment, often require more capital than the small operator can generate. Another development in the stone industry was the growth of underground operations in the State. Year-round operation, selective mining, excessive overburden, and reclamation are factors affecting this trend.[3]

Kentucky led the Nation in the apparent consumption of explosives and blasting agents used in 1981. Although most of the explosives sold were used in coal mining, the State ranked second, behind Pennsylvania, in sales for quarrying and nonmetal mining. Approximately 40,400 pounds was sold in the State for this usage in 1981.

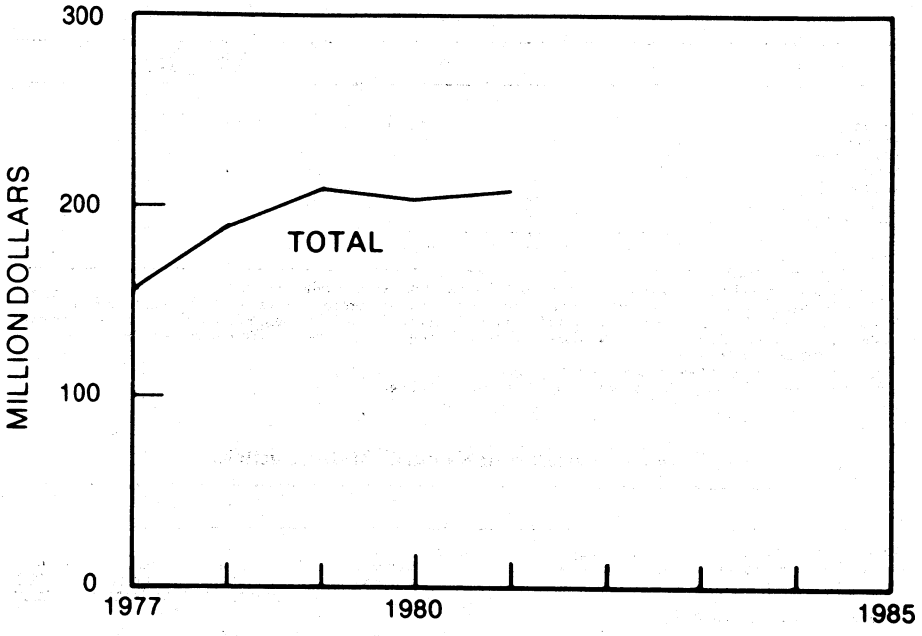

Figure 1.—Total value of nonfuel mineral production in Kentucky.

Legislation and Government Programs.—In July, under a new minerals tax revenue sharing program, the State began distributing $22.7 million collected in mineral severance taxes. Under the new program, 50% of all coal severance taxes collected above a base of $177.6 million would be returned to cities and counties that produced or were impacted by coal mining. Also, 50% of the current severance taxes collected on minerals other than coal would be returned to the cities and counties where the minerals were produced. Legislation creating the severance tax and local government economic assistance fund was passed into law in 1980.

During 1981, the Kentucky Geological Survey continued identification and characterization investigations of barite, fluorspar, limestone, sand and gravel, and zinc. Results of investigations in the Western Kentucky Fluorspar District pertaining to Chesterian (Mississippian) rocks at the Stevens Hill cut area along the western Kentucky Parkway in Caldwell County were published in a report that helped clarify stratigraphic and nomenclature problems in part of the district.[4]

Also during the year, a geologic map of Kentucky (scale 1:250,000) was published by the U.S. Geological Survey (USGS) in cooperation with the Kentucky Geological Survey. Compiled from more than 700 USGS Geological Quadrangle maps (scale 1:24,000), the new map of Kentucky is the only statewide geologic map in the United States that is based entirely on published detailed mapping.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Cement.—Moore McCormack Resources, Inc., operated the only cement plant in the State. The company purchased the 670,000-ton-per-year-capacity[5] Kosmos plant near Louisville in late 1980 from The Flintkote Co., a subsidiary of Genstar Ltd., Montreal, Canada.

In 1981, shipments of portland and masonry cement declined moderately compared with those of 1980 because of the continued slowdown in the construction industry. The cement was produced by the dry proc-

ess and was used by ready-mix concrete companies, concrete-product manufacturers, highway contractors, and building-material dealers.

Clays.—A total of 12 companies operating 15 pits produced common clay and shale, fire clay, and ball clay.

Common clay and shale was produced by eight companies at eight operations in Bullitt, Hancock, Jefferson, Powell, and Whitley Counties. Principal uses were in the manufacture of common and face brick, quarry tile, lightweight aggregate, and portland cement.

Fire clay was mined by two companies in Carter and Graves Counties, while ball clay was produced by two companies with five operations in Carlisle and Graves Counties. Both fire and ball clays were processed or packaged and shipped in bulk to manufacturers of pottery ware, floor and wall tile, or used as paper filler, in refractory ware, and in firebrick.

In late 1981, Old Hickory Clay Co. completed installation of a new $500,000 hammer (impact) mill at the company's Mayfield plant and also erected several new storage sheds at the site. Old Hickory produced ball clay from operations in both Kentucky and Tennessee. Most shipments were to the Midwest; some of the clay was exported to Mexico and Canada.

Fluorspar.—Although no production has been reported since 1978, several firms were evaluating deposits in the Western Kentucky Fluorspar District.

As part of a long-term investigation of the geology and minerals deposits of the Western Kentucky Fluorspar District, the Kentucky Geological Survey investigated the Tabb area in Crittenden and Caldwell Counties. Although the Tabb area has been the most productive part of the district, little has been published on the area for more than 50 years. A report, which includes detailed surface and underground maps, was still awaiting drafting and editorial processing.[6]

Gem Stones.—Gem material and mineral specimens have been collected in various parts of the State. The State is well known for its Halls Gap millerite and honessite, agate, and coalfield fossils. Some of the other minerals found in the State included barite, calcite, chalcopyrite, fluorite, galena, pyrite, and sphalerite.[7]

Graphite (Synthetic).—Two companies produced synthetic graphite in the State. Superior Graphite Co. operated a plant at Hopkinsville, Christian County. The graphite was sold for use as an additive in iron-making. Sigri Carbon Corp. operated a plant in Hickman, Fulton County. The graphite was primarily used to make electrodes.

During the year, Superior Graphite completed a $3.5 million expansion at its Hopkinsville plant, increasing annual capacity to 22,000 tons.

Lime.—In 1981, Kentucky ranked fourth nationally in lime output. Two companies operated underground mines and calcining facilities in Mason and Pendleton Counties. These plants were two of the Nation's leading individual plants in terms of total lime output.

Dravo Lime Co., a subsidiary of Dravo Corp., produced Thiosorbic lime (quicklime) from a 1-million-ton-per-year-capacity plant at Maysville in Mason County. The Thiosorbic lime was primarily sold to coal-fired electric generating plants in the Ohio Valley for use in sulfur dioxide removal. In 1981, the plant operated at near full capacity; full plant production (1 million tons) was scheduled for 1982.[8] Also, the company announced that the planning and preliminary engineering stages for a fourth calcining system at the site was completed. Actual construction will depend on market conditions.

The Black River Lime Co., jointly owned by Armco Inc. and Jones & Laughlin Steel Corp., produced both quicklime and hydrated lime at the Nation's fifth largest plant at Carntown in Pendleton County. The lime was sold for basic-oxygen furnace (BOF) steel production and other industrial and chemical uses, primarily in the Midwest and upper South.

Since 1978, the U.S. Bureau of Mines Pittsburgh Research Center has been monitoring and evaluating an audio, digital, and communications system installed in the Black River underground limestone mine. The system uses closed-circuit television surveillance to monitor conveyor belt transfer points and rock crusher operations. In 1981, the Bureau began operating an environmental monitoring and status reporting system in the mine. Both systems use the coaxial cable for communications in and out of the mine.

Mullite.—Didier-Taylor Refractories Corp. was one of four producers of high-temperature sintered synthetic mullite in the United States. Output came from the company's plant in Greenup County and was used primarily in refractory products.

Perlite (Expanded).—Two companies expanded perlite shipped from other States.

Grefco, Inc., operated a plant at Florence in Boone County, and W. R. Grace & Co., at Wilder, Campbell County. Total State production in 1981 was about the same as that of 1980. The expanded perlite was used in the manufacture of roofing materials, for horticultural purposes, and as lightweight construction aggregate.

Sand and Gravel.—The U.S. Bureau of Mines, to reduce reporting burdens and costs, implemented new sand and gravel canvassing procedures for the survey of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel operators will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but contains complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Based on these preliminary estimates, both output and value of construction sand and gravel decreased in 1981. Principal uses included concrete aggregate, asphaltic concrete, and fill. A small amount of industrial sand was also produced in 1981. Main uses were for foundry sand, blasting sand, traction sand, and for refractories.

Sand and gravel was the fourth most valuable commodity produced in the State. Principal production in Kentucky was concentrated in the channels and valleys of the Ohio and Mississippi Rivers. Approximately two-thirds of the production was derived from floating-dredge operations in the Ohio River and from glacial outwash deposits of the Wisconsin age along its valley.[9]

According to a report by the Kentucky survey, problems facing the sand and gravel industry in Kentucky include irregular distribution and variable composition of deposits, competition for land, costs of meeting environmental and reclamation regulations, and zoning restrictions.[10]

Table 4.—Kentucky: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	6,151	$13,231	$2.15	NA	NA	NA
Gravel	1,616	4,406	2.73	NA	NA	NA
Total or average	7,767	17,637	2.27	pr7,000	p$15,300	p$2.19
Industrial sand	W	W	r19.25	W	247	W
Grand total or average	W	W	2.30	W	p15,547	p2.22

pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data.

Stone.—Crushed stone continued to be Kentucky's most valuable mineral construction material and accounted for more than 50% of the State's nonfuel mineral value. In 1981, stone was produced by 56 companies operating 103 quarries in 69 counties. The majority of the quarries (101) produced limestone; sandstone was produced at 2 quarries in Floyd and Knott Counties. Main uses of all crushed stone were for road base, road base aggregate, and riprap.

At midyear, Amoco Minerals Co., a subsidiary of Standard Oil Co. (Indiana), acquired the Harbert Corp. mining operations in exchange for 5 million shares of Standard Oil. The transaction included Harbert's eastern Kentucky coal mines and a 4-million-ton-per-year limestone quarry in the State.

During 1981, the State Highway Department experimented with using sandstone as a substitute for limestone for roadbuilding material along a 44-mile stretch of State Route 80 in the eastern part of the State. Although sandstone has been used on a few smaller roadbuilding jobs in the State, the Route 80 project is the first large-scale substitution of the material for limestone on a major highway. The high cost of transporting limestone from sources west of the project prompted the study. The locally mined sandstone costs $5 per ton compared with $12 to $14 per ton for the transported limestone.[11]

Table 5.—Kentucky: Crushed limestone sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	2,111	7,008	1,963	7,203
Poultry grit and mineral food	6	90	W	W
Concrete aggregate (coarse)	3,002	10,324	3,230	11,454
Bituminous aggregate	3,050	10,427	3,279	12,119
Macadam aggregate	1,038	2,840	1,104	3,109
Dense-graded road base stone	8,156	25,078	6,837	22,803
Surface-treatment aggregate	1,119	3,752	974	2,921
Other construction aggregate and road stone	7,862	24,917	7,807	24,806
Riprap and jetty stone	3,413	9,357	2,263	6,809
Railroad ballast	308	943	482	1,631
Filter stone	193	622	562	2,249
Manufactured fine aggregate (stone sand)	647	2,027	535	1,720
Lime manufacture	W	W	1,621	3,913
Flux stone	31	110	47	164
Mine dusting	301	2,177	354	2,552
Asphalt filler	(1)	4	--	--
Other fillers or extenders	6	55	6	71
Other[2]	2,444	5,477	837	1,884
Total[3]	33,687	105,207	31,900	105,407

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Less than 1/2 unit.
[2]Includes stone used for cement manufacture, fill, other uses not specified, and items indicated by symbol W.
[3]Data may not add to totals shown because of independent rounding.

Vermiculite (Exfoliated).—W. R. Grace exfoliated crude vermiculite mined in other States at a plant in Wilder. The product was used primarily for block and loose-fill insulation, fireproofing, lightweight aggregate, and soil conditioning.

METALS

Aluminum.—Kentucky ranked second, behind Washington, in the production of primary aluminum. Output in 1981 remained about the same as that of 1980. Two companies each operated 180,000-ton-per-year smelters in the State: National-Southwire Aluminum Co. in Hawesville, Hancock County, and Anaconda Aluminum Co. in Seebree, Webster County.

During the year, Anaconda began construction of a new $400-million rolling mill complex near Russellville in Logan County. Initial capacity of the plant was to be 200,000 tons per year, with an ultimate capacity of 500,000 tons per year. The plant was expected to be operational in 1983 and employ nearly 400 people.

At yearend, the Howmet Aluminum Corp. agreed to purchase the National Steel Corp. aluminum sheet-rolling mill at Hawesville, which was closed in July 1979. Under terms of the agreement, Howmet was to buy the mill and production equipment and lease additional buildings and land for 2 years with an option to buy. Howmet also agreed to process National's ingot into coil for a 2-year period. Production at the mill was expected to begin in January 1982.

Iron and Steel.—Armco produced both pig iron and regenerator iron oxides at its Ashland plant in Boyd County. At midyear, the company began construction of a new $90 million continuous caster plant near Ashland for production of blooms for "oil country" tubular products. Also, the company announced plans to build a $290 million seamless tubular plant at Ashland. The plant was expected to produce 450,000 tons per year of tubular products for oil and gas well drilling and production. Expected date of completion was 1984.

Interlake Inc., which closed its steel plants at Wilder and Newport in northern Kentucky in 1980, sold its facilities to a group of former employees under the name of Newport Steel Corp. The plants were reactivated by the new company in 1981.

Zinc.—Sphalerite (zinc ore) was recovered as a byproduct of underground limestone mining at Lexington Quarry Co., Jessamine County, in central Kentucky. The company built a small mill to concentrate the ore, which occurs in a narrow vein deposit. Some of the zinc concentrate was shipped to an out-of-State smelter during 1981.

[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]Assistant State geologist, Kentucky Geological Survey.
[3]McGrain, P. Trends in the Industrial Mineral Industries in Kentucky. Ky. Geol. Survey Inf. Circ. 6, Ser. XI, 1982, 8 pp.
[4]Trace, R. D. Middle Chesterian Rocks in the Stevens Hill Cut, Caldwell County, Ky. Ky. Geol. Survey Misc. Rept., 1981, 52 pp.
[5]Moore McCormack Resources. 1980 Annual Report. P. 3.
[6]Trace, R. D. Geology and Ore Deposits of the Tabb Area, Tabb Fault System, Crittenden and Caldwell Counties, Ky. Ky. Geol. Survey. (Report in review.)
[7]Rocks and Minerals. V. 56, No. 3, May-June 1981, pp. 92-138.
[8]Dravo Corp. 1981 Annual Report. P. 15.
[9]Work cited in footnote 3.
[10]McGrain, P. Overview of Sand and Gravel Resources in Kentucky. Ky. Geol. Survey Rept. of Invest. 1, Ser. XI, 1982, 19 pp.
[11]The Courier Journal (Louisville, Ky.). July 9, 1980.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum (primary):			
Anaconda Aluminum Co	Box 1654 Louisville, KY 40201	Smelter	Webster.
National-Southwire Aluminum Co.	Box M Hawesville, KY 42348	do	Hancock.
Cement:			
Kosmos Cement Co., Inc.[1]	Dixie Highway Kosmosdale, KY 40272	Plant	Jefferson.
Clays:			
General Shale Products Co	Box 3567 CRS Johnson City, TN 37601	Mine and plant	Do.
Kentucky Solite Corp	Box 27211 Richmond, VA 23261	do	Bullitt.
Kentucky-Tennessee Clay Co	Box 77 Mayfield, KY 42066	do	Carlisle and Graves.
Iron (pig):			
Armco Inc	Middletown, OH 45202	Plant	Boyd.
Newport Steel Corp	9th & Lowell Sts. Newport, KY 41072	Plants	Campbell.
Lime:			
Black River Lime Co	Route 1 Butler, KY 41006	Mine and plant	Pendleton.
Dravo Lime Co	650 Smithfield St. Pittsburgh, PA 15222	do	Mason.
Perlite (expanded):			
W. R. Grace & Co.[2]	62 Whittemore Ave. Cambridge, MA 02140	Plant	Campbell.
Grefco, Inc	Box 35 Florence, KY 41042	do	Boone.
Sand and gravel:			
Evansville Materials, Inc	Box 248 Tell City, IN 47586	Dredges	Breckinridge and Daviess.
Ingram Materials, Inc	Box 1049 Nashville, TN 37202	Dredge	Livingston.
Martin Marietta Corp.[3]	Box 789 Cedar Rapids, IA 52406	Dredge and pits	Boone, Carroll, Jefferson, Oldham.
E. T. Slider, Inc	1602 East Market Jeffersonville, IN 47130	Dredge	Oldham.
Stone:			
Kentucky Stone Co	400 Sherburn Lane Louisville, KY 40207	Underground mines, quarries, plants.	Various.
Medusa Aggregates Co	175 Moore Dr. Lexington, KY 40502	do	Do.
Reed Crushed Stone Co	Box 35 Gilbertsville, KY 42044	Quarry and plant	Livingston.
Three Rivers Rock Co	Box 218 Smithland, KY 42081	do	Do.

[1]Also clays.
[2]Also exfoliated vermiculite.
[3]Also stone.

The Mineral Industry of Louisiana

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Louisiana Geological Survey for collecting information on all nonfuel minerals.

By Albert E. Ward[1]

Total value of nonfuel minerals declined in 1981 to $574 million, down slightly from the record $584 million in 1980. Louisiana led in salt output with almost one-third of national production. The State was ranked second in Frasch sulfur recovery with more than one-third of the Nation's output. The combined value of salt and sulfur represented more than two-thirds of the State's total nonfuel minerals value in 1981. Much of the salt and sulfur was used to supply in-State chemical industry demands, and the remainder was marketed nationwide. Other important minerals produced were clays, gypsum, lime, sand and gravel, and stone; these minerals or their products were marketed mostly in-State or in bordering States.

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

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
Clays thousand short tons	380	$5,841	[2]380	[2]$6,338
Gem stones	--	--	NA	1
Salt thousand short tons	12,662	132,182	12,565	113,190
Sand and gravel do	18,505	66,413	[p]18,293	[p]66,426
Stone (crushed) do	W	W	[3]7,228	[3]34,566
Sulfur (Frasch) thousand metric tons	2,590	W	2,235	W
Combined value of cement, clays (bentonite, 1981), gypsum, lime, and values indicated by symbol W	XX	379,330	XX	353,438
Total	XX	583,766	XX	573,959

[p]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes bentonite; value included with "Combined value" figure.
[3]Excludes some crushed stone; value included with "Combined value" figure.

Table 2.—Value of nonfuel mineral production in Louisiana, by parish[1]

(Thousands)

Parish	1979	1980	Minerals produced in 1980 in order of value
Allen	W	W	Sand and gravel.
Ascension	W	W	Salt.
Assumption	W	W	Do.
Beauregard	$2,937	W	Sand and gravel.
Bienville	W	W	Clays.
Caddo	W	W	Do.
Calcasieu	W	W	Salt.
Catahoula	417	$492	Sand and gravel.
East Baton Rouge	W	7,863	Do.
East Feliciana	2,790	2,632	Do.
Grant	3,432	1,897	Do.
Iberia	59,441	72,986	Salt.
Iberville	W	W	Do.
Jefferson	W	W	Sulfur, salt.
Jefferson Davis	W	W	Sand and gravel.
Lafayette	687	725	Do.
Lafourche	W	--	
La Salle	967	2,706	Sand and gravel.
Livingston	739	674	Do.
Morehouse	W	W	Do.
Natchitoches	W	W	Clays.
Orleans	W	W	Cement, stone, lime.
Ouachita	3,417	1,903	Sand and gravel.
Plaquemines	W	W	Sulfur, salt.
Pointe Coupee	W	W	Clays.
Rapides	4,892	6,378	Sand and gravel.
Red River	358	438	Do.
Sabine	3	17	Do.
St. Bernard	W	W	Do.
St. Helena	W	W	Sand and gravel, clays.
St. James	W	W	Salt.
St. Martin	W	W	Salt, sand and gravel.
St. Mary	W	W	Salt, lime, stone.
St. Tammany	W	W	Sand and gravel, clays.
Tangipahoa	3,753	3,608	Sand and gravel.
Terrebonne	--	W	Sulfur, salt.
Union	276	--	
Vermilion	--	252	Sand and gravel.
Vernon	982	1,317	Do.
Washington	4,929	4,540	Do.
Webster	6,304	7,322	Do.
West Feliciana	1,063	1,307	Do.
Winn	W	W	Stone, gypsum.
Undistributed	357,890	466,712	
Total[2]	455,276	583,766	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]No nonfuel mineral production was reported for Acadia, Avoyelles, Bossier, Caldwell, Cameron, Claiborne, Concordia, De Soto, East Carroll, Evangeline, Franklin, Jackson, Lincoln, Madison, Richland, St. Charles, St. John the Baptist, St. Landry, Tensas, West Baton Rouge, and West Carroll Parishes.

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

Table 3.—Indicators of Louisiana business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	1,747.1	1,770.7	+1.4
Unemployment	do	118.3	151.8	+28.3
Employment (nonagricultural):				
Mining[1]	do	87.3	97.4	+11.6
Manufacturing	do	212.2	220.1	+3.7
Contract construction	do	140.6	139.3	-.9
Transportation and public utilities	do	124.3	132.1	+6.3
Wholesale and retail trade	do	355.9	369.2	+3.7
Finance, insurance, real estate	do	74.7	75.1	+.5
Services	do	270.0	288.1	+6.7
Government	do	306.1	306.2	--
Total nonagricultural employment[1]	do	1,571.1	1,627.5	+3.6
Personal income:				
Total	millions	$35,637	$40,861	+14.6
Per capita		$8,456	$9,486	+12.2

See footnotes at end of table.

Table 3.—Indicators of Louisiana business activity —Continued

	1980	1981[p]	Change, percent
Construction activity:			
Number of private and public residential units authorized	20,609	18,403	-10.7
Value of nonresidential construction millions	$539.6	$651.9	+20.8
Value of State road contract awards do	$486.8	$219.0	-55.0
Shipments of portland and masonry cement to and within the State thousand short tons	2,808	2,667	-5.0
Nonfuel mineral production value:			
Total crude mineral value millions	$583.8	$574.0	-1.7
Value per capita, resident population	$139	$137	-1.4
Value per square mile	$12,031	$11,828	-1.7

[p]Preliminary.
[1]Includes oil and gas extraction.

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

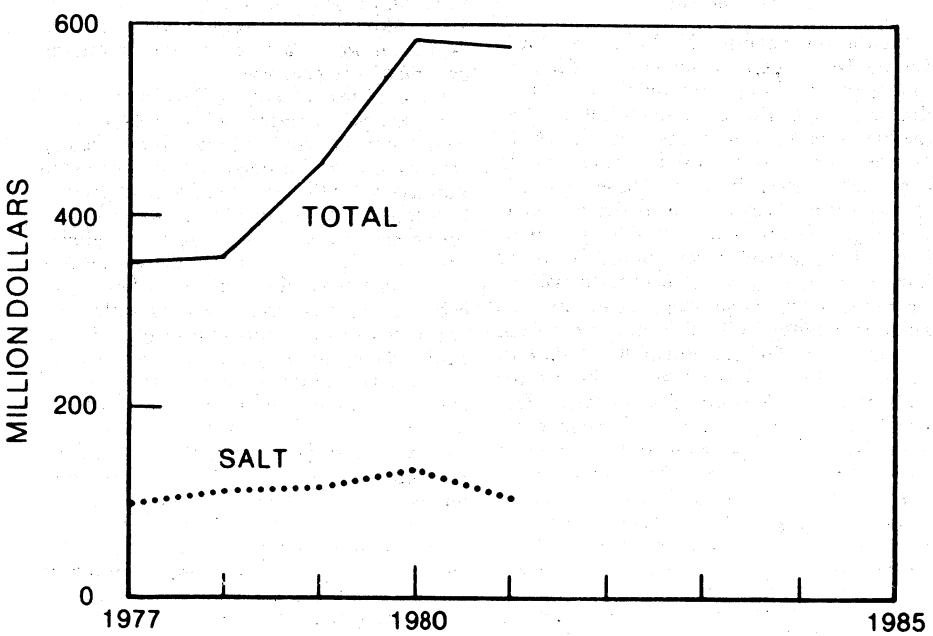

Figure 1.—Value of salt and total value of nonfuel mineral production in Louisiana.

Legislation and Government Programs.—In 1981, the Louisiana Legislature passed Act 760 (House Bill 1794) that grants expropriation authority to the State or corporations for developing carbon dioxide pipelines for use in connection with secondary or tertiary oil and gas recovery projects, and authorizes the commissioner of conservation to adopt rules for regulating construction and operation of such pipelines.

As in recent years, considerable legislation was introduced relating to environmental protection and hazardous-waste disposal. In the autumn, a brief but lively debate flared during the special session of the legislature concerning management of the State's Enhanced Mineral Trust Fund (EMTF). The EMTF is the State's "rainy day" fund based upon mineral severance taxes, now mainly from oil. Because costs of

proposed major construction programs have risen sharply in recent years, proponents of State highway and bridge projects, for example, called for immediate funding from the EMTF. Opponents who foresaw the eventual ebbing of mineral severance taxes as minerals are depleted preferred to build up the EMTF now and spend the interest and some principal as needed in later years to cushion declining employment in minerals industries. The debate was triggered because inflation had undercut the dollar value of the fund, and real interest income had been only marginally rewarding. Although outcome of the debate was inconclusive, the fund was not tapped in 1981.

The Louisiana Geological Survey, a nonregulatory component of the Department of Natural Resources, conducted geological research programs that produced information useful to developing the State's natural resources and protecting its environment. Studies related to water resources and coastal erosion problems were stressed. The Survey started a 1:250,000-scale geologic map series, was preparing a 1:500,000-scale State geological map, and continued its parish mapping program.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Barite.—At yearend, NL Industries, Inc.'s Baroid Div. began constructing a $25 million barite grinding plant and drilling-fluids distribution center at Lake Charles. The facility was scheduled for completion in October 1982, and capacity operation is expected by 1984. Both land-based and offshore drilling operations in Texas as well as Louisiana, Baroid's largest domestic market, will be served by the plant. Imported barite ore from several countries will be unloaded from deepwater vessels and be supplemented by rail shipments of ore from Nevada. Two 66-inch Raymond mills will grind barite to desired specifications for waterfront storage and subsequent distribution by barge, rail, and truck. Earlier in the year, NL Baroid opened a service center in Port Allen to serve the Tuscaloosa trend drilling. Although oil drilling activity eased in late 1981, regional deep gas is expected to remain an economically attractive target thereby assuring a firm, long-term market for barite drilling products.

A. W. Arnold Co. at Baton Rouge and Old Soldier Minerals Co. at Abbeville constructed new grinding plants. Blast Abrasives Co. and Halliburton Co.'s Imco Services Div. both completed new grinding plants at Houma. The following firms completed expansion of their respective plants: Chromalloy Mining & Minerals, a division of Chromalloy American Corp. at Houma; Dresser Minerals, a division of Dresser Industries, Inc., at Baton Rouge; Galveston-Houston's Fluid Services Div. at Amelia; and Milchem, Inc., a subsidiary of Baker International Corp. at New Orleans.

Cement.—Lone Star Industries, Inc., continued to operate two wet-process cement kilns at its plant in New Orleans during 1981. Most of the output was portland cement; however, a small amount of masonry cement was produced.

Demand for cement in Louisiana, strong in recent years, decreased sharply in 1981 owing to weakness in highway and housing construction and a downturn in petroleum industry activities. Portland cement production fell by about one-fourth, whereas masonry cement output plunged by almost one-half. Prices were firm, essentially unchanged from those of 1980. Lone Star exercised firm control of stocks with yearend inventories of portland down substantially and masonry up a negligible amount.

Disposition of portland cement by type of customer was mostly unchanged from that of 1980. Ready-mix concrete companies continued to take about one-half of the cement. Highway contractors took about the same quantity as in 1980, a reflection of the continued stagnation in highway construction. Building-material dealers reflected their depressed housing-industry needs by taking less than one-half the amount of cement they bought in 1980.

National Gypsum Co. sold its mineral-fiber cement plant in New Orleans, operated by its Gold Bond Building Products Div., to International Building Products, Inc. An expanded line of mineral-fiber cement products was foreseen at the plant, which in recent years has had a product mix of more than 300 building materials and supplies. No interruption of output occurred because of the change in ownership.

Clays.—Output of common clay in 1981 was unchanged from that of 1980 to halt a 3-year downtrend. Average price of common clay was firm, rising about 9% from $15.37 to $16.68 per ton. Louisiana also produced

bentonite clay in 1981. Six companies produced common clay at nine mines, and Filtrol Corp. operated one bentonite mine in Claiborne Parish. Common clay was produced in the following parishes: Bienville, Caddo, Natchitoches, Pointe Coupee, St. Helena, and St. Tammany. End uses of the common clay were face brick and concrete block, about one-third of total output for each; and structural concrete and highway surfacing, about one-sixth of total output for each—all essentially unchanged from 1980 uses.

St. Joe Brick Works, a privately owned brickyard, marked its 100th year of operation under the guidance of a fourth-generation member of the Schneider family. St. Joe bricks are still crafted in the traditional soft-mud process, formed in sand-dusted wooden molds in the plant north of Slidell in St. Tammany Parish. Wooden molds provide the flexibility in brick dimensions increasingly needed to meet custom demands for small-scale restoration projects in New Orleans and other nearby markets. Varying the temperature in the three brickyard kilns provides a wide color range, commonly flecked with black inclusions from disseminated pyrite in the St. Tammany clay. Local clay resources are sufficient for prolonged operations.

Table 4.—Louisiana: Clays sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1977	401	785
1978	517	4,786
1979	416	6,073
1980	380	5,841
1981[1]	380	6,338

[1]Excludes bentonite.

Gypsum.—Output of gypsum at Winn Rock, Inc.'s quarry near Winnfield, Winn Parish, increased 5% in 1981, sustained by an 8% increase of road base construction aggregate. However, sales of set retardant dropped about 50% in 1981 following a one-third fall in 1980. Prices held firm in 1981. National Gypsum Co. in Jefferson Parish and United States Gypsum Co. in Orleans Parish produced calcined gypsum—both companies used gypsum that was shipped into the State. Calcined gypsum output inched up slightly; but price, reflecting weak construction-industry markets, was off about 12%.

Lime.—Oyster shell continued as the principal raw material used to manufacture lime at the United States Gypsum plant in Orleans Parish and S. I. Lime Co.'s plant in St. Mary Parish. Quicklime output was down almost one-tenth, hydrated lime was off about one-fifth, and total lime by about one-seventh. Prices were firm—quicklime rose about 5%, hydrated lime up 20%, and total lime increased by about one-eighth. Lime markets in the regional aluminum and petrochemical industries weakened as the year progressed.

Perlite (Expanded).—Filter Media Co. of Louisiana continued to expand perlite shipped into the State at its plant in Reserve, St. John the Baptist Parish. Production was off slightly owing to weakness in housing construction.

Salt.—Louisiana retained its leading position among 16 salt-producing States in 1981 with 32% of the Nation's output, about the same as in 1980. Generally, most markets for Louisiana salt weakened in 1981 following strong demand in 1979 and early 1980. Almost two-thirds of the salt output normally has been consumed as brine in-State by the extensive chemical industry, but this industrial activity weakened as 1981 progressed. Much of the rock salt was barged up the Mississippi River to the upper Midwest for use in deicing; however, in contrast to some severe winters in the late 1970's, weather conditions in early 1981 were somewhat moderate, and salt demand was off. Following the relatively mild upper Midwest winter, some Louisiana rock salt producers made aggressive marketing efforts in the summer of 1981, and as a result of price reductions, production continued firm as northern consumer States built up stocks of rock salt for the winter of 1981-82. Because of the weakened markets, the average price of salt fell from $10.44 per ton in 1980 to $9.01 in 1981, down about 16%; however, output eased less than 1%.

As in 1980, 14 companies recovered salt from 17 operations in southern Louisiana parishes. Five of the mines were underground; the remainder were solution mines.

Louisiana's salt industry appeared to have entered a period of stable output following moderately strong growth in production during the latter half of the 1970's. The State's salt industry is favored by a reliable labor force, good climate, and easy access to low-cost water transportation. However, the industry usually sells 60% and more of its output to the regional chemical industry. The chemical industry

in Louisiana's southern parishes has the same above-listed advantages as the salt industry, plus a history of access to low-cost natural gas and abundant water supply. Soaring natural gas prices and water quality problems in recent years have required the chemical industry to direct a substantial share of its capital investments toward energy-saving and pollution-control expenditures rather than to plant improvements and expansions. Until most of the costly energy- and pollution-related investments are completed, the in-State markets for brine are unlikely to exhibit much growth. Salt output and price in the interim may become increasingly sensitive to the smaller quantity of rock salt produced for the volatile, unpredictable, weather-induced needs for deicing in the upper Midwest.

Local economic activity largely returned to normal soon after the November 20, 1980, flooding of the Diamond Crystal Salt Co. mine at Jefferson Island. The salt mine is permanently lost to water from overlying Lake Peigneur. In early 1981, however, Diamond Crystal was pumping brine from the mine area for salt recovery and later in the year barged rock salt and evaporated salt to the area and bagged them for marketing. The work force was reduced about two-thirds to approximately 100 workers. Some of the former mine employees found work in the regionally active oil and gas industry. Commercial fishing soon returned to normal, and in Delcambre Canal, after a temporary backward surge of water from the Gulf of Mexico to the downdrawn lake, fishing conditions improved because the channel was deepened. Live Oak Gardens botanical park, severely damaged by subsidence and lake encroachment, was temporarily closed as administrators awaited the results of geologic and geophysical studies to determine whether the garden's area is safe for redevelopment. Numerous lawsuits and countersuits have been filed among the following: Diamond Crystal; Texaco, Inc., whose drilling apparently penetrated the 1,300-foot level of the mine; Wilson Brothers Corp. of Lafayette, operators of the drilling rig; salt mine workers whose jobs were lost; Live Oak Gardens; and others who suffered property damage or loss. Initial lawsuits are not likely to be tried before late 1982, and trials may be scheduled for several years.

Mine Safety and Health Administration (MSHA) investigated the incident and issued a report, "The Jefferson Island Mine Inundation: Report of Mine Inundation, Jefferson Island Mine, Diamond Crystal Salt Co., New Iberia, Iberia Parish, Louisiana, November 20, 1980." Because much evidence was lost in the flooded mine, the exact cause of the flooding was not determined, but three possibilities are identified and discussed in the MSHA report. The 32 appendices to the report contain much information pertinent to the investigation.

At midyear, Diamond Crystal announced a major reorganization of the company that created a separate division to manage salt operations. Following the flooding of its Jefferson Island Mine, the company contracted for long-term supplies of rock salt from other sources in Southern States and from the Mines Seleine, Inc., operation on Magdalen Island in the Gulf of St. Lawrence, Quebec. Evaporator units with a 60,000-ton-per-year total capacity at the Jefferson Island site, closed when the mine was flooded, were reactivated in early 1981. In recent years, the company marketed more salt than it produced, buying bulk salt supplies from other producers in Southern States and on the open market from Caribbean and Mexican sources. The company also was investigating the development of a new mine in the gulf coast area.

Louisiana Offshore Oil Port (LOOP), the Nation's first supertanker terminal, became operational at yearend. The system will have a 100,000-barrel-per-hour unloading capacity and the capability of handling 1.4 million barrels of oil daily. Two of eight planned storage cavities have been developed in the Clovelly Salt Dome. Each cavity will be 190 feet in diameter with a 1,000-foot vertical dimension and a capacity of 4 million barrels of crude. The huge storage facility in Clovelly Salt Dome is a vital link between LOOP, which will be subject to weather-induced interruptions, and the pipeline network capable of feeding crude from the salt dome to refineries in Louisiana and others as far north as Buffalo and Chicago.

Archaeologist Ian W. Brown of Harvard University completed archaeological excavations at Salt Mine Valley on Avery Island and published a booklet entitled "The Role of Salt in Eastern North American Prehistory." The booklet recounts the use of salt by local Indians from about A.D. 1000 to A.D. 1200 and from about A.D. 1550 to A.D. 1650. Brown reported that, during the latter period, Avery Island Indians used a fire-induced evaporation technique similar to that used by prehistoric people in Africa,

Asia, and Europe. Moistened salt subsequently was packed into pottery molds, dried, and traded to other tribes in Louisiana and the Southeast.

Sand and Gravel.—To reduce reporting burdens and costs, the U.S. Bureau of Mines implemented new canvassing procedures for its 1981 surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but contains complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and completed the following year.

Sand and gravel was ranked first on the 1981 list of construction minerals produced in Louisiana. Tonnage figures were off slightly, following more substantial declines in 1980 and 1979 from the peak output of 1978. Heavy-construction activities related to energy-industry developments in southern Louisiana parishes began to weaken in 1981. Estimated average price for sand and gravel was essentially unchanged from that of 1980.

Three companies produced industrial sand and gravel from three operations in three parishes in 1981. The blasting-sand market took almost one-half of the output. Other leading uses in order of importance were for container manufacture, various chemical-industry needs, moldings, hydraulic fracturing (for oil and gas recovery), fillers, traction, and filtration.

Ingram Aggregates, Inc., is the new name of Acadian Sand & Limestone, Inc., of Abbeville. The new corporate name more accurately reflects the status of the Louisiana-based aggregate supplier and its parent organization, Ingram Industries, Inc., in Nashville, Tenn. Ingram Aggregates, markets sand and limestone aggregates, from four storage yards in Louisiana, largely to the Acadiana area and to construction sites from New Orleans to east Texas.

Ottawa Silica Co., of Ottawa, Ill., purchased the silica sand operation at Dubberly, east of Shreveport. The former Dresser Industries plant, to be known as the Louisiana Industrial Sand Co., will operate as a subsidiary of Ottawa Silica Co. Dubberly silica sand is principally used as a foundry sand in Gulf Coast States, where demand has been noticeably strong in recent years, and in lesser quantities for the manufacture of container glass in regional plants.

Table 5.—Louisiana: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	8,233	$23,252	$2.82	NA	NA	NA
Gravel	9,919	39,316	3.96	NA	NA	NA
Total or average	18,152	62,568	3.45	ᵖ18,000	ᵖ$62,400	ᵖ$3.47
Industrial sand	353	3,845	ʳ10.89	293	4,026	13.74
Grand total or average	18,505	66,413	3.59	ᵖ18,293	ᵖ66,426	ᵖ3.63

ᵖPreliminary. ʳRevised. NA Not available.

Stone.—Production of stone in Louisiana was marked by stability in 1981—shell recovery eased slightly, anhydrite rose moderately, and total stone output was essentially unchanged. Shell continued to represent more than 90% of the State's total stone production. Shell prices increased about 25% in 1981; anhydrite rose moderately following a sharp increase in 1980. Four companies produced shell in Orleans and St. Mary Parishes at 10 operations. Anhydrite was quarried from the caprock overlying a near-surface salt dome in Winn Parish.

About 56% of Louisiana shell was used for aggregates in 1981, down 64% from that of 1980, reflecting further easing of highway and other construction demands. Demand for shell was up sharply for cement manufacture and moderately down for lime manufacture. Other minor uses for shell include riprap and jetty, for road-surface treatment, and in poultry grit. All the anhydrite is used for roadbeds. Each of the five stone

operators in the State produced more than 500,000 tons.

Conoco Coal Development Co. and Stone & Webster Engineering Corp. developed a new process for clean burning high-sulfur coal, petroleum coke, and industrial wastes. Limestone is used to remove 90% of sulfur dioxide from the fuel during combustion in fluidized-bed boilers. A unique feature is a solids circulation system outside the combustion chamber that affords improved control of heat transfer and flexibility commonly associated with oil-fired systems. Costly scrubbers are eliminated from plant design, and the system is responsive to sharp changes in steam demand. Retrofitting existing coal-fired boilers is believed to be feasible; however, the retrofit of oil-fired boilers for the new process is not foreseen. To demonstrate the new process at its Lake Charles chemical complex, Conoco plans to construct a $10 million to $20 million commercial-size plant with a capacity of 50,000 pounds of steam per hour.

Table 6.—Louisiana: Crushed shell[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Dense-graded road base stone	1,476	8,098	1,488	9,273
Surface-treatment aggregate			369	2,352
Other construction aggregate and road stone	4,708	16,085	4,025	17,442
Other uses[1]	1,154	3,350	1,345	5,500
Total[2]	7,339	27,533	7,228	34,566

[1]Includes stone used for poultry grit and mineral food, bituminous aggregate, riprap and jetty stone, cement manufacture, lime manufacture, and other uses not specified.
[2]Data may not add to totals shown because of independent rounding.

Sulfur.—Louisiana was ranked second nationally in Frasch sulfur output and sixth in recovered elemental sulfur production; both positions unchanged from those of 1980. In total sulfur recovery, the State produced about 24% of national output, up from 21% in 1980. Freeport Sulphur Co., a division of Freeport Minerals Co., mined Frasch sulfur in Jefferson, Plaquemines, and Terrebonne Parishes. Eight oil companies recovered elemental sulfur from eight operations in seven parishes.

Markets for sulfur weakened in 1981—total demand for Louisiana Frasch sulfur fell by almost 14%; however, price rose by more than 20%. Stocks of Frasch sulfur were up about one-third at yearend, whereas the negligible stocks of recovered elemental sulfur were about unchanged.

Freeport's new Frasch sulfur operation at Caillou Island in Timbalier Bay, Terrebonne Parish, about 35 miles south of Houma, completed its first full year of operation. Owing to slack demand for sulfur, Freeport's yearend report to stockholders stated that output was held considerably below the 300,000-ton mine capacity.

Table 7.—Louisiana: Sulfur produced and shipped from Frasch mines

(Thousand metric tons and thousand dollars)

Year	Production	Shipments	
		Quantity	Value
1977	2,461	2,494	W
1978	1,928	1,984	W
1979	2,460	2,858	W
1980	2,309	2,590	W
1981	2,440	2,235	W

W Withheld to avoid disclosing company proprietary data.

METALS

Aluminum.—Consolidated Aluminum Corp. announced plans to shut permanently its 36,000-ton-per-year aluminum reduction operation at Lake Charles. The closure was precipitated by a force majeure notice from Texaco that stated it would no longer be able to supply the operation with 60 billion cubic feet of gas annually. After a reevaluation study in the late 1970's, Texaco sharply lowered its estimated domestic gas reserves. Rising natural gas prices and the

difficulty in acquiring firm long-term intrastate gas supplies probably will be major problems facing Louisiana aluminum operations in the 1980's. The closure will reduce total U.S. primary production capacity by about 0.7%.

Because of reduced demand, Kaiser Aluminum & Chemical Corp. closed one potline in August and two potlines in October at its Chalmette works. Total shutdown was 93,000 tons, about 36% of the plant's 260,000-ton-per-year capacity.

The Louisiana Environmental Control Commission approved Kaiser's $200 million coal-conversion project at its Gramercy plant. Four gas-fueled boilers and heat-recovery units would be replaced by four coal-burning boilers; coal would be barged to and stored at the plant and pulverized in an enclosed structure before being used. Ash initially would be disposed of onsite.

Already in the midst of a $154 million project to reduce energy costs by 25% in the process area of its Baton Rouge complex, Kaiser announced an additional $97 million cost-cutting investment. Four fluid-bed calciners are to replace seven rotary-type units; all new calciners will produce reduction-grade alumina for primary smelters, and one calciner will have the capability to yield special calcines for the adjacent tabular alumina plant. Feedstocks have been calcined in long, horizontal rotary kilns. In the modern fluid-bed units, a turbulent rising stream of combustion gases that calcines the alumina results in better heat use and fuel saving of approximately 30%. Completion of this modernization program is expected by the end of 1983. At its Baton Rouge complex, Kaiser was also in the process of tripling the capacity of its alumina substrate plant and expanding its tabular alumina operations.

Cobalt.—AMAX Nickel, Inc., proposed to the Federal Emergency Management Agency that the Government prepurchase cobalt for the National Defense Stockpile from the AMAX refinery at Braithwaite (Port Nickel): This is the only U.S. refinery producing nickel and byproduct copper and cobalt from imported matte. However, as of the end of 1981, no funding was available under the Stockpiling Act or the Defense Production Act for such procurement. AMAX has developed a new solvent extraction process to purify the impure recovered cobalt to meet stockpile standards. The new process also appeared suitable to treat cobalt-bearing concentrates recoverable from Missouri lead-zinc ores. The U.S. Bureau of Mines has estimated that 1,250 tons of cobalt annually was lost in Missouri because of the lack of an economic recovery method.

Port Nickel refinery had in 1981 an annual design capacity of 40,000 tons of nickel, 23,500 tons of copper, 500 tons of cobalt, and 100,000 tons of ammonium sulfate. The AMAX proposal called for a limited research and development program to be followed by installation of solvent extraction and electrowinning facilities.

The price of cobalt rose from about $4 per pound in the mid-1970's to $25 in the early 1980's. Annual domestic consumption during this same interval was approximately 8,000 tons, with an alltime record consumption of almost 10,000 tons in 1978, generated by a surge in jet-aircraft production.

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[1]State Liaison Officer, Bureau of Mines, Denver, Colo.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	Parish
Aluminum:			
Consolidated Aluminum Corp	Box LL Lake Charles, LA 70601	Plant	Calcasieu.
Kaiser Aluminum & Chemical Corp	Box 1600 Chalmette, LA 70043	do	St. Bernard.
Cement:			
Lone Star Industries, Inc	1 Greenwich Plaza Greenwich, CT 06830	do	Orleans.
Clays:			
Big River Industries, Inc	Box 66377 Baton Rouge, LA 70806	Mine and plant	Pointe Coupee.
Kentwood Brick & Tile Manufacturing Co., Inc.	Drawer F Kenwood, LA 70444	do	St. Helena.
Gypsum:			
Winn Rock, Inc	Box 790 Winnfield, LA 71483	Quarry and plant	Winn.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	Parish
Lime:			
S. I. Lime Co	Pelican State Lime Div. Suite 204 Three Riverchase Office Plaza Birmingham, AL 35244	Plant	St. Mary.
United States Gypsum Co	101 South Wacker Dr. Chicago, IL 60606	do	Orleans.
Salt:			
Cargill, Inc	Cargill Bldg. Minneapolis, MN 55402	Underground mine	St. Mary.
Diamond Crystal Salt Co	916 Riverside Ave. St. Clair, MI 48079	do	Iberia.
Domtar Chemicals, Inc., Shifto Salt Div	9950 West Lawrence Suite 400 Shiller Park, IL 60276	do	St. Mary.
The Dow Chemical Co	Midland, MI 48640	Brine wells	Iberville.
International Salt Co	Clarks Summit, PA 18411	Underground mine	Iberia.
Morton Salt Co	110 North Wacker Dr. Chicago, IL 60606	do	Do.
PPG Industries, Inc	Box 1000 Lake Charles, LA 70604	do	Calcasieu.
Sand and gravel:			
Gifford-Hill & Co., Inc	Box 47127 Dallas, TX 75247	Plants, dredges, pits.	Jefferson Davis, Rapides, Tangipahoa, Webster.
Louisiana Sand and Gravel Co	Box 963 Baton Rouge, LA 70821	Plant and dredge	St. Helena.
Standard Gravel Co., Inc	Route 4, Box 17 Franklinton, LA 70438	do	Washington.
Texas Industries, Inc	Box 5472 Alexandria, LA 71301	Plants, dredges, pits.	Beauregard, Grant, La Salle, Ouachita, Rapides, St. Tammany, Washington.
Shell:			
Louisiana Materials Co	Box 8214 New Orleans, LA 70182	Dredge	Orleans.
Pontchartrain Dredging Corp	Box 8005 New Orleans, LA 70182	do	Do.
Stone:			
Winn Rock, Inc	Box 790 Winnfield, LA 71483	Quarry and plant	Winn.
Sulfur, native:			
Freeport Minerals Co	161 East 42d St. New York, NY 10017	Frasch process	Jefferson, Plaquemines, Terrebonne.
Sulfur, recovered:			
Cities Service Oil Co	Box 300 Tulsa, OK 74102	Refinery	Calcasieu.
Exxon Co., U.S.A	Box 551 Baton Rouge, LA 70821	Plant	East Baton Rouge.
Vermiculite, exfoliated:			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	do	Orleans.

The Mineral Industry of Maine

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Maine Geological Survey, for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.,[1] Walter Anderson,[2] and Carolyn Lepage[3]

The value of nonfuel mineral production in Maine in 1981 was $38.4 million, an increase of $1.4 million over that of 1980, but $7.5 million below the record level of 1979. Six mineral commodities were produced; output of garnet, sand and gravel, and stone increased, and output of cement, clays, and peat decreased.

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

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	thousand short tons	78	$174	57	$166
Peat	do	8	534	W	W
Sand and gravel	do	6,978	15,434	p7,100	p14,400
Stone (crushed)	do	1,130	3,969	1,375	5,532
Combined value of other nonmetals and value indicated by symbol W		XX	16,856	XX	18,271
Total		XX	36,967	XX	38,369

pPreliminary. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of nonfuel mineral production in Maine, by county

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Androscoggin	W	W	Sand and gravel, clays.
Aroostook	W	$1,574	Sand and gravel, stone.
Cumberland	W	W	Sand and gravel, stone, clays.
Franklin	$851	656	Sand and gravel.
Hancock	W	818	Do.
Kennebec	W	W	Sand and gravel, stone.
Knox	19,564	W	Cement, stone, sand and gravel, clays.
Lincoln	478	398	Sand and gravel.
Oxford	W	W	Sand and gravel, garnet.
Penobscot	3,106	2,352	Sand and gravel.
Piscataquis	489	369	Do.
Sagadahoc	124	11	Do.
Somerset	782	395	Do.
Waldo	W	W	Sand and gravel, peat.
Washington	W	W	Peat, sand and gravel, stone.
York	2,426	1,648	Sand and gravel.
Undistributed[1]	18,077	28,746	
Total	[2]45,898	36,967	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Includes gem stones and values indicated by symbol W.
[2]Data do not add to total shown because of independent rounding.

Table 3.—Indicators of Maine business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	498.2	492.3	-1.2
Unemployment	do	39.4	31.6	-19.8
Employment (nonagricultural):				
Mining	do	([1])	([1])	--
Manufacturing	do	113.2	112.8	-.4
Contract construction	do	19.5	17.3	-11.3
Transportation and public utilities	do	18.7	18.5	-1.1
Wholesale and retail trade	do	88.9	88.7	-.2
Finance, insurance, real estate	do	16.5	17.0	+3.0
Services	do	[2]78.2	[2]80.2	+2.6
Government	do	83.3	82.6	-.8
Total nonagricultural employment	do	418.3	417.1	-.3
Personal income:				
Total	millions	$8,869	$9,805	+10.6
Per capita		$7,868	$8,655	+10.0
Construction activity:				
Number of private and public residential units authorized		3,542	2,256	-36.3
Value of nonresidential construction	millions	$56.2	$100.6	+79.0
Value of State road contract awards	do	$42.5	$54.5	+28.2
Shipments of portland and masonry cement to and within the State	thousand short tons	230	236	+2.6
Nonfuel mineral production value:				
Total crude mineral value	millions	$37.0	$38.4	+3.8
Value per capita, resident population		$33	$34	+3.0
Value per square mile		$1,113	$1,155	+3.8

[p]Preliminary.
[1]Included with "Services."
[2]Includes mining.

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

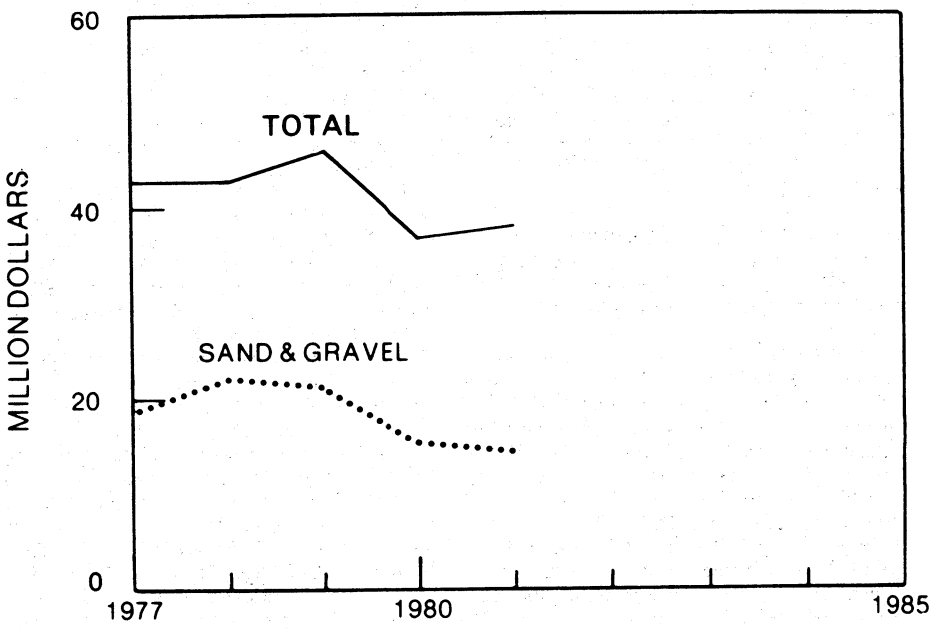

Figure 1.—Value of sand and gravel and total value of nonfuel mineral production in Maine.

Trends and Developments.—The outlook for renewed metal mining in Maine remained in question at yearend. The last metal mining operation in the State closed in 1977. Ironically, at about the same time, a 36-million-ton copper-zinc deposit in Aroostook County was discovered. Since that time, Superior Mining Co. has conducted drilling, environmental, and metallurgical studies on the deposit, which has indicated reserves of about 25 million tons of 1.54% copper and about 10 million tons of 2.50% zinc. Two factors, the final rate structure of a proposed State severance tax on mining metallic minerals and the decline in copper prices, have delayed the company's decision on mining the deposit. Tax legislation was expected to be introduced again in 1982 after proposals in 1981 were opposed by many State and mining industry officials. Copper prices declined steadily throughout the year, and industry analysts estimated that a $1.25-per-pound price would be necessary for mining to become economical.

Exploration activity in Maine continued to increase although most metal prices declined in 1981. Houston International & Minerals Corp. was reportedly interested in nickel and zinc mineralization at Alden Stream in western Maine,[4] and two firms were prospecting an area of nickel-copper occurrences near Rockport, Knox County.[5]

Scintilore Explorations, Ltd., drilled 23 holes (about 20,000 feet of core) at its silver-zinc-lead property near Pembroke, Washington County.[6] The company reported about 4.9 million tons of proven reserves grading 2.24 ounces silver and 1.58% combined zinc and lead (4:1) and 22 million tons of indicated reserves grading 0.60 ounce silver and 1.75% zinc and lead.[7]

In addition to these companies, the Maine Geological Survey (MGS) reported about 20 firms were exploring in the State in 1981.

A State Labor Department report, prepared by the Employment and Training Council, predicted continued economic growth for Maine in the 1980's despite high interest rates and inflation. The report listed mining among the sectors of the economy with potential for growth. The copper-zinc deposit in Aroostook County and the continuing exploration for metallic minerals in Franklin and Oxford Counties were noted as areas that could develop rapidly depending on market prices for

metals. The primary metals industry was expected to remain strong, and shipping was expected to grow, particularly if ports in Boothbay Harbor, Kennebunkport, Portland, and Vinalhaven were renovated. On the negative side, the report projected a decline in construction industry employment, which would adversely affect nonmetallic mineral production.

Legislation and Government Programs.—During the 1981 legislative session, two severance tax bills on mining metallic ore minerals were introduced. Both bills were opposed by various groups and neither was passed.

Legislative Document 1525 (subsequently withdrawn) proposed a minimum severance tax of 1% on gross proceeds instead of a property tax, with most of the tax revenues disbursed to the local communities affected by mining. The second bill, Legislative Document 1621, included a variable tax rate structure (minimum 2% on gross proceeds) instead of a property tax, with tax revenue mainly distributed on a statewide basis. Both bills proposed a tax rate formula that increased on a percentage basis as gross proceeds increased.

On November 3, Maine voters approved a $33.3 million economic development bond issue that was expected to boost employment. The development bond provided $13 million for expansion of port facilities at Searsport and about $15 million for Bath Iron Works to construct a ship repair and overhaul facility in Portland.

In the final days before adjournment in 1981, the U.S. Congress passed a bill deauthorizing the massive Dickey-Lincoln hydroelectric project. Construction costs for the proposed project had been estimated to be in excess of $1 billion.

During 1981, MGS continued bedrock and surficial mapping programs in various parts of the State. Under a cooperative agreement with the U.S. Geological Survey, MGS also worked on the Conterminous United States Mineral Appraisal Program. Initially, potential mineral resources in western Maine were to be evaluated under this program.

For the third year, MGS continued work on the Maine Peat Resource Evaluation Program, investigating 56 deposits, mostly in southern and western Maine. Funded by the U.S. Department of Energy (DOE), the program concentrated on sample analysis and compilation of data for resource estimates. MGS also received funding from DOE for consultation work on the National (High Level Radioactive) Waste Terminal Storage Program. MGS acted in a review and oversight capacity and was not involved in the actual study of potential disposal sites. The grant also included funding for compilation and publication of new bedrock and surficial maps (1:500,000) and for development of a computer-based data management system for geological information.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Cement.—Martin Marietta Corp. operated the only cement plant in New England. Both portland and masonry cement were produced at the plant located in Thomaston, Knox County. Shipments of both types of cement remained about the same as those of 1980.

Raw materials used in the manufacture of cement included limestone and clay, which were mined by the company near the plantsite. Martin Marietta was the leading producer of both of these commodities in Maine in 1981. Other raw materials used were sand (local), iron-bearing material (Pennsylvania), and gypsum (Canada). Most of the cement was sold to ready-mix concrete companies, concrete product manufactures, and building material dealers in Maine and Massachusetts.

Clays.—Output declined for the third consecutive year, dropping to 57,000 tons from 78,000 tons in 1980. The decline in residential construction and increased competition from producers in Massachusetts and Connecticut adversely affected Maine's output in 1981.

Five companies operated pits in Androscoggin, Cumberland, and Knox Counties in southern Maine. All five companies mined common clay. Major uses were for brick and cement manufacture.

Garnet.—Maine ranked third, behind Idaho and New York, in garnet production in 1981. Industrial Garnet Extractives, Inc., mined almandine garnet near Rangeley in Franklin County. The material was mined by open pit methods and crushed onsite. The garnet was transported to a mill in West Paris, Oxford County, about 75 miles south of Rangeley, for further crushing, screening, and bagging.

In addition to garnet, the company pro-

duced a lower grade material marketed as a utility sand. The garnet was marketed for abrasive, filtration, heavy media, nonskid, wear-resistant, and surface-coating applications. The utility sand was sold for use in sandblasting, as filtration sand, and nonskid aggregrate.

Gem Stones.—Areas in Androscoggin and Oxford Counties continued to attract rockhounds and mineral specimen collectors. Among the semiprecious and gem-quality specimens collected in 1981 were amethyst, aquamarine, citrine, topaz, and tourmaline.

Peat.—Deer Hill Farms, Inc., Waldo County, and Down East Peat Co., Washington County, were the only two companies that reported production in 1981. Output decreased because of above average rainfall during the summer and fall months, reducing the number of harvest days for peat mining.

After mining and drying, peat was packaged in 2-, 4-, and 6-cubic-foot bales. All sales were for horticultural applications. Market areas included Maine, Massachusetts, and other Eastern States, Japan, and Puerto Rico.

Down East Peat, which began operations in 1978, continued to mine peat with a unique machine—the "Martian Bigfoot." This vacuum-type harvester has a capacity 50 times greater than that of conventional vacuum machines.

Perlite.—Crude perlite, shipped by rail from New Mexico, was expanded by Chemrock Corp., the State's only producer, in Rockland, Knox County. Most of the company's sales were for use as a filter agent. Maine and Massachusetts were the only two New England States with expanded perlite operations in 1981.

Sand and Gravel.—The U.S. Bureau of Mines, to reduce reporting burdens and costs, implemented new sand and gravel canvassing procedures for the survey of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel operators will be conducted for even-numbered years only. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Production of construction sand and gravel in 1981 increased slightly (based on the preliminary data) after dropping more than 4 million tons during the 1979 to 1980 period. In New England, Maine ranked second to Massachusetts in output and produced about 20% of the region's tonnage.

Historically, sand and gravel production was reported from all of the State's 16 counties. During the past few years, leading counties in terms of output were Cumberland, Penobscot, and York. No industrial sand was produced in Maine.

Table 4.—Maine: Construction sand and gravel sold or used by producers

	1980			1981[p]		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Sand	2,769	$5,750	$2.08	NA	NA	NA
Gravel	4,209	9,685	2.30	NA	NA	NA
Total or average	6,978	[1]15,434	2.21	7,100	$14,400	$2.03

[p]Preliminary. NA Not available.
[1]Data do not add to total shown because of independent rounding.

Stone.—Production of crushed stone increased slightly in 1981 compared with that of 1980 after dropping about 1.1 million tons from 1979 to 1980. Types of stone mined, in descending order of output, were limestone, sandstone, traprock, and marl. Limestone was mined by 4 companies operating 5 of the State's 10 crushed stone quarries. Two operations were in Aroostook County in northern Maine; the other three were in Knox County, in the southern part of the State. Leading uses were for cement manufacture, aggregate, and railroad ballast.

One company mined sandstone at two quarries in Cumberland County in southwestern Maine. The crushed sandstone was used for aggregate, riprap, jetty, and railroad ballast.

Two companies, one in Cumberland and one in Washington County, mined traprock. The stone was sold for use as concrete aggregate, riprap, and jetty applications. Manufactured fine aggregate was also produced.

Marl was produced by one company in Aroostook County and used in agricultural applications.

New England Stone Industries, headquartered in Providence, R.I., resumed quarrying operations on Crotch Island off Maine's southern coast. The company shipped 20-ton blocks to Rockland, Knox County, for truck transport to Providence, where the firm operates a fabricating plant. New England Stone also announced plans to build a fabricating shop on the island and to operate year round because of increased demand for granite.

Dimension granite was last mined on Crotch Island in 1976 by Deer Island Granite Co. Previously, the granite was quarried in 1963 for the John F. Kennedy Memorial in Arlington, Va.

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[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]Maine state geologist and director, Maine Geological Survey, Augusta, Maine.
[3]Geologist, Maine Geological Survey, Augusta, Maine.
[4]Bangor Daily News. Dec. 5, 1981, pp. WE1, WE8.
[5]Skillings' Mining Review. V. 70, No. 43, Oct. 24, 1981, p. 13.
[6]Northern Miner. Nov. 12, 1981, p. 6.
[7]———. Apr. 22, 1982, p. 3.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Martin Marietta Corp.[1]	6801 Rockledge Dr. Bethesda, MD 20817	Quarry and plant	Knox.
Clays:			
LaChance Brick Co., a division of Morin Brick Co.	Mosher Rd. Gorham, ME 04038	Pit and mill	Cumberland.
Garnet:			
Industrial Garnet Extractives, Inc.	Box 56A West Paris, ME 04289	Quarry and mill	Oxford.
Peat:			
Deer Hill Farms, Inc	Weeks Mills, ME 04361	Bog and plant	Waldo.
Down East Peat Co	Star Route Deblois, ME 04622	do	Washington.
Perlite (expanded):			
Chemrock Corp	End of Osage St. Nashville, TN 37208	Plant	Knox.
Sand and gravel:			
Cianbro Corp	Box D Pittsfield, ME 04967	Pits and mills	Androscoggin, Franklin, Hancock, Oxford, Penobscot, Somerset.
George C. Hall Construction	Box 506 Rockland, ME 04841	do	Knox.
Lane Construction Corp	965 East Main St. Bangor, ME 04401	do	Aroostook, Penobscot, Waldo, Washington.
H. E. Sargent, Inc	101 Bennoch Rd. Stillwater, ME 04489	do	Kennebec, Penobscot, Sagadahoc, Somerset.
Maine Department of Transportation.	Augusta, ME 04333	do	Androscoggin, Aroostook, Franklin, Hancock, Oxford, Penobscot, Somerset, Waldo, Washington.
Stone:			
Blue Rock Industries	58 Main St. Westbrook, ME 04092	Quarries and mill	Cumberland and Kennebec.
Lane Construction Corp	965 East Main St. Bangor, ME 04401	Quarry	Aroostock.
Lime Products Corp	Box 357 Union, ME 04862	2 quarries and mill	Knox.

[1]Also clays and stone.

The Mineral Industry of Maryland

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Maryland Geological Survey for collecting statistical information on all nonfuel minerals.

By Doss H. White, Jr.,[1] and Karen R. Kuff[2]

The State's nonfuel mineral production was valued at $178.7 million in 1981, a $7.5 million decrease from that of the previous year, and $14.3 million below the 1979 record. Much of Maryland's mineral output was sold to the building and highway construction industries, and the depressed economy, which deepened into a recession during midyear, resulted in decreased sales of clays, sand and gravel, and stone used in residential and commercial construction. Aggregate sales were also affected in many areas of Maryland by cutbacks in State and Federal spending that reduced funds for highway construction and maintenance. One highlight in an otherwise dismal year for many of the State's mineral producers was the continued demand for mineral construction materials in the Baltimore, Md., and Washington, D.C., area.

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

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2]	thousand short tons	733	$2,267	597	$1,984
Gem stones		--	--	NA	2
Lime	thousand short tons	12	497	9	441
Peat	do	4	W	W	W
Sand and gravel	do	10,732	33,625	p10,900	p35,000
Stone:					
Crushed	do	18,945	77,431	16,485	74,289
Dimension	do	15	612	34	1,002
Combined value of cement, clays (ball clay), and values indicated by symbol W		XX	71,703	XX	65,937
Total		XX	186,135	XX	178,655

pPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes ball clay; value included with "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Allegany	W	W	Stone.
Anne Arundel	$4,382	$4,739	Sand and gravel.
Baltimore[2]	W	W	Stone, sand and gravel, clays.
Caroline	29	31	Sand and gravel.
Carroll	40,761	W	Cement, stone, clays.
Cecil	12,594	12,039	Stone, sand and gravel.
Charles	3,938	4,436	Sand and gravel.
Dorchester	W	W	Do.
Frederick	W	W	Cement, stone, clays, lime.
Garrett	1,662	W	Stone, sand and gravel, peat.
Harford	W	W	Stone, sand and gravel.
Howard	1,646	W	Stone.
Kent	W	56	Clays.
Montgomery	W	W	Stone.
Prince Georges	18,340	10,568	Sand and gravel, clays.
Queen Annes	2,486	W	Stone.
St. Marys	531	W	Sand and gravel.
Washington	W	W	Cement, stone, clays.
Wicomico	W	W	Sand and gravel.
Worcester	804	1,963	Do.
Undistributed	105,788	152,300	
Total[3]	192,962	186,135	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Calvert, Somerset, and Talbot Counties are not listed because no nonfuel mineral production was reported.
[2]Includes Baltimore City.
[3]Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Maryland business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	2,144.0	2,162.1	+0.8
Unemployment	do	132.4	171.3	+29.4
Employment (nonagricultural):				
Mining[1]	do	(2)	(2)	
Manufacturing	do	236.7	231.0	-2.4
Contract construction	do	102.9	95.9	-6.8
Transportation and public utilities	do	85.3	85.9	+.7
Wholesale and retail trade	do	401.7	405.5	+.9
Finance, insurance, real estate	do	91.9	93.3	+1.5
Services	do	[3]358.5	[3]376.6	+5.0
Government	do	434.8	421.9	-3.0
Total nonagricultural employment[1]	do	1,711.8	1,710.1	-.1
Personal income:				
Total	millions	$44,281	$49,172	+11.0
Per capita		$10,477	$11,534	+10.1
Construction activity:				
Number of private and public residential units authorized		20,308	17,156	-15.5
Value of nonresidential construction	millions	$702.1	$797.5	+13.6
Value of State road contract awards	do	$79.2	$90.2	+13.9
Shipments of portland and masonry cement to and within the State	thousand short tons	1,405	1,262	-10.2
Nonfuel mineral production value:				
Total crude mineral value	millions	$186.1	$178.7	-4.0
Value per capita, resident population		$44	$42	-4.6
Value per square mile		$17,598	$16,891	-4.0

[p]Preliminary.
[1]Includes bituminous coal and gas extraction.
[2]Included with "Services."
[3]Includes "Mining."

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

Trends and Developments.—Currently, industrial minerals account for most of Maryland's mineral output. However, the State was once a leader in mining metallic minerals including minerals listed as "strategic and critical" to the Nation's defense.

Chromium, in the strategic and critical minerals category because of its importance in stainless and other steel alloy manufacture, was first mined in Baltimore County around 1810. Initial production was sold to a paint manufacturer in Philadelphia, and between 1828 and 1850 most of the world's supply was mined in Harford and Cecil Counties. Production declined during the late 1800's, and the last recorded mining was in 1928.

Cobalt and copper, two other strategic and critical minerals, were mined along with iron in Baltimore, Carroll, and Frederick Counties in the 1850's. A cobalt smelting furnace was built on the Patapsco River but was never operated. Interest in the State's cobalt potential renewed during 1981 as Denver-based Noranda Exploration, Inc., sought a contract with Baltimore officials to drill for cobalt near Liberty Reservoir northwest of the city. The project, expected to take about 3 months, was scheduled to begin in 1982.

Over the centuries, Maryland's mineral industry developed gradually from metals to industrial minerals, and a continuing conflict has arisen over land use because of demand for construction mineral materials and the increase in population. Maryland's sand and gravel and stone operators, with approximately 60% of the sales reported by the State's mineral industry in 1981, again experienced strong citizen opposition to most mining plans. In one case, a 3-year legal battle between citizen groups and a sand and gravel company apparently ended in August when the Maryland Circuit Court ruled that the company could construct a wet processing plant in Zekiah Swamp in the Cedarville area. Zekiah Swamp is the State's largest natural hardwood area, and opponents of construction and operation of the plant feared damage to the swamp's unique ecology. An appeal by the Prince Georges County Council to the Court of Special Appeals was pending at yearend.

In December, the Prince Georges County Council voted to help a sand and gravel company secure a low-interest loan for construction of a wet processing plant. The $3.25 million loan, to be financed by the sale of industrial development bonds, was opposed by citizens who asked if the County Council would help secure loans for other business endeavors. The Council's response was unreported at yearend.

Another ongoing conflict in the State concerned fugitive dust from the Lehigh Portland Cement Co. plant in Union Bridge. Local citizens complained about damage to personal property from the cement kiln dust. The cement plant, which employs more than 200 people, many living in Union Bridge, has spent over $15 million since 1973 for air pollution equipment or other equipment maintenance.

Positive developments in the State's construction mineral industry included a number of Government-funded commercial and nonresidential projects in the Baltimore area that provided markets for Maryland's aggregate producers. Work on the Baltimore subway required significant amounts of aggregate for concrete. Construction of the Fort McHenry tunnel, which began in mid-1981, was estimated to require in excess of 500,000 cubic yards of concrete. Over 2 million tons of aggregate was expected to be used for this project, scheduled to continue through 1983. The Hart and Miller Islands Dike Disposal Area, to confine materials dredged from Baltimore Harbor and access channels, will require over 300,000 tons of riprap and 100,000 tons of smaller stone.

In other developments, work on the Atlantic Cement Co., Inc., slag cement facility at Sparrows Point continued and was scheduled for completion in April 1982. The plant, the first of this type in the United States, is adjacent to the Bethlehem Steel Corp. "L" blast furnace, which produces 800,000 tons of slag per year. The cementitious material, termed "Newcem," will be barged to the company's existing network of tidewater distribution terminals located along the eastern seaboard for blending with portland cement to produce concrete.

Bethlehem Steel announced plans to spend approximately $100 million to modernize the continuous slab casting and other Sparrows Point facilities. Bethlehem Steel, the State's largest employer, is upgrading the plant to make the operation more competitive with foreign steel operations.

Legislation and Government Programs.—The State Board of Public Works approved proposed regulations that would permit exploration and recovery of oil and gas on State-owned lands. A significant discovery of oil in the State could provide new markets for construction mineral pro-

ducers. Under the regulations approved by the board, the Department of Natural Resources must secure board approval before a tract of land can be leased. The State reserves the right to negotiate some leases, though the general policy will be to award leases to the highest bidder.

During 1981, the staff of the Maryland Geological Survey was involved in a number of studies on mineral resources and environmental geology. Geologic mapping was completed in one quadrangle and was underway in three others. Topographic map revision was ongoing in Baltimore, Charles, Frederick, and Garrett Counties. Two studies were ongoing on lands for potential mineral resource development, one in the Baltimore-Washington area, and the second in western Maryland. An agreement was made with Carroll County officials for a mineral resource study. The county was in the process of initiating a new method of establishing zoning ordinances using mineral resource overlay to determine areas for potential mineral development. The Maryland Geological Survey was involved in the preparation of policy for leasing oil and gas mineral rights on State lands and also worked on a number of hydrologic studies.

Scientists with the U.S. Geological Survey conducted fieldwork in various areas of the State as part of a number of regional geological investigations. Of interest to the State's mineral industry were studies on high-purity sands in areas underlain by the Tuscarora and Oriskany Formations, and the evaluation of mineral fuel resources in Allegany and Garrett Counties.

Other government agency activity included the release, in April, of a 200-page report by the Montgomery County Department of Environmental Protection on the use of serpentinite, a stone containing asbestos fibers, used for aggregate applications. In 1977, the county spent $2.7 million on asbestos control for roadways and school playgrounds. The 1981 report stated that serpentinite could be used on driveways, road shoulders, parking lots, and biking and walking paths with no apparent danger, provided dust levels were controlled.

Throughout the year, Maryland's Environmental Service sponsored a series of hazardous waste siting programs in many of the State's communities. The Maryland General Assembly, in 1980, directed that a Hazardous Waste Siting Board be impaneled to identify sites suitable for containment of waste generated by Maryland industry. Environmentally acceptable waste disposal is a continuing concern for many of the State's mineral processing and metal fabricating operations.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Calcite.—Genstar Stone Products Co. mined calcite by surface and underground methods to produce a calcium carbonate filler used primarily in paper, paints, and plastic. The mine and plant are located at the company's Texas, Md., operation, north of Baltimore.

Cement.—Three companies in Carroll, Frederick, and Washington Counties in the north-central part of the State produced portland cement and two of them also produced both portland and masonry cement. A fourth company operated a grinding plant to produce masonry cement only. Output for both cement types fell for the second consecutive year as the recession severely affected construction activity.

Work continued on the Atlantic Cement Co., Inc., slag cement facility at Sparrows Point. The $77 million facility is scheduled for completion in 1982.

Clays.—Common and ball clay and shale were produced by 7 companies operating 10 surface mines in Baltimore, Carroll, Frederick, Kent, Prince Georges, and Washington Counties. Common clay output slumped approximately 136,000 tons from that reported in 1980 as the recession continued to depress new construction activity.

Cyprus Industrial Minerals Co. in Baltimore County was the State's only ball clay producer. Much of the company's sales were in the Canadian market. Production remained the same as in the previous year.

Also during the year, the Arundel Corp., a building materials and land development company, sold their subsidiary, Baltimore Brick Co., to the Merry Co., Inc., of Augusta, Ga. Merry Co. is one of the largest brick manufacturers in the Southeast.

Gypsum.—National Gypsum Co. and United States Gypsum Co. imported gypsum mined in Nova Scotia and New Brunswick. The gypsum was calcined at company facilities in the Baltimore area for use in the manufacture of construction mate-

rials such as wallboard and lath.

Iron and Steel Slag.—Although Maryland continued to rank as a leading slag-producing State, output fell for the second consecutive year as demand for domestic steel slumped. Both air-cooled and expanded slag were produced as a byproduct of steelmaking. Principal sales of the former were for construction aggregate while the latter, a lighter weight slag, was used primarily in the manufacture of lightweight concrete block.

Lime.—One company in north-central Maryland, S. W. Barrick & Sons, Inc., in Frederick County, calcined limestone to produce quicklime and hydrated lime. Major sales were in-State for agricultural purposes.

Peat.—Garrett County Processing & Packing Corp. recovered peat for horticultural sales. The operation is located in the northwestern part of the State near the community of Accident.

Sand and Gravel.—The U.S. Bureau of Mines, to reduce reporting burden and costs, implemented new sand and gravel canvassing procedures for the survey of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel operators will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Table 4.—Maryland: Construction sand and gravel sold or used by producers

	1980			1981[p]		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Sand	5,895	$18,801	$3.19	NA	NA	NA
Gravel	4,837	14,825	3.06	NA	NA	NA
Total or average	10,732	[1]33,625	3.13	10,900	$35,000	$3.21

[p]Preliminary. NA Not available.
[1]Data do not add to total shown because of independent rounding.

During 1981, sand and gravel continued to rank in the top three mineral commodities in value. Preliminary data indicated that production increased 168,000 tons over that reported in 1980.

Harford Sands, Inc., in eastern Maryland near Joppa, continued as the State's only industrial sand producer—approximately 40% of the company's output was sold for water treatment and as an antiskid medium for airport runways. The company also supplied an industrial-grade sand to Bethlehem Steel Corp. at Sparrows Point.

Stone.—Production and sales of stone, again the leading mineral commodity in the State, fell for the second year as economic conditions continued to depress construction activity. Although a few producers reported 1981 to be an "average" or "better" year, most operations reported slumping demand and sales. Output fell 2.4 million tons and sales dropped nearly $3 million.

The State's crushed stone industry consisted of 19 reporting companies with mining and crushing operations in 10 counties. Output consisted of limestone, marble, sandstone, serpentinite, and gneiss.

Table 5.—Maryland: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Concrete aggregate	2,589	9,540	2,441	9,148
Bituminous aggregate	1,963	7,064	2,217	7,972
Macadam aggregate	2,127	7,590	W	W
Dense-graded road base stone	1,234	4,572	1,205	4,761
Surface-treatment aggregate	364	1,374	376	1,389
Other construction aggregate and roadstone	6,537	23,531	6,078	22,421
Riprap and jetty stone	280	1,276	334	1,643
Railroad ballast	126	352	98	307
Manufactured fine aggregate (stone sand)	170	751	W	W
Cement manufacture	2,250	3,807	1,055	2,379
Lime manufacture	W	W	17	64
Other[2]	1,305	17,574	2,664	24,206
Total	18,945	77,431	16,485	[3]74,289

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

[1]Includes limestone, granite, sandstone, shell, traprock, and miscellaneous stone.

[2]Includes stone used for agricultural limestone, agricultural marl and other soil conditioners, poultry grit and mineral food, filter stone (1981), flux stone, refractory stone (1980), mine dusting, asphalt filler, whiting or whiting substitute, other fillers or extenders, other uses not specified, and items indicated by symbol W.

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

Major sales were for aggregate with lesser amounts of crushed sandstone sold to the steel industry for flux. One marble producer marketed a high-quality, wet-ground, calcium carbonate filler.

Langenfelder & Sons, Inc., operated a dredge on Chesapeake Bay to recover oyster shell. Major sales were for aggregate and poultry grit.

Dimension sandstone and quartzite were quarried in Baltimore and Howard Counties; dimension gneiss was produced in Montgomery County. Major sales of the sandstone and quartzite were as rough block and rubble; gneiss sales were for construction applications.

Talc.—Harford Talc Co., Harford County, purchased talc from Colorado-based Cyprus Industrial Minerals Co., a division of Amoco Minerals Co., for raw material in insulator manufacture.

Vermiculite.—South Carolina-mined vermiculite was expanded by W. R. Grace & Co. at a plant in Prince Georges County. Principal sales were for fireproofing, block insulation, concrete aggregate, and loose fill insulation.

METALS

Aluminum.—Maryland's primary aluminum producer, Eastalco Aluminum Co. in Frederick County near Buckeystown, reduced alumina imported from Australia. The company operated two potlines to produce rolling ingots, melt ingots, and billets. Production was virtually unchanged from that of 1980.

Two secondary producers in the Baltimore area, Tomke Aluminum Co. and Cambridge Iron & Metals Co., Inc., melted aluminum scrap to produce a variety of aluminum products.

Copper.—Kennecott Refining Co. operated one of four primary copper refineries in the Eastern United States. Copper, shipped by rail from Arizona, Nevada, New Mexico, and Utah, was refined into cathode and rod for worldwide export.

Iron and Steel.—Bethlehem Steel Corp. at Sparrows Point, Baltimore, produced pig iron, raw steel, and semifabricated steel products from South American ore. Production was severely curtailed because of a slump in the automotive industry and an upswing in foreign steel imports. At yearend, a new $170 million coke battery was in operation at the Sparrows Point facility.

Titanium Dioxide.—During 1981, Glidden Pigments Group, SCM Corp., completed expansion work at the Baltimore plant. With the expansion, the company has the capacity to produce 42,000 tons per year.

[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]Geologist, Maryland Geological Survey, Baltimore, Md.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Portland:			
Alpha Portland Cement Co.[1]	15 South 3d St. Easton, PA 18042	Plant and quarry.	Frederick.
Portland and masonry:			
Lehigh Portland Cement Co.[2]	718 Hamilton Mall Allentown, PA 18105	do	Carroll.
Marquette Co.[1]	One Commerce Pl. Nashville, TN 37238	do	Washington.
Masonry:			
Genstar Stone Products Co	Executive Plaza 4 11350 McCormick Rd. Hunt Valley, MD 21031	Plant	Baltimore.
Clays:			
Baltimore Brick Co	501 St. Paul Pl. Baltimore, MD 21202	Pits	Baltimore and Frederick.
Victor Cushwa & Sons, Inc	Box 160 Williamsport, MD 21795	Pit	Washington.
Cyprus Industrial Minerals Co	7000 Yosemite St. Box 3299 Englewood, CO 80155	Pit	Baltimore.
Gypsum (calcined):			
National Gypsum Co	4100 1st International Bldg. Dallas, TX 75270	Plant	Do.
United States Gypsum Co	101 South Wacker Dr. Chicago, IL 60606	do	Do.
Lime:			
S. W. Barrick & Sons, Inc.[1]	Woodsboro, MD 21798	do	Frederick.
Peat:			
Garrett County Processing & Packing Corp.	Route 1 Accident, MD 21520	Bog	Garrett.
Sand and gravel:			
Contee Sand & Gravel Co., Inc	Box 1000 Laurel, MD 20810	Pit	Prince Georges.
Genstar Stone Products Co	Executive Plaza 4 11350 McCormick Rd. Hunt Valley, MD 21031	Pits	Baltimore.
York Building Products Co., Inc	Box 1708 York, PA 17405	Pit	Cecil.
Stone:			
Arundel Corp	110 West Rd. Baltimore, MD 21204	Quarries	Baltimore and Howard.
Genstar Stone Products Co	Executive Plaza 4 11350 McCormick Rd. Hunt Valley, MD 21031	do	Baltimore, Carroll, Frederick, Harford.
Rockville Crushed Stone, Inc	Box 407 Rockville, MD 20850	do	Montgomery.

[1]Also stone.
[2]Also clays and stone.

The Mineral Industry of Massachusetts

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Massachusetts Department of Environmental Quality, Office of the State Geologist, for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.,[1] and Joseph A. Sinnott[2]

The value of nonfuel mineral production in Massachusetts in 1981 was $97 million, an increase of $5.8 million over that of 1980. The $97 million represents the highest value of mineral production recorded for the State and marks the fourth consecutive year that sales exceeded the $90 million level.

Massachusetts continued its dominant position in the mineral industry among the six New England States, with over one-third of the mineral sales in the region. Of the New England States, Massachusetts ranked first in output of clays, lime, sand and gravel (construction and industrial), and stone (crushed). The State also produced peat and dimension stone.

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

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	thousand short tons	210	$870	259	$1,322
Lime	do.	180	10,806	170	10,793
Sand and gravel	do.	[2]13,925	[2]34,459	[p]13,087	[p][2]33,600
Stone:					
Crushed	do.	7,316	36,804	7,997	41,037
Dimension	do.	51	7,018	50	8,616
Combined value of other nonmetals		XX	1,254	XX	1,669
Total		XX	91,211	XX	97,037

[p]Preliminary. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes industrial sand; value included with "Combined value" figure.

Table 2.—Value of nonfuel mineral production in Massachusetts, by county

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Barnstable	$1,504	$1,484	Sand and gravel.
Berkshire	W	W	Stone, lime, sand and gravel.
Bristol	W	5,924	Stone, sand and gravel.
Dukes	110	109	Sand and gravel.
Essex	5,722	4,925	Stone, sand and gravel.
Franklin	W	W	Do.
Hampden	W	W	Do.
Hampshire	1,411	W	Sand and gravel, stone.
Middlesex	18,738	19,546	Stone, sand and gravel.
Nantucket	W	W	Sand and gravel.
Norfolk	W	W	Sand and gravel, stone, clays.
Plymouth	W	W	Sand and gravel, clays, stone.
Suffolk	1,160	797	Stone.
Worcester	10,748	W	Sand and gravel, stone, peat.
Undistributed[1]	53,154	58,428	
Total[2]	92,546	91,211	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Includes gem stones and values indicated by symbol W.
[2]Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Massachusetts business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	2,954.0	3,045.0	+3.1
Unemployment	do	129.0	211.3	+63.8
Employment (nonagricultural):				
Mining	do	([1])	([1])	
Manufacturing	do	674.9	666.8	-1.2
Contract construction	do	77.4	78.3	+1.2
Transportation and public utilities	do	121.6	119.8	-1.5
Wholesale and retail trade	do	574.5	575.1	+.1
Finance, insurance, real estate	do	159.0	164.0	+3.1
Services	do	[2]634.5	[2]663.6	+4.6
Government	do	410.3	386.5	-5.8
Total nonagricultural employment	do	2,652.2	2,654.1	+.1
Personal income:				
Total	millions	$58,190	$64,420	+10.7
Per capita		$10,118	$11,158	+10.3
Construction activity:				
Number of private and public residential units authorized		16,719	15,969	-4.5
Value of nonresidential construction	millions	$719.0	$1,194.8	+66.2
Value of State road contract awards	do	$190.0	$119.0	-37.4
Shipments of portland and masonry cement to and within the State	thousand short tons	994	1,033	+3.9
Nonfuel mineral production value:				
Total crude mineral value	millions	$91.2	$97.0	+6.4
Value per capita, resident population		$16	$17	+6.2
Value per square mile		$11,047	$11,752	+6.4

[p]Preliminary.
[1]Included with "Services."
[2]Includes "Mining."

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

Trends and Developments.—The value of mineral production in Massachusetts has surpassed $90 million in each of the last 4 years. From 1978 to 1981, clays, lime, sand and gravel (construction), and stone (crushed) were the leading nonfuel mineral commodities produced. Combined output of these commodities annually has accounted for about four-fifths of the State's value of mineral production.

The $90 million level of value of mineral production has been maintained because of increased unit prices. Of the four commodities, only clay production has increased from that of 1978 (155,000 tons) compared with that of 1981 (259,000 tons). Comparing 1981 production figures with those of 1978, sand and gravel output declined nearly 5 million tons; stone, more than 400,000 tons; and lime, nearly 20,000 tons. For the same years, unit prices increased for clays, $2.15 to $5.11; lime, $42.60 to $60.03; sand and gravel, $2.10 to $2.58; and stone, $4.33 to $5.13.

One of the State's leading manufacturers of fabricated metal products is Wyman-Gordon Co. Steel, titanium, and high-temperature alloy-forged aerospace turbine engines and structural components are fabricated at the firm's three Eastern Div. plants in Worcester, Grafton, and Millbury. During the year, Wyman-Gordon announced a $30 million expansion program that included installation of an 8,000-ton isothermal forge.[3]

Legislation and Government Programs.—The Office of the State Geologist, Department of Environmental Quality, continued cooperative agreements with the U.S. Bureau of Mines and U.S. Geological Survey relating to the geology and mineral resources of the State. During the year, work continued on a project detailing the Massachusetts surficial resources potential. The project included maps showing areal distribution of sand and gravel resources (1:125,000 scale) and gravel distribution by volume for selected towns.

In 1981, the U.S. Bureau of Mines had several active contracts with Massachusetts industrial firms and universities. Most of the research programs pertained to mining equipment, mine health and safety, and minerals and materials technology. Funding for the work totaled nearly $3 million.

The Massachusetts Institute of Technology received $194,000 in grants for fiscal year 1981 from the U.S. Office of Surface Mining as one of the 31 mineral institutes being funded. The funding was for studies covering various aspects of the minerals industry including mining, exploration, and minerals processing.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Clays.—Massachusetts again ranked first among the New England States that produced clays in 1981. Output increased for the sixth consecutive year; during that time, more than 1 million tons of clay and shale were mined.

In 1981, three companies produced clay and shale—K-F Brick Co., Inc., and Stiles & Hart Brick Co., Plymouth County, and Plainville Corp., Norfolk County. The companies manufactured brick and concrete products, with most sales being in the Boston market area.

During the year, Stiles & Hart began using coal for kiln fuel, following a trend in the brick industry aimed at lowering costs. Fuel costs were reduced by about two-thirds per 1,000 pounds of clay fired by using coal instead of No. 2 fuel oil.[4]

Gem Stones.—Collection of mineral specimens and gem stones added a small amount (estimated) to the State's value of mineral production.

Graphite (Synthetic).—In 1981, Massachusetts was 1 of 15 States that manufactured synthetic graphite. Avco Corp. and Stackpole Fibers Co., both in Middlesex County, were the State's two producers. The graphite fibers were sold primarily to the aerospace industry.

Gypsum.—Crude gypsum imported from Canada was calcined by United States Gypsum Co. at a plant in Suffolk County and used for wallboard manufacture. Output remained about the same in 1981 compared with that of 1980.

Lime.—Massachusetts ranked 1st in New England and 23d nationally in lime production. Two companies manufactured lime, both operating facilities in Berkshire County in western Massachusetts.

Lee Lime Corp. manufactured quicklime and hydrated lime for agricultural and construction uses. Pfizer, Inc., Mineral Pigments & Metals Div., produced quicklime for industrial and chemical uses. Some of

the Pfizer output was shipped to the company's Canaan, Conn., facility for use in calcium metal manufacture.

Peat.—Sterling Peat Co. was the State's only peat producer. Reed sedge peat was mined in Worcester County and sold locally for agricultural uses.

Perlite (Expanded).—Crude perlite was imported from New Mexico by Whittemore Products, Inc. The perlite was expanded at the company's facility in Andover, Essex County, for use in insulation and for horticultural applications.

Sand and Gravel.—The U.S. Bureau of Mines, to reduce reporting burdens and costs, implemented new sand and gravel canvassing procedures for the survey of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel operators will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but contains complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Table 4.—Massachusetts: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	6,072	$14,306	$2.36	NA	NA	NA
Gravel	7,853	20,152	2.57	NA	NA	NA
Total or average	13,925	[1]34,459	2.47	[p]13,000	[p]$33,600	[p]$2.58
Industrial sand	W	W	10.10	87	W	W
Grand total or average	W	W	2.54	[p]13,087	W	W

[p] Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1] Data do not add to total shown because of independent rounding.

Massachusetts again ranked 1st in New England and 18th nationally in output of construction sand and gravel. Based on preliminary data for 1981, production declined about 800,000 tons compared with that of 1980.

Industrial sand was produced by two companies, one in Middlesex County and the other in Plymouth County. The sand was sold primarily for foundry use in moldings.

Stone.—Production of crushed and dimension stone added nearly $50 million to the value of mineral production in Massachusetts in 1981. Crushed stone was produced in 11 of the State's 14 counties; dimension stone was quarried in 4 counties.

Traprock was mined and crushed at 27 operations in 9 counties. Output increased to 6.2 million tons in 1981 compared with 5.8 million tons in 1980. About four-fifths of the traprock was sold for aggregate and railroad ballast.

About 1.1 million tons of crushed granite was produced in the State in 1981, an increase of over 300,000 tons compared with 1980 output. Four companies operated four quarries; two were in Norfolk County, and one each, in Middlesex and Plymouth Counties. About three-fourths of the output was sold for aggregate.

Crushed limestone was produced by three companies, all in Berkshire County. Three of the four active quarries in the county were operated by the State's two lime manufacturers. Output declined slightly in 1981 compared with that of 1980.

Nationally, Massachusetts ranked seventh in dimension stone production. Dimension granite and marble were produced at eight quarries. Both stone types were mined in Berkshire County with dimension granite also being extracted in Middlesex, Norfolk, and Plymouth Counties. About four-fifths of the dimension granite was sold for curbing. The small quantity of dimension marble quarried was sold for rough block.

Table 5.—Massachusetts: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	142	1,421	128	1,568
Concrete aggregate	417	1,642	215	936
Bituminous aggregate	2,150	9,094	2,877	12,811
Macadam aggregate	300	1,135	103	419
Dense-graded road base stone	582	2,341	562	2,361
Surface-treatment aggregate	55	229	50	212
Other construction aggregate and road stone	1,740	6,906	1,857	7,802
Riprap and jetty stone	123	433	58	214
Railroad ballast	901	3,049	1,007	3,514
Filter stone	W	W	114	434
Manufactured fine aggregate (stone sand)	135	431	281	961
Flux stone	W	W	5	73
Roofing granules	115	468	W	W
Other[2]	655	9,656	740	9,732
Total[3]	7,316	36,804	7,997	41,037

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, granite, traprock, and miscellaneous stone (1980).
[2]Includes stone used for poultry grit and mineral food, lime manufacture, asphalt filler, and other fillers or extenders.
[3]Data may not add to totals shown because of independent rounding.

Vermiculite (Exfoliated).—W. R. Grace & Co. exfoliated vermiculite at its Easthampton plant in Hampshire County. The vermiculite was shipped from the company's mining and beneficiating operations in Montana and South Carolina.

Nationally, Massachusetts ranked 12th among the States that exfoliated vermiculite. Output remained about the same in 1981 compared with that of 1980. Major uses were for insulation and fireproofing.

[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]State geologist, Massachusetts Department of Environmental Quality, Boston, Mass.
[3]Wyman-Gordon Co. Form 10-K, Dec. 31, 1981, 4 pp.
[4]Brick & Clay Record. April 1981, 62 pp.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
K-F Brick Co., Inc	River St. Middleboro, MA 02346	Pit	Plymouth.
Plainville Corp., Masslite Div.[1]	Box 327 Walpole, MA 02081	Pit	Norfolk.
Stiles & Hart Brick Co	Box 367 Bridgewater, MA 02324	Pit	Plymouth.
Gypsum, calcined:			
United States Gypsum Co	101 South Wacker Dr. Chicago, IL 60606	Plant	Suffolk.
Lime:			
Lee Lime Corp.[2]	Marble St. Lee, MA 01238	Plant and pit	Berkshire.
Pfizer, Inc.[2]	260 Columbia St. Adams, MA 01220	---do	Do.
Peat:			
Sterling Peat Co	Sterling Junction, MA 01565	Bog	Worcester.
Perlite, expanded:			
Whittemore Products, Inc	Dundee Park Andover, MA 01810	Plant	Essex.
Sand and gravel:			
Construction:			
Baldarelli Bros. Inc	71 Temple St. West Boylston, MA 01583	Pit	Worcester.
E. L. Dauphinais, Inc	160 Worcester Rd. North Grafton, MA 01536	Pit	Middlesex and Worcester.
Nemasket Construction Co., Inc.	Box 296 Middleboro, MA 02341	Pit	Plymouth.
West Sand & Gravel Co	331 West St. Walpole, MA 02081	Pit	Norfolk.

See footnotes at end of table.

Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel —Continued			
Industrial:			
Holliston Sand Co., Inc	303 Lowland St. Holliston, MA 01746	Pit	Middlesex.
Whitehead Bros. Co	60 Hanover Rd. Florham Park, NJ 07932	do	Plymouth.
Stone:			
P. J. Keating Co	Box 367 Fitchburg, MA 01420	Quarries	Middlesex and Worcester.
John S. Lane & Son, Inc	Box 125 Westfield, MA 01085	do	Berkshire, Hampden, Hampshire.
S. M. Lorusso & Sons, Inc	331 West St. Walpole, MA 02081	do	Middlesex, Norfolk, Suffolk.
Simeone Corp	1185 Turnpike St. Stoughton, MA 02072	do	Bristol and Norfolk.
Tilcon Tomasso, Inc	Box 114 Acushnet, MA 02743	Quarry	Bristol.
Vermiculite, exfoliated:			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plant	Hampshire.

[1]Also sand and gravel.
[2]Also stone.

The Mineral Industry of Michigan

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

By James J. Hill[1] and Robert J. Tuchman[2]

The value of Michigan's nonfuel mineral production dropped to $1.44 billion in 1981, representing a decline in the State's mineral economy for the second consecutive year. Nationally, Michigan ranked sixth in value of total nonfuel mineral output and led in the production of calcium chloride, crude iron oxide pigments, magnesium compounds, and peat. The State ranked second in the production of bromine, crude iodine, iron ore, and industrial sand. In terms of value, leading mineral commodities were iron ore, portland cement, magnesium compounds, salt, sand and gravel, and stone. Other mineral commodities produced were clays, copper, crude gypsum, lime, masonry cement, and silver. Gem stones and mineral specimens were collected by mineral dealers and amateur collectors. Perlite, iron and steel slag, and vermiculite were processed in the State. Sulfur was recovered as a byproduct at oil refineries and natural gas processing plants.

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

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:					
Masonry	thousand short tons	206	$14,292	173	$10,584
Portland	do.	4,651	224,685	3,871	180,641
Clays	do.	1,982	7,212	1,610	5,862
Gem stones		NA	10	NA	15
Gypsum	thousand short tons	1,383	8,605	1,066	6,762
Iron ore (usable)	thousand long tons, gross weight	15,895	634,355	14,193	W
Lime	thousand short tons	836	36,750	807	36,800
Peat	do.	253	4,739	237	4,540
Salt	do.	2,406	104,842	2,321	103,293
Sand and gravel	do.	36,597	98,354	[p]32,893	[p]95,787
Stone:					
Crushed	do.	32,121	91,727	30,013	94,324
Dimension	do.	7	144	6	129
Combined value of bromine, calcium chloride, copper, iodine, iron oxide pigments (crude), magnesium compounds, and silver		XX	[r]259,435	XX	899,618
Total		XX	[r]1,485,150	XX	1,438,355

[p]Preliminary. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Alcona	$138	W	Sand and gravel.
Alger	29	$25	Do.
Allegan	W	W	Sand and gravel, stone, peat.
Alpena	W	W	Cement, stone, clays, sand and gravel.
Antrim	W	W	Clays, sand and gravel.
Arenac	1,089	W	Stone, sand and gravel.
Baraga	149	270	Sand and gravel.
Barry	222	W	Do.
Bay	19,095	16,992	Cement, sand and gravel, lime.
Benzie	51	44	Sand and gravel.
Berrien	2,902	2,510	Do.
Branch	515	W	Sand and gravel, stone.
Calhoun	1,512	848	Do.
Cass	W	W	Do.
Charlevoix	W	W	Cement, stone, sand and gravel.
Cheboygan	340	213	Stone, sand and gravel.
Chippewa	W	W	Do.
Clare	567	448	Sand and gravel.
Clinton	W	W	Sand and gravel, clays.
Delta	W	W	Sand and gravel, stone.
Dickinson	W	W	Iron ore, sand and gravel, stone.
Eaton	W	W	Stone, sand and gravel, peat.
Emmet	W	W	Cement, stone, clays, sand and gravel.
Genesee	W	505	Sand and gravel.
Gladwin	W	W	Do.
Gogebic	202	119	Do.
Grand Traverse	97	78	Do.
Gratiot	459	435	Do.
Hillsdale	1,594	1,225	Do.
Houghton	W	W	Sand and gravel, stone.
Huron	W	W	Stone, sand and gravel, lime.
Ingham	W	W	Sand and gravel, peat.
Ionia	122	W	Sand and gravel, stone.
Iosco	13,162	W	Gypsum, sand and gravel.
Iron	W	W	Iron ore, sand and gravel.
Isabella	W	W	Sand and gravel.
Jackson	W	1,014	Sand and gravel, stone.
Kalamazoo	1,940	W	Do.
Kalkaska	27	24	Sand and gravel.
Kent	W	W	Sand and gravel, gypsum, peat.
Lake	144	126	Sand and gravel.
Lapeer	W	W	Peat, sand and gravel, calcium chloride.
Leelanau	W	W	Sand and gravel.
Lenawee	900	964	Do.
Livingston	3,592	3,440	Do.
Luce	28	69	Do.
Mackinac	W	W	Stone, sand and gravel.
Macomb	7,313	6,321	Sand and gravel.
Manistee	96,643	101,601	Magnesium compounds, salt, sand and gravel.
Marquette	W	W	Iron ore, sand and gravel, stone, crude iron oxide pigments.
Mason	98,737	97,621	Magnesium compounds, calcium chloride, lime, bromine, sand and gravel.
Mecosta	W	W	Sand and gravel, peat.
Menominee	502	393	Sand and gravel.
Midland	W	35,830	Bromine, calcium chloride, magnesium compounds, salt, iodine.
Missaukee	W	3	Sand and gravel.
Monroe	51,785	42,616	Cement, stone, clays, peat.
Montcalm	W	W	Sand and gravel.
Montmorency	--	W	Do.
Muskegon	W	W	Sand and gravel, salt.
Newaygo	W	--	
Oakland	25,693	21,934	Sand and gravel, peat.
Oceana	3,429	2,704	Sand and gravel.
Ogemaw	736	1,107	Do.
Ontonagon	W	W	Copper, silver, sand and gravel.
Osceola	483	W	Sand and gravel.
Otsego	204	208	Do.
Ottawa	5,643	5,063	Do.
Presque Isle	W	W	Stone, sand and gravel.
Saginaw	W	W	Sand and gravel, lime.
St. Clair	W	W	Salt, sand and gravel.
St. Joseph	W	W	Sand and gravel, stone, peat.
Sanilac	W	W	Peat, sand and gravel, lime.
Schoolcraft	W	W	Stone, sand and gravel.
Shiawassee	W	W	Clays, peat, sand and gravel.
Tuscola	W	W	Sand and gravel, lime.
Van Buren	297	266	Sand and gravel.
Washtenaw	3,531	3,449	Do.

See footnotes at end of table.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Wayne	$99,406	$73,826	Cement, lime, salt, sand and gravel, stone, clays.
Wexford	1,979	1,230	Sand and gravel.
Undistributed[2]	1,061,268	1,061,633	
Total[3]	1,506,526	1,485,150	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]Crawford, Keweenaw, Oscoda, and Roscommon Counties are not listed because no nonfuel mineral production was reported.

[2]Includes gem stones, some sand and gravel that cannot be assigned to specific counties, and values indicated by symbol W.

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

Table 3.—Indicators of Michigan business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	4,296.0	4,351.0	+1.3
Unemployment	do	538.0	627.1	+17.6
Employment (nonagricultural):				
Mining[1]	do	12.5	12.1	-3.2
Manufacturing	do	998.9	977.6	-2.1
Contract construction	do	116.8	103.0	-11.8
Transportation and public utilities	do	152.2	144.8	-4.9
Wholesale and retail trade	do	733.7	713.3	-2.8
Finance, insurance, real estate	do	156.5	154.0	-1.6
Services	do	644.4	655.2	+1.7
Government	do	627.8	617.7	-1.6
Total nonagricultural employment[1]	do	3,442.8	[2]3,377.6	-1.9
Personal income:				
Total	millions	$92,494	$101,335	+9.6
Per capita		$9,967	$11,009	+10.4
Construction activity:				
Number of private and public residential units authorized		29,828	18,668	-37.4
Value of nonresidential construction	millions	$1,123.6	$898.6	-20.0
Value of State road contract awards	do	$152.0	$186.4	+22.6
Shipments of portland and masonry cement to and within the State	thousand short tons	2,102	1,815	-13.7
Nonfuel mineral production value:				
Total crude mineral value	millions	$1,485.2	$1,438.4	-3.2
Value per capita, resident population		$160	$155	-3.1
Value per square mile		$25,516	$24,707	-3.2

[p]Preliminary.

[1]Includes oil and gas extraction.

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

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

Trends and Developments.-The effects of the nationwide recession and Michigan's faltering economy impacted on mineral production during 1981. Most mineral producers reported a decline in production from 1980 to 1981. High interest rates hindered the housing and general construction industries for the second consecutive year, reducing demand for nonmetallic mineral commodities. The U.S. Department of Commerce reported a 37% drop in the number of units for which permits were issued for residential construction (public and private). Also, the value of private nonresidential construction dropped 20% below 1980 figures.

For the second year in a row, Michigan steel mills operated below capacity because of reduced demand from the automotive industry and other durable goods manufacturers. Demand for mineral commodities used in manufacturing suffered accordingly.

In April, an 11-day strike by the Marine Engineers Beneficial Association, District 2, Toledo, Ohio, which represents about 1,500 employees on American-owned Great Lakes ships, temporarily hindered production at several mining operations dependent on lake vessels for transportation. Railroads that transport taconite from the Upper Peninsula's mines and mills to Great Lakes

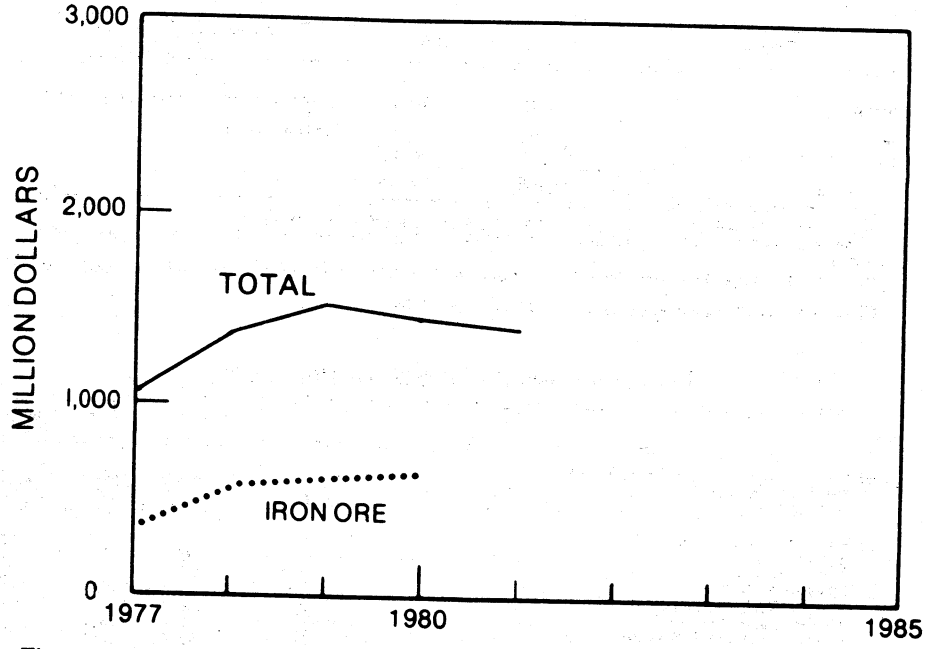

Figure 1.—Value of iron ore and total value of nonfuel mineral production in Michigan.

loading facilities were forced to lay off personnel for a short time. Also, several large limestone quarries suspended operations because of overflowing dockside inventories.

Exploration in the Upper Peninsula was less intense than during the previous year. Only four companies reported drilling activity; footage totaled about 7,200 feet. Several exploration firms indicated they were awaiting rules to be promulgated governing the State's new mineral leasing program. State-owned lands in the Upper Peninsula have not been open for mineral leasing since 1974.

Early in the year, Hanna Mining Co. halted production at the Groveland Mine in Dickinson County. The iron ore pellet operation remained closed at yearend. In Marquette County, the Cleveland-Cliffs Iron Co. (CCI) taconite facility operated at a reduced rate for part of the year. Both the Empire and Republic Mines were also temporarily closed for part of the year because of sagging steel demand.

In May, White Pine Copper Co., a division of Copper Range Co., held formal groundbreaking ceremonies to launch construction of its new $78 million electrolytic copper refinery in Ontonagon County. Scheduled for completion in 1982, the refinery incorporates the latest technology and reportedly will have an annual production capacity of 60,000 tons. When full production is reached, approximately 500 to 600 new employees will be required for the mine and mill.

McLouth Steel Corp., Detroit, the Nation's 11th largest steel producer, filed for protection from creditors under chapter 11 proceedings of the Federal bankruptcy laws in December. The financially burdened firm sells about 80% of its steel to the automotive industry and 20% to construction and appliance firms. All three industries suffered heavily during the year from rising costs and interest rates, reducing their demand for steel.

In another steel-related action, Ford Motor Co. announced the creation of a new subsidiary out of its former steel division. Effective January 1, 1982, the subsidiary will be known as Rouge Steel Co. Formulation of the new subsidiary was expected to provide additional operating and financial flexibility for future growth of steel operations. About 70% of Ford's steel is sold to outside customers.

Resource Exploration, Inc., completed ex-

ploration at the Ropes gold mine near Ishpeming, in Marquette County, for Callahan Mining Corp. The program included underground drilling, mapping, and sampling. During the year, a 35-ton bulk sample of mineralized rock from the mine was shipped to the Institute of Mineral Research (IMR) at Michigan Technological University at Houghton for metallurgical tests. Callahan's board of directors was expected to announce sometime in 1982 whether it would proceed with the mining project.

Dundee Cement Co. of Dundee purchased the Penn-Dixie Industries, Inc., cement facilities at a bankruptcy auction in April. Included were the Petoskey plant and quarry and distribution terminals in Detroit and Holland. Also during the year, Domtar Industries, Inc., purchased the financially troubled Grand Rapids Gypsum Co. mine and plant at Grand Rapids.

Legislation and Government Programs.—In 1981, the Michigan Legislature enacted three laws that relate to the mineral industry. Public Act 88 revised bonding requirements for licensing of solid waste disposal areas to ensure closure and postclosure monitoring and maintenance. Excluded from the act's requirements were slag processing and related activities. Public Acts 106 and 116 were companion laws dealing, respectively, with air and water pollution fees that firms must pay for surveillance programs of the Department of Natural Resources (DNR). The laws doubled the maximum rate charged to firms considered the greatest polluters but provided for a gradual decrease in fees until October 1, 1984, when the State's general fund or other sources of revenue must assume all costs of the DNR pollution monitoring program.

Work continued on Michigan's proposed metallic mineral-lease regulations that have been under development by DNR for the past several years. Several public hearings were conducted, with industry representatives and environmentalists providing input on the structure and content of the lease document. At yearend, the proposed lease format was finalized and submitted to the Natural Resources Commission for consideration. Approval of the lease document was expected in early 1982.

Michigan Tech at Houghton was designated as a training agency by the State and began working with several community colleges to develop a program to provide mine safety training to employees of mining operations. Many small mine and quarry operators do not have training facilities, and Federal law mandates that new mine employees receive 24 hours of safety training and all employees receive an 8-hour refresher course each year.

IMR at Michigan Tech continued to provide technical services to industry and State and Federal agencies on the geology and mineral resources of Michigan. During the year, IMR conducted metallurgical research on a mineralized bulk sample from the Ropes gold mine for Callahan Mining Corp. Other ongoing studies included research on elastic stress wave propagation from blasting in underground mines and development of guidelines for closing underground mines.

The Geological Survey Div. of DNR continued to provide services and information to the public, industry, and Government agencies on Michigan's geology and mineral resources. Several personnel were involved in the development of the State's new metallic mineral leasing policy, which was transmitted to the Natural Resources Commission for approval. Budget restrictions forced cutbacks in several Survey programs, resulting in the abolishment of the General Geology and Geological and Minerals Research units during the year. Regulatory functions continued, and several personnel were added to the oil and gas management and surveillance program.

In fiscal year 1981, the Federal Government returned approximately $808,000 to the State for its share of funds generated by activities on national forest lands (timbering, minerals leasing, recreation, user fees, etc.). This compares with $827,900 the State received in fiscal year 1980. No action was taken by the U.S. Congress in 1981 on the seven national forest areas previously nominated for wilderness designation.

During the year, the U.S. Bureau of Mines had several active contracts and grants with industrial firms, educational institutions, and consulting firms in Michigan for services, equipment, and research. Funding totaled approximately $598,000. The Bureau of Mines Albany Research Center, Albany, Oreg., conducted a study on the characterization and beneficiation of phosphate-bearing rocks from northern Michigan. Results of the study were published in 1981 as a Bureau of Mines Report of Investigations (RI 8562). Concentrates obtained during the beneficiation tests were reported to be suitable for fertilizer manufacture.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Abrasives, Manufactured.—Three companies reported production of metallic abrasives in 1981. Steel shot and grit were manufactured by Ervin Industries, Inc., Lenawee County; Metal Tec Steel Abrasives Co., Wayne County; and Abrasive Materials, Inc., Hillsdale County.

Bromine.—Michigan was one of two States that produced bromine in 1981. Both production and value increased from 1980 to 1981. Bromine was produced from well brines by Dow Chemical Co. in Mason and Midland Counties and Morton Chemical Co. in Manistee County. Major uses were in flame retardants, agricultural chemicals, and well-drilling and completion fluids.

Calcium Chloride.—Michigan and California were the only States that produced natural calcium chloride in 1981; Michigan accounted for most of the U.S. production. Two companies produced from subsurface brines: Dow Chemical Co. in Mason and Midland Counties and Wilkinson Chemical Corp. in Lapeer County. Calcium chloride was used mainly for deicing, dust control, industrial applications, and oil and gas drilling.

Cement.—Nationally, Michigan ranked fourth in portland cement shipments and seventh in masonry cement shipments. Total shipments decreased about 17% in quantity from 1980 to 1981 because of the depressed economy and drop in construction activity. Six plants were active in the State during 1981; two of the plants operated as grinding facilities. All kiln operations in Michigan reported some downtime during the year owing to either maintenance and repairs or high inventories.

Table 4.—Michigan: Portland cement salient statistics

(Short tons)

	1980	1981
Number of active plants	7	6
Production	4,766,911	3,931,294
Shipments from mills:		
Quantity	4,650,942	3,871,319
Value	$224,685,322	$180,641,283
Stocks at mills, Dec. 31	397,035	356,362

Table 5.—Michigan: Masonry cement salient statistics

(Short tons)

	1980	1981
Number of active plants	5	4
Production	205,419	181,087
Shipments from mills:		
Quantity	205,523	172,973
Value	$14,292,353	$10,583,633
Stocks at mills, Dec. 31	70,869	72,136

Most cement shipped from plants to distribution terminals was transported by lake vessel and barge because several facilities are located along the Great Lakes. Cement shipped from plants and terminals to end users was transported mainly by truck. Ready-mix companies purchased the most cement, followed by concrete-products manufacturers, highway contractors, and building-material dealers.

In late 1980, Penn-Dixie Industries, Inc., closed its plant in Petoskey, Emmet County. Dundee Cement Co. purchased the plant for $9.7 million in April, with plans to use the site for storage and distribution. The purchase also included distribution terminals at Detroit and Holland.

Medusa Corp. continued to fine-tune its new plant at Charlevoix, which went onstream in 1979. The firm also began construction on a new distribution terminal near Chicago, which will serve northeastern Illinois and northwestern Indiana markets. Cement from the Charlevoix plant will be shipped to the new terminal on Medusa's lake vessel *Challenger*.

Clays.—Michigan ranked 10th of 44 States in clay production in 1981. Seven companies, each operating one mine, produced common clay and shale. Output and value decreased nearly 19% compared with 1980 levels. Principal producers were the Cement Div. of National Gypsum Co., Dundee Cement Co., and Amcord, Inc. Michigan Brick, Inc., the State's largest producer of face brick, had one kiln down for repairs most of the year. Clay was used mainly in cement manufacture; other uses were for the manufacture of face brick, flower pots, drain tile, sewer pipe, and flue linings.

Gem Stones.—Gem stones and mineral

specimens were collected mainly by amateur collectors and mineral dealers. Value of gem stones collected in 1981 was estimated at $15,000. In August, a group of 55 mineral collectors from the Central Canadian Federation of Mineralogical Societies visited the Marquette area for 2 days to collect mineral specimens. The field trips were guided by members of the Midwest Federation of Gem and Mineral Societies.

Gypsum.—Michigan ranked 5th of 22 States in production of crude gypsum during 1981. Crude gypsum was mined by four companies in two counties. National Gypsum Co., United States Gypsum Co., and Michigan Gypsum Co. produced in Iosco County; Georgia-Pacific Corp. produced in Kent County. During the year, Domtar Industries, Inc., of Montreal, Canada, purchased the Grand Rapids Gypsum Co. facilities in Grand Rapids; the company had ceased operations in August 1980. The gypsum mine and wallboard plant were not operated by Domtar in 1981 because of the depressed economy.

Michigan dropped to 14th place in the production of calcined gypsum. Three companies in Iosco, Kent, and Wayne Counties reported output. Gypsum was used for wallboard production, cement manufacture, industrial or building plaster, and agricultural purposes.

Iodine.—Michigan was one of two States that produced iodine in 1981. Dow Chemical Co. in Midland, the State's only producer, recovered iodine from subsurface brines. End product uses included animal feed additives, catalysts, pharmaceuticals, disinfectants, stabilizers, and inks and colorants.

Iron and Steel Slag.—Michigan rose to third place among the States in the production of iron and steel slag. Output decreased nearly 12%, but value remained fairly constant from 1980 to 1981. Edward C. Levy Co. in Wayne County processed slag from Ford Motor Co.'s Steel Div., Great Lakes Steel, and McLouth Steel Corp. Slag, a byproduct of steelmaking, was processed for road base material, concrete aggregate, railroad ballast, concrete products, and fill.

Lime.—Michigan ranked ninth among the States in lime production during 1981. Lime was produced by five companies at nine plants in seven counties. Dow Chemical Co. and Marblehead Lime Co., a subsidiary of General Dynamics Corp., were principal producers in the State. Leading uses for lime were in steelmaking, alkalies, sugar refining, water treatment, and paper and pulp manufacture.

Magnesium Compounds.—Michigan continued to lead the Nation in production of magnesium compounds. Three companies produced from well brines: Dow Chemical Co. in Ludington and Midland, and Martin Marietta Chemicals and Morton Chemical Co., both in Manistee. Magnesium compounds were used mainly in the production of high-temperature, basic refractories.

During the year, Martin Marietta culminated a 3-year modernization program at its Manistee plant with the startup of a third multiple-hearth furnace, expanding the firm's capacity for premium grades of high-purity magnesium oxide.

Peat.—Michigan ranked first nationwide in sales of peat, although production and value decreased for the second consecutive year. Peat was mined at 15 operations in 11 counties by 14 companies and sold in bulk and packaged form. Types of peat produced included reed-sedge, humus, hypnum moss, and sphagnum moss. Principal producers were Anderson Peat Co., Michigan Peat, Inc., and Al-Par Peat Co. Peat was used mainly for soil improvement and potting soil.

Perlite.—Perlite imported from other States was expanded by Harborlite Corp. in Vicksburg and United States Gypsum in Detroit. Principal end uses were in plaster aggregate and as a filter aid.

Salt.—Michigan ranked 5th in output and 3d in value among the 16 salt-producing States in 1981. Production and value decreased slightly compared with those of the previous year owing to inventory carryovers resulting from a mild winter and a downturn in salt usage by certain food-product industries. Eight companies in five counties produced nearly 6% of the national output during the year. Uses included table salt, ice control, and food and chemical processing.

In 1981, Diamond Crystal Salt Co. formed a joint venture with a private energy firm to develop underground storage for hydrocarbons at its solution mining site in St. Clair County. The company is currently creating two caverns with an estimated capacity of 1 million barrels each in conjunction with its brine extraction operations.

Sand and Gravel.—In late 1980, the U.S. Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered

years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but contains complete data on industrial sand and gravel. Estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

During 1981, Michigan ranked fifth nationally in production of construction sand and gravel. Estimated output and value decreased about 12% and 10%, respectively, compared with those of 1980.

Michigan ranked second, behind Illinois, in industrial sand production during the year, contributing about 15% to the national output. Production and value increased about 8% and 18%, respectively, over those of 1980. Industrial sand was mined from 14 operations in 10 of Michigan's 83 counties. Principal producers were Construction Aggregates Corp., Ottawa County; Sand Products Corp., Oceana County; and Ottawa Silica Co., Wayne County. Most industrial sand produced in Michigan was sold to foundries as molding sand. Other major sales were for the manufacture of silicon carbide and glass containers.

Table 6.—Michigan: Sand and gravel sold or used by producers, by use

Use	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	13,336	$27,872	$2.09	NA	NA	NA
Gravel	19,200	45,294	2.36	NA	NA	NA
Total or average	32,536	73,166	2.25	p28,500	p $66,000	p $2.32
Industrial sand	4,062	25,188	6.20	4,393	29,787	6.78
Grand total or average	[1]36,597	98,354	2.69	p32,893	p 95,787	p 2.91

pPreliminary. NA Not available.
[1]Data do not add to total shown because of independent rounding.

Two industrial sand producers received sand dune mining permits from DNR during the year. Nugent Sand Co. received a permit for its operation at Norton Shores, south of Muskegon, and Martin Marietta Aggregates received permission to mine a site near Bridgman, in Berrien County, after the Michigan Natural Resources Commission narrowly ruled in favor of the mining operation. At yearend, several environmental groups planned to contest the permit issued to Martin Marietta. One firm, Manley Bros., Inc., was refused a mining permit by DNR for a site south of St. Joseph in Berrien County for environmental reasons.

Stone.—In 1981, stone was extracted in 29 counties at 53 quarries. Eight of these quarries each produced more than 1 million tons of stone. Leading counties, in decreasing order of tonnage, were Presque Isle, Mackinac, Alpena, Monroe, and Chippewa. Together these counties accounted for 85% of the State's 1981 output.

Crushed stone comprised most of the stone produced in the State. Limestone was the leading rock-type mined, followed by marl and traprock. Most crushed stone was shipped by truck; other means were waterway and rail. Several large crushed stone producers that ship by water were forced to curtail production in April and May when Great Lakes freighter crews went on strike, causing high inventories that virtually clogged the shipping docks.

Small amounts of limestone and sandstone were quarried for dimension stone. Production valued at about $129,000 was reported from five quarries in Easton, Jackson, Presque Isle, and Schoolcraft Counties. Sales were for cut stone, flagging, and stone veneer.

Sulfur.—Three refineries produced elemental sulfur as a byproduct in 1981. Marathon Oil Corp. recovered sulfur in Detroit; Total Petroleum, Inc., in Alma; and Shell Oil Co., in Manistee. Sulfur was used mainly for manufacturing sulfuric acid.

Vermiculite.—W. R. Grace & Co. exfoliated vermiculite imported from out of State at its plant in Dearborn, Wayne County. Although sales declined from 1980 to 1981, unit values increased slightly. The product was used for concrete and plaster aggregate, loosefill and block insulation, horticultural applications, soil conditioning, and fireproofing.

Table 7.—Michigan: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	221	773	248	948
Agricultural marl and other soil conditioners	27	54	43	112
Concrete aggregate (coarse)	3,223	7,761	2,705	7,337
Bituminous aggregate	1,732	5,355	1,494	5,112
Macadam aggregate	372	1,008	359	866
Dense-graded road base stone	1,044	3,279	1,047	3,393
Surface treatment aggregate	162	482	82	287
Other construction aggregate and road stone	1,817	5,753	1,469	4,851
Riprap and jetty stone	443	1,168	297	1,006
Railroad ballast	W	W	378	1,081
Manufactured fine aggregate (stone sand)	W	W	13	39
Cement manufacture	6,589	14,455	6,357	14,251
Lime manufacture	7,698	22,580	8,450	28,166
Flux stone	7,702	25,909	6,537	25,055
Other[2]	1,090	3,150	532	1,819
Total[3]	32,121	91,727	30,013	94,324

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

[1]Includes limestone, marl, traprock, and miscellaneous stone (1981).

[2]Includes stone used for poultry grit and mineral food, terrazzo and exposed aggregate, chemical stone for alkali works, paper manufacture, sugar refining, waste material, and other uses not specified (1981).

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

METALS

Copper and Silver.—All copper mined in Michigan, along with byproduct silver, originated from the Copper Range Co. White Pine Mine in Ontonagon County in the western Upper Peninsula. Copper production increased about 18% from 1980 to 1981, accompanied by a slightly greater percentage increase in silver production. This increase reflects output lost in 1980 because of a 2-month strike over a contract agreement. Compared with 1979 figures, copper production in 1981 increased about 1%, but value decreased about 8% because of depressed prices.

In May, Copper Range began construction of a $78 million, 60,000-ton-per-year electrolytic refinery, with completion slated for late 1982. The new refinery will incorporate the latest technology and allow the company to produce high-purity copper in the form of cathodes and continuously cast wirebars, billets, and cakes. When operating, the new facilities are expected to result in 500 to 600 new jobs and allow the company to enter new markets to remain competitively viable. Also during the year, Copper Range sold about 120,000 acres of timberland near its White Pine complex to Mead Corp. The company will retain exploration and mining rights for areas not yet completely explored.

Iron Ore.—Michigan ranked second behind Minnesota in iron ore shipments, accounting for about 20% of the national output during 1981. Production decreased about 11% compared with 1980 levels as lagging demand for steel continued into 1981, resulting in layoffs and shutdowns at all four open pit mines in Michigan's Upper Peninsula.

Table 8.—Michigan: Usable iron ore[1] produced (direct shipping and all forms of concentrates), by range

(Thousand long tons)

Year	Marquette Range	Menominee Range (Michigan part)	Gogebic Range (Michigan part)	Total		
				Gross weight		Iron content (percent)
				Ore	Iron content	
1854-1976	453,785	307,355	249,625	1,010,765	NA	NA
1977	9,799	2,520	--	12,319	7,798	63.3
1978	W	W	--	16,752	10,652	63.6
1979	W	W	--	17,132	10,933	63.8
1980	W	W	--	16,421	10,482	63.8
1981	W	W	--	15,583	10,020	64.3
Total	523,116	[2]316,232	[2]249,625	1,088,972	NA	NA

NA Not available. W Withheld to avoid disclosing company proprietary data; included in "Total."
[1]Exclusive after 1905 of iron ore containing 5% or more manganese.
[2]Distribution by range partly estimated before 1906.

Table 9.—Michigan: Iron ore shipped from mines

(Thousand long tons)

Year	Direct-shipping ore[1]	Concentrates and agglomerates, total	Total usable ore	Proportion of beneficiated ore to total usable ore (percent)
1977	253	11,756	12,009	97.9
1978	W	W	17,538	W
1979	W	W	17,196	W
1980	W	W	15,895	W
1981	W	W	14,193	W

W Withheld to avoid disclosing company proprietary data.
[1]Includes crushed, screened, and sized ore not further treated.

Reduced demand for iron ore pellets forced Hanna Mining Co. to shut down the Groveland Mine and mill in Dickinson County in January. Except for some shipments of stockpiled pellets, the facility remained idle through yearend.

Production at the CCI Tilden Mine was reduced to 50% of capacity from late October until mid-December, and the Empire Mine was shut down from mid-November through yearend. Production from the Republic Mine was also reduced for most of the year and halted completely in early October.

During the year, Pickands Mather & Co. released a map identifying lands of possible mining interest in the Pine Creek, Traders Mine, Lake Antoine, and Fumee Lake areas, directly northwest of Iron Mountain in Dickinson County. The map was released to inform the public of the firm's maximum "area of interest," although there were no definite plans for mine development. The firm controls the mineral rights to iron formation in the area and has been active in exploratory drilling and surface rights acquisition since 1978.

Iron Oxide Pigments.—Michigan ranked first of four States in shipments of crude iron oxide pigments during 1981. Shipments originated from stockpile at the CCI Mather Mine in Marquette County, which closed in 1979. Finished iron oxide pigments were produced by BASF Wyandotte Corp. at Wyandotte, Wayne County. Iron oxide pigments were used in paint and coatings.

Iron and Steel Scrap.—Cargill, Inc.'s North Star Steel Co. completed construction of a new minimill at Monroe in southeastern Michigan in 1980. The plant produced special bar-quality steel and carbon and alloy rounds from recycled scrap for the automotive industry.

Pig Iron and Steel.—Michigan ranked fourth among the States in pig iron shipments during 1981. Compared with 1980 levels, shipments increased about 5% in quantity, accompanied by a slight increase

in value.

McLouth Steel Corp., the Nation's 11th largest steel producer, continued to suffer severe financial losses during the year owing to the faltering automotive industry, the firm's principal market. At midyear, McLouth sold its stainless steel division to Jones & Laughlin Steel Corp. for $23.5 million. By yearend, the company was forced to file for reorganization under chapter 11 of the Federal bankruptcy laws.

Ford Motor Co., the Nation's ninth largest steel producer, created a new subsidiary out of its former steel division, which will be known as Rouge Steel Co. The subsidiary was expected to provide additional operating and financial flexibility for future growth of steel operations. In another action, Ford and the U.S. Environmental Protection Agency came to an agreement whereby the firm will spend $20 million to reduce air pollution at its Dearborn facility. Ford remained the only U.S. automobile company to manufacture its own steel.

National Steel Corp.'s Great Lakes Steel Div. restructured its operation in Ecorse, Wayne County, and cut its steelmaking capacity by about 2 million tons during the year. The plant had been reduced to two blast furnaces from four and to one basic oxygen furnace from two. The firm established a new record in March for the longest period of nonstop steel production ever achieved by a North American continuous-casting facility.

[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]Liaison program assistant, Bureau of Mines, Pittsburgh, Pa.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Dundee Cement Co.[1 2]	Box 122 Dundee, MI 48131	Quarry and plant	Monroe.
Medusa Cement Co., Medusa Corp., a subsidiary of Crane Co. [1 2]	Box 5668 Cleveland, OH 44101	do	Charlevoix.
National Gypsum Co., Cement Div.[1 2]	4000 Town Center, Suite 2000 Southfield, MI 48075	do	Alpena.
Peerless Cement Co., Gifford-Hill & Co., Inc.[1]	9333 Dearborn St. Detroit, MI 48209	do	Wayne.
Clay and shale:			
Michigan Brick Inc	3820 Serr Rd. Corunna, MI 48817	Pit and plant	Shiawassee.
Copper:			
White Pine Copper Div. of Copper Range Co.[3]	Box 427 White Pine, MI 49971	Underground mine and plant.	Ontonagon.
Gypsum:			
Georgia-Pacific Corp	900 SW. 5th Ave. Portland, OR 97204	do	Kent.
Michigan Gypsum Co	2840 Bay Rd. Saginaw, MI 48608	Open pit mine and plant.	Iosco.
National Gypsum Co	4100 First International Bldg. Dallas, TX 75270	do	Do.
United States Gypsum Co	101 South Wacker Dr. Chicago, IL 60606	do	Iosco and Wayne.
Iron ore:			
Cleveland-Cliffs Iron Co.[4]	504 Spruce St. Ishpeming, MI 49849	Open pit mines and plants.	Marquette.
Hanna Mining Co	Star Route 1, Box 131 Iron Mountain, MI 49801	Open pit mine and plant.	Dickinson.
Iron and steel:			
Ford Motor Co	American Rd. Dearborn, MI 48121	Plant	Wayne.
McLouth Steel Corp	300 South Livernois Ave. Detroit, MI 48209	do	Do.
National Steel Corp	2800 Grant Bldg. Pittsburgh, PA 15219	do	Do.
Lime:			
Detroit Lime Co., a subsidiary of Edward C. Levy Co.	9300 Dix Ave. Dearborn, MI 48120	do	Do.
Dow Chemical Co., Ludington Div	2020 Dow Center Midland, MI 48640	do	Mason.
Marblehead Lime Co., a division of General Dynamics Corp.	300 West Washington St. Chicago, IL 60606	do	Wayne.
Natural salines:[5]			
Dow Chemical Co	2020 Dow Center Midland, MI 48640	Brine wells and plant	Mason and Midland.
Martin Marietta Chemicals, Refractories Div.	Executive Plaza II Hunt Valley, MD 21030	do	Manistee.
Morton Chemical Co	110 North Wacker Dr. Chicago, IL 60606	do	Do.

See footnotes at end of table.

Table 10.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Peat:			
Al-Par Peat Co	9551 Krouse Ovid, MI 48866	Bog and plant	Shiawassee.
Anderson Peat Co	Box 575 Perry, MI 48872	do	Lapeer and Shiawassee.
Michigan Peat, Inc	Box 66388 Houston, TX 77006	Bogs and plants	Sanilac.
Salt:			
Diamond Crystal Salt Co	916 South Riverside St. Clair, MI 48079	Brine wells and plant	St. Clair.
International Salt Co., Inc	12841 Saunders St. Detroit, MI 48217	Underground mine	Wayne.
Sand and gravel:			
Construction:			
American Aggregates Corp	Drawer 160 Greenville, OH 45331	Surface pits and stationary plants.	Kalamazoo, Livingston, Macomb, Oakland.
Grand Rapids Gravel Co	2700 28th St., SW Grand Rapids, MI 49509	do	Kent.
Holly Sand & Gravel Co., Aggregate Div. of J. P. Burroughs & Son, Inc.	Box 1468 Saginaw, MI 48605	Surface pit, stationary and portable plants.	Oakland.
Medusa Materials Co	3135 Trabue Rd. Columbus, OH 43204	Surface pit and stationary plant.	Do.
Spartan Aggregates	Box 25 Holt, MI 48842	Surface pits and stationary plants.	Clinton, Genesee, Ingham, Jackson, Oakland, Ottawa.
Whittaker & Gooding Co	5800 Cherry Hill Rd. Ypsilanti, MI 48197	do	Washtenaw.
Industrial:			
Construction Aggregates Corp	Box 6830 Ferrysburg, MI 49409	Surface pit and stationary plant.	Ottawa.
Ottawa Silica Co., Michigan Silica Div.	Box 100 Rockwood, MI 48173	do	Wayne.
Sand Products Corp	2489 1st National Bldg. Detroit, MI 48226	Surface pits and stationary plants.	Oceana.
Sargent Sand Co	2840 Bay Rd. Saginaw, MI 48608	Surface pit and stationary plant.	Bay, Mason, Saginaw.
Slag:			
Edward C. Levy Co	8800 Dix Ave. Detroit, MI 48209	Plant	Wayne.
Stone:			
Limestone:			
Drummond Dolomite Inc., Div. of Bethlehem Steel Corp.	Martin Tower Bethlehem, PA 18016	Quarry and plant	Chippewa.
Inland Lime & Stone Co., a division of Inland Steel Co.	Gulliver, MI 49840	do	Mackinac and Schoolcraft.
Presque Isle Corp	Box 426 Alpena, MI 49707	Quarry	Presque Isle.
United States Steel Corp., Michigan Limestone Operations.	Rogers City, MI 49779	do	Mackinac and Presque Isle.
Marl:			
Kevin D. Brenner	Route 1 Hopkins, MI 49328	do	Allegan.
Sandstone:			
Jude Stone Quarry Co	338 Austin Rd. Napoleon, MI 49261	do	Jackson.

[1]Also clay and shale.
[2]Also stone.
[3]Also silver.
[4]Also iron oxide pigments.
[5]Includes bromine, bromine compounds, calcium compounds, iodine, and magnesium compounds.

The Mineral Industry of Minnesota

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Mineral Resources Research Center, University of Minnesota, for collecting information on all nonfuel minerals.

By James H. Aase[1]

The value of nonfuel mineral production in Minnesota rose to a record high of $2,151.9 million during 1981, a 21% increase over that of 1980 and 4% above the previous record high set in 1979. This gain was attributed primarily to increased iron ore shipments, supplemented by higher prices received for selected mineral commodities.

Minnesota continued to lead the Nation in iron ore output and was ranked second among the States in total nonfuel production value.

Four of the nine mineral commodities produced in the State gained in either output or value in 1981, over levels recorded for 1980. Nearly 96 cents out of every dollar of the State's total mineral value was generated by the metallic sector, principally iron ore. Leading the nonmetal commodities in value was sand and gravel, followed by stone, both recording production decreases from 1980 levels, reflecting the construction industry's continuing downturn in demand for these industrial minerals.

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

Mineral	1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	94	$1,206	84	$1,077
Gem stones	NA	5	NA	5
Iron ore (usable) thousand long tons, gross weight	45,472	1,686,839	50,176	2,062,118
Lime thousand short tons	162	3,562	155	3,818
Manganiferous ore short tons	119,029	W	139,571	W
Peat thousand short tons	25	1,140	25	940
Sand and gravel[2] do.	25,110	49,180	p23,200	p46,800
Stone:				
Crushed do.	8,606	21,731	6,995	18,438
Dimension do.	44	14,189	41	14,298
Combined value of abrasive stone, industrial sand, and values indicated by symbol W	XX	4,458	XX	4,377
Total	XX	1,782,310	XX	2,151,871

pPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes industrial sand; value included with "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Aitkin	$115	$39	Peat.
Anoka	432	W	Sand and gravel.
Becker	220	143	Do.
Beltrami	299	135	Do.
Benton	161	W	Do.
Big Stone	W	2,850	Stone.
Blue Earth	W	2,420	Stone, sand and gravel.
Brown	W	W	Sand and gravel, clays.
Carlton	W	W	Peat, sand and gravel.
Carver	W	W	Sand and gravel.
Cass	• 903	751	Do.
Chippewa	228	172	Do.
Chisago	270	336	Do.
Clay	6,191	3,095	Sand and gravel, lime.
Clearwater	137	W	Sand and gravel.
Cook	55	47	Do.
Cottonwood	W	399	Do.
Crow Wing	W	W	Manganiferous ore, sand and gravel.
Dakota	4,565	6,813	Sand and gravel, stone.
Dodge	680	737	Stone, sand and gravel.
Douglas	498	413	Sand and gravel.
Faribault	W	W	Do.
Fillmore	1,505	W	Stone, sand and gravel.
Freeborn	819	625	Sand and gravel.
Goodhue	899	721	Sand and gravel, stone.
Grant	W	W	Sand and gravel.
Hennepin	W	W	Sand and gravel, clays.
Houston	759	1,223	Stone, sand and gravel.
Hubbard	399	333	Sand and gravel.
Itasca	147,353	109,263	Iron ore, sand and gravel.
Jackson	W	W	Sand and gravel.
Kanabec	153	117	Do.
Kandiyohi	1,056	W	Do.
Kittson	453	W	Do.
Koochiching	378	346	Do.
Lac qui Parle	W	W	Stone, sand and gravel.
Lake	268	W	Sand and gravel.
Lake of the Woods	78	--	
Le Sueur	W	W	Sand and gravel, stone.
Lincoln	11	--	
Lyon	W	W	Sand and gravel.
McLeod	19	W	Do.
Mahnomen	240	208	Do.
Marshall	328	255	Do.
Meeker	335	255	Do.
Mille Lacs	W	649	Sand and gravel, stone.
Morrison	403	278	Sand and gravel.
Mower	558	234	Stone, sand and gravel.
Murray	27	68	Sand and gravel.
Nicollet	1,256	994	Stone, sand and gravel.
Nobles	W	W	Sand and gravel.
Norman	271	244	Do.
Olmsted	W	2,159	Stone, sand and gravel.
Otter Tail	269	460	Sand and gravel.
Pennington	243	79	Do.
Pine	160	W	Do.
Polk	3,544	2,384	Lime, sand and gravel.
Pope	227	216	Sand and gravel.
Ramsey	W	W	Do.
Red Lake	5	--	
Redwood	W	187	Sand and gravel, stone.
Renville	2,496	W	Lime, stone, sand and gravel.
Rice	722	619	Sand and gravel, stone.
Rock	W	1,082	Sand and gravel, abrasives, stone.
Roseau	W	70	Sand and gravel.
St. Louis	W	W	Iron ore, sand and gravel, peat, stone.
Scott	4,456	W	Stone, sand and gravel.
Sherburne	2,983	2,440	Sand and gravel.
Sibley	W	W	Do.
Stearns	W	W	Stone, sand and gravel.
Steele	W	W	Sand and gravel, stone.
Stevens	W	W	Sand and gravel.
Swift	W	115	Do.
Todd	569	517	Do.
Wabasha	798	741	Stone, sand and gravel.
Wadena	10	99	Sand and gravel.

See footnotes at end of table.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Waseca	W	W	Sand and gravel.
Washington	$8,264	$7,564	Sand and gravel, stone.
Watonwan	121	105	Sand and gravel.
Wilkin	158	W	Do.
Winona	W	2,182	Stone, sand and gravel.
Wright	W	622	Sand and gravel.
Yellow Medicine	W	1,723	Stone, sand and gravel.
Undistributed[2]	1,870,641	1,624,782	
Total[3]	2,067,990	1,782,310	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Isanti, Martin, Pipestone, and Traverse Counties are not listed because no production was reported.
[2]Includes gem stones, sand and gravel 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 Minnesota business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	2,086.9	2,157.0	+3.4
Unemployment	do.	129.6	140.8	+8.6
Employment (nonagricultural):				
Mining	do.	15.6	15.7	+.6
Manufacturing	do.	370.9	362.3	-2.3
Contract construction	do.	76.4	67.9	-11.1
Transportation and public utilities	do.	99.8	98.5	-1.3
Wholesale and retail trade	do.	442.8	440.1	-.6
Finance, insurance, real estate	do.	94.6	97.5	+3.1
Services	do.	370.0	381.8	+3.2
Government	do.	300.1	298.9	-.4
Total nonagricultural employment	do.	1,770.2	[1]1,762.6	-.4
Personal income:				
Total	millions	$39,908	$44,000	+10.3
Per capita		$9,765	$10,747	+10.1
Construction activity:				
Number of private and public residential units authorized		21,741	17,399	-20.0
Value of nonresidential construction	millions	$674.8	$632.4	-6.3
Value of State road contract awards	do.	$138.8	$125.0	-10.0
Shipments of portland and masonry cement to and within the State	thousand short tons	1,490	1,276	-14.4
Nonfuel mineral production value:				
Total crude mineral value	millions	$1,782.3	$2,151.9	+20.7
Value per capita, resident population		$437	$528	+20.8
Value per square mile		$21,201	$25,597	+20.7

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

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

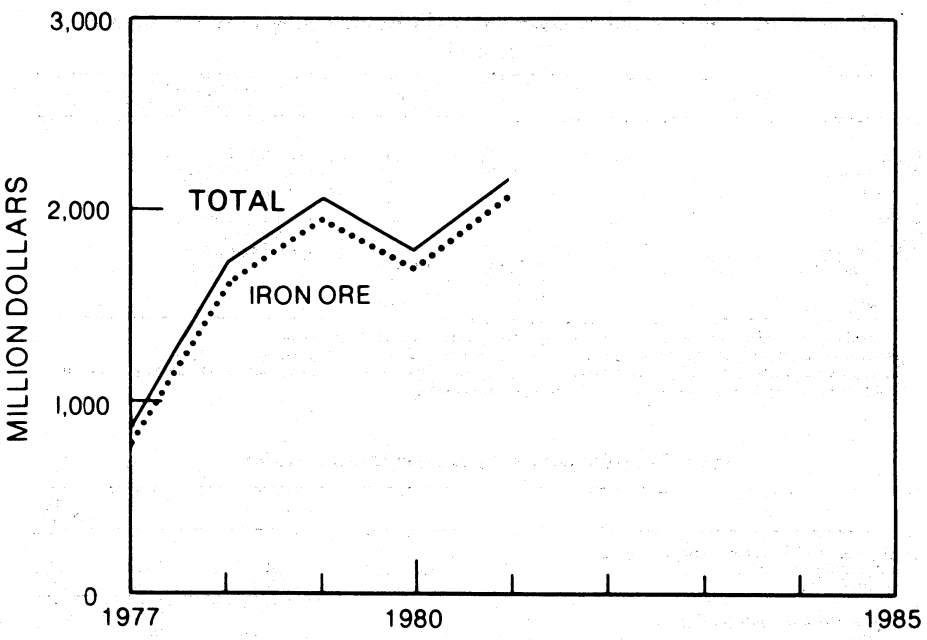

Figure 1.—Value of iron ore shipments and total value of nonfuel mineral production in Minnesota.

A weak demand for steel nationally precipitated cutbacks and temporary closures at many of the State's taconite pellet production facilities. During the year, taconite pellet production was approximately 80% of the combined rated production capacity of the State's plants.

Copper-nickel exploration and development at the AMAX, Inc., Minnamax project site near Babbitt was at a near standstill for the second consecutive year. Near yearend, the work force had been reduced to a skeleton staff retained to handle required environmental monitoring activities and to keep the 1,728-foot shaft at the site dewatered. According to company officials, dismissal of personnel and slowdown in activities were reactions to the depressed economy, the relatively low world prices for copper and nickel, and the low grade of the Minnamax reserve. AMAX of Greenwich, Conn., has invested a reported $20 million in the northeastern part of the State since 1974 when it began its exploration activities. Company officials indicated that early in 1982 the corporation would decide whether to continue developing the massive low-grade deposit.

In the nonmetallic sector, the year was highlighted by two firms developing industrial sand resources in the southern part of the State. The specialty material produced was a hydrofracturing sand used by the petroleum industry to enhance oil and gas recovery from production wells.

At the Port of Duluth, construction was underway on a new cement transshipment facility, and ground was broken to mark the beginning of an improvement project at the iron ore docks. The St. Lawrence Cement Co., Inc., of Montreal, Quebec, was well along on its 43,000-ton-capacity multiple-silo storage, vessel berthing, and unloading facility. The company will use the facility in receiving cement by vessel from its manufacturing plant in Mississauga, Ontario.

Near midyear, the Duluth Missabe & Iron Range Railway initiated work on a $26 million improvement project at its iron ore dock. Most of the project is the conversion of one side of its Dock No. 6 from a gravity-chute loading system to a conveyor-type system that will permit loading vessels up to 1,100 feet long and 105 feet wide. The project is to be completed by spring 1983.

The Minnesota Department of Natural

Resources granted leases for base metal exploration to Lehmann Exploration Management, Inc., Minneapolis, on State lands in Beltrami County; and the Itasca County Board of Commissioners granted Lehmann additional leases on county-tax-forfeited lands.

Employment.—According to statistics the Minnesota Department of Economic Security published, employment in the State's mining and quarrying industries ranged from a high of 16,700 persons working an average of 39.9 hours weekly during July to a low of 12,900 workers averaging 36.9 hours weekly during November. Peak employment during the year was approximately 4% above that in 1980.

Workers in the metal mining sector comprised 89% of the total mining and quarrying work force. At yearend, the average hourly earnings for the entire work force was $12.98, with those in the metal mining sector receiving the highest rate averaging $13.58, a 9% increase over that for the same period in 1980.

Legislation and Government Programs.—The Minnesota Legislature considered a host of mineral-related bills introduced during the 1981 legislative session and passed three into law. Legislation enacted included measures that (1) authorized leasing State-owned peatland for agricultural purposes for up to 25 years, (2) established guidelines for the commissioner of revenue in managing the mineral tax, and (3) provided a basis for the valuation and assessment of property taxes on property taconite mining companies used as tailings ponds.

Throughout 1981, the Minnesota Department of Natural Resources (DNR) Division of Minerals continued to assess the mineral potential of State-administered mineral lands in northeastern Minnesota. During the year, geological, geochemical, and geophysical surveys, together with diamond core drilling, were conducted in the Duluth Gabbro complex of Lake County. The DNR reported that drilling northeast of Toimi near Crest Lake, Lake County, encountered mineralization on an anomaly extending from Greenwood Lake to the southwest for approximately 20 miles. The DNR deemed the results of the drilling significant and the area deserving of further exploration. A report on the surveys and drilling is available from the agency.[2]

During 1981, the Minnesota Geological Survey was involved in a variety of activities directed toward achieving a better understanding of the State's geology and mineral resources. Included among the projects were (1) completion of a study estimating the manganese resources of the Cuyuna Range in east-central Minnesota and (2) completion of an aeromagnetic survey for all of Aitkin and Kanabec Counties and parts of nine other counties. Continuation of aeromagnetic surveys is planned for the next few years until the entire State has been covered. Results from the surveys will provide more information about the bedrock geology of the State in the large areas where the bedrock is concealed.

The U.S. Geological Survey, in cooperation with the Upper Great Lakes Regional Commission and the State of Minnesota, completed a project identifying and summarizing environmental and land use permits required by the State for developing energy, mineral, and other selected natural resources. The findings, published as a guidebook[3] available to all interested groups, provide concise, easy-to-use information on the State regulations that govern the development of such resources.

Research at the Twin Cities Research Center of the Federal Bureau of Mines included investigating new and improved processing technology applicable for expanding the State's mineral resource base. Among the findings the Bureau of Mines published during the year were reports on flotation responses and low-pressure leaching of copper-nickel ores,[4] and reduction roasting, flotation, and magnetic separation of various iron ores.[5]

REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Iron Ore.—Minnesota was ranked first among the States in iron ore production, accounting for approximately 70% of the total usable iron ore shipped from all U.S. mines during the year. The State's usable iron ore production in 1981 was obtained from 14 open pit mines or mine groups that 9 companies operated on the Mesabi Range in Itasca and St. Louis Counties.

Taconite pellet production, which accounted for 97% of the State's usable iron ore output, improved slightly over that of 1980 but fell short of the higher levels attained in 1978 and 1979.

Late in 1981, a large inventory of taconite pellets, coupled with a sluggish steel demand, forced cutbacks in production at Minnesota taconite operations. United States Steel Corp.'s Minntac plant near Mountain Iron curtailed production to 40% of its annual capacity of 18.5 million tons. Inland Steel Mining Co.'s Minorca Mine and plant in Virginia shut down for 5 weeks. Designed to produce about 2.6 million tons of iron ore pellets annually, the Minorca Mine is the primary source of pellets used in Inland Steel Co.'s new 7,000-ton-per-day Madeline No. 7 blast furnace at its East Chicago, Ind., steelworks. The Hanna Mining Co.'s Butler plant, Nashwauk, and the National Steel Pellet Plant, Keewatin, were closed for 8 weeks. The Butler operation is rated at 2.6 million tons annually, and the National Steel plant's capacity is about 5.8 million tons per year.

Table 4.—Minnesota: Iron ore[1] data in 1981, by county

(Thousand long tons)

County	Crude ore production[2]	Usable ore				
		Stocks, Jan. 1	Production	Iron content of production	Shipments	Stocks, Dec. 31
Itasca	12,590	W	3,984	2,496	4,532	W
St. Louis[3]	152,361	W	47,042	30,051	45,644	W
Total[4]	164,950	4,644	51,025	32,547	50,176	5,536

W Withheld to avoid disclosing company proprietary data; included with "Total."
[1]Exclusive of ore containing 5% or more manganese.
[2]Entire production from Mesabi Range open pit mines.
[3]Includes Lake County.
[4]Data may not add to totals shown because of independent rounding.

Table 5.—Minnesota: Production and shipments of usable iron ore[1]

(Thousand long tons unless otherwise specified)

Year	Production				Shipments			
	Natural ore and concentrates	Pellets	Total	Iron content (percent)	Natural ore and concentrates	Pellets	Total	Proportion of pellets to total ore (percent)
1977	4,600	26,343	30,943	61.9	5,123	25,122	30,245	83.1
1978	5,829	49,487	55,316	62.4	5,445	51,029	[2]56,473	90.3
1979	4,028	55,292	59,320	62.8	3,626	56,056	59,682	93.9
1980	2,050	43,112	45,162	63.4	2,371	43,101	45,472	94.8
1981	1,698	49,327	51,025	63.7	2,719	47,457	50,176	94.6

[1]Exclusive of ore containing 5% or more manganese.
[2]Data do not add to total shown because of independent rounding.

The mining of natural iron ore, which transformed northeastern Minnesota from a wilderness into a world mining center, has moved nearer to extinction. In October, U.S. Steel closed its last natural iron ore mining operation, the Arcturus Mine in Marble on the western end of the Mesabi Range. Three natural iron ore processing facilities that have historical ties to the development of Minnesota's mining industry were in the process of being dismantled during the year: the Rouchleau crushing and screening plant in Virginia; the Sherman crushing, screening, and concentrating plant near Chisholm; and the Trout Lake washing plant near Coleraine. The Trout Lake plant has particular significance since it was the first to concentrate natural iron ore on the Mesabi Range. Built in 1909, the plant became a model for developing other concentrating plants on the range. During its operations, it treated 160 million tons of ore. The Rouchleau plant, built in 1922, handled 220 million tons of ore, and the Sherman plant, built in 1951, treated more than 125 million tons of ore. Although U.S. Steel ceased its natural-ore mining operations, three smaller companies continue to extract natural ores on the Mesabi Range: Jones & Laughlin Steel Corp., Pittsburgh

Pacific Co., and Rhude & Fryberger, Inc.

The Minnesota Department of Economic Development sponsored a study to find new ways for keeping the Mesabi Range taconite competitive with foreign ores; Batelle Columbus Laboratories of Columbus, Ohio, investigated the feasibility of using taconite pellets for direct reduction steelmaking at northern Minnesota sites. Results of the study are to be released early in 1982.

According to figures the Lake Superior Industrial Bureau released, wages paid to employees of the State's iron ore industry exceeded $420 million, up from $365 million in 1980. Purchases of goods and services by the eight taconite operations exceeded $880 million, up from $710 million in 1980.

Two new self-unloading, supersize ore carriers were added to the Great Lakes fleet in 1981. The Pickands Mather-operated Interlake Steamship Co. christened and put in service the largest ore-carrying vessel to operate on the Great Lakes, the *William J. DeLancey,* 1,013.5 feet long. Designed to carry 61,000 tons, a second ore carrier, the 1,000-foot-long *Columbia Star,* owned by Oglebay Norton Co.'s Columbia Transportation Div., made its debut in the iron ore trade.

Table 6.—Dates of first and final cargoes of Minnesota iron ore shipped from Upper Great Lakes ports

Port and dock	1980			1981		
	First shipment	Final shipment	Total tonnage (thousand long tons)	First shipment	Final shipment	Total tonnage (thousand long tons)
Duluth, Minn.: DM&IR	Mar. 30	Dec. 22	13,263	Apr. 1	Dec. 16	[1]13,071
Silver Bay, Minn.: Reserve	Apr. 3	Dec. 16	4,399	Apr. 8	Dec. 10	6,351
Superior, Wis.: Burlington-Northern	Apr. 3	Dec. 25	10,146	Apr. 13	Dec. 17	10,669
Taconite Harbor, Minn.: Erie	Apr. 15	Dec. 28	6,097	Apr. 13	Dec. 10	7,644
Two Harbors, Minn.: DM&IR	Apr. 2	Dec. 30	10,010	Apr. 2	Dec. 28	9,996
Total			43,915			[2]47,730

[1]Includes 522,000 tons of flue dust from the former Duluth works of United States Steel Corp.
[2]Data do not add to total shown because of independent rounding.

Sources: American Iron Ore Association and various issues of Skillings' Mining Review.

Published prices for Lake Superior iron ore increased during the year. Prices—all for ore delivered at rail-of-vessel at lower Lake ports and based on 51.50% natural iron content—in effect on December 31, 1981, were as follows: Mesabi non-Bessemer, $32.53 per ton; Old Range non-Bessemer, $32.78 per ton; and manganiferous, $32.78 per ton. The lower Lake price for pellets was 80.50 cents per long ton iron unit. These prices reflect a 9.3% increase in the price of pellets, a 14% increase in the price of Mesabi non-Bessemer and Old Range non-Bessemer, and a 32% increase in the price of manganiferous ore during 1981. The average weighted mine value of Minnesota iron ore shipped in 1981 was $41.10 per ton.

Combined rail and lake freight rates for transporting iron ore from the Mesabi Range to lower Lake ports ranged from $10.59 to $12.39 per gross ton at midyear, compared with $9.61 to $10.72 per gross ton in mid-1980. These rates exclude storage and dock-handling charges.

Manganiferous Ore.—Pittsburgh Pacific Co., the State's sole producer of manganiferous ore (containing 5% to 35% manganese, natural) in 1981, mined crude material from the Algoma-Zeno Mine and processed it at its concentration plant near Ironton in Crow Wing County on the Cuyuna Range. Shipments during the year increased 17% compared with those of 1980.

Findings of a Minnesota Geological Survey study[4] indicated that the Cuyuna Range contains a minimum of 176 million metric tons of marginally economic manganiferous rock containing 10.46% manganese.

Table 7.—Minnesota: Shipments of manganiferous ores[1] from the Cuyuna Range

Year	Ferruginous manganese ore (10% to 35% Mn, natural)		
	Quantity (long tons)	Contents (natural)	
		Fe (percent)	Mn (percent)
1977	148,607	29.17	13.39
1978	226,249	28.22	12.98
1979	162,056	28.82	14.09
1980	106,276	32.00	14.04
1981	124,617	29.84	14.84

[1]All manganiferous ore shipped from the Cuyuna Range during 1977-81 was ferruginous manganese ore containing 10% to 35% manganese. There have been no shipments of manganiferous iron ore containing 5% to 10% manganese since 1969.

NONMETALS

Abrasive Stone.—At a quarry site near Jasper in Rock County, the Jasper Stone Co. produced abrasive stone from the Sioux Quartzite Formation of Precambrian age. The red-faced quartzite has been mined at the site nearly continually since the quarry was first opened in 1888. Most of the stone produced is turned into mill-liner blocks used in grinding silica sand for glass companies and in fine grinding industrial powders where metal liners are unsatisfactory. In addition, quartzite scraps are cut into "pebbles"—tennis-ball-sized cubes used inside tumbler mills as grinding media.

Clays.—The quantity and value of common clay and shale produced in 1981 fell nearly 11% from the level attained in 1980. Production was obtained from pits in Brown and Hennepin Counties. Output was used by Ochs Brick & Tile Co., Springfield, in face-brick manufacturing, and by Aglite, Inc., Minneapolis, in manufacturing lightweight aggregate. The latter operation was permanently closed in midyear.

Near Redwood Falls, Redwood County, interest was renewed in developing kaolin deposits first discovered about 20 years ago. Western Minerals Exploration Co., a Colorado company, obtained a lease agreement to take samples from city-owned land, reportedly containing approximately 25 million tons of kaolin.

Lime.—The total amount of domestically produced lime consumed in Minnesota during 1981 was 251,000 tons. Of this total, only 62% was manufactured in-State at facilities operated by American Crystal Sugar Co. and Southern Minnesota Sugar Coop. Lime production by American Crystal Sugar was from plants at Crookston, East Grand Forks, and Moorhead; and by Southern Minnesota Sugar Coop. at a plant in Renville. Both companies used all lime produced in their sugar refining operations at these same locations. The high-quality limestone used in manufacturing the lime was shipped into the State from Michigan.

Peat.—Four companies produced peat from bogs in Aitkin, Carlton, Otter Tail, and St. Louis Counties. Although the quantity sold in 1981 was essentially the same as in 1980, the total value of sales decreased approximately 18%. The principal types of peat produced were reed-sedge and sphagnum moss, with a small amount of hypnum moss also reported. Approximately two-thirds of the sales were in packaged form, primarily for use as an ingredient in potting soils and for general soil improvement. Sales in bulk form were for nursery use, golf courses, general soil improvement, and other miscellaneous uses.

Perlite.—Perlite mined in other States was expanded by Conwed Corp. at its plant near Cloquet in Carlton County. The expanded material was used in manufacturing acoustic tile.

Sand and Gravel.—To reduce reporting burden and costs, the Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for 1981 production of construction sand and gravel but complete data on industrial sand and gravel. The preliminary estimates for construction sand and gravel

production of odd years will be revised and made final the following year.

The estimated quantity of sand and gravel produced during the year was the least since 1953, reflecting the impact of the continuing recession in construction. Production dropped 8% from that of 1980 and was 51% below the record level set in 1969. Owing to inflation, the average unit value for all sand and gravel produced rose to a record high of $2.09 per ton in 1981.

Table 8.—Minnesota: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	9,609	$17,271	$1.80	NA	NA	NA
Gravel	15,501	31,909	2.06	NA	NA	NA
Total or average	25,110	49,180	1.96	p23,200	p$46,800	p$2.02
Industrial sand	W	W	7.91	W	W	8.06
Grand total or average	W	W	2.03	W	W	p2.09

pPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.

Industrial sand production during the year came from operations of Minnesota Frac Sand Co. in Scott County; Twin City Silica, Inc., in Washington County; and UNIMIN Corp., in Le Sueur County.

In late summer, construction was completed and production commenced at the industrial sand mine and plant of Minnesota Frac Sand Co. near Jordan. As its principal product, the new multimillion-dollar facility produces a specialty sand the oil and gas industry uses.

Near midyear, UNIMIN began constructing a new silica sand mine and plant near Kasota in Le Sueur County. The facility, to be completed and onstream in the summer of 1982, will initially produce only one type of sand, a product petroleum companies use in hydraulic fracturing.

Stone.—Forty-four firms, operating out of 106 quarries in 25 counties, accounted for the State's stone production in 1981. Production of granite, limestone, quartzite, and traprock collectively dropped 19% below the output in 1980. The average 1981 unit value of the material produced rose to an alltime high of $2.64 per ton for all types of crushed stone, and $347.06 for dimension stone.

Among the 48 States reporting crushed stone production in 1981, Minnesota was ranked 35th in output value. The value of the State's dimension stone production ranked Minnesota 4th among the 38 states reporting output.

Table 9.—Minnesota: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	527	1,411	599	1,691
Concrete aggregate	720	1,988	683	2,175
Bituminous aggregate	425	1,099	338	906
Macadam aggregate	W	530	W	W
Dense-graded road base stone	2,640	5,873	1,818	4,602
Surface treatment aggregate	507	1,264	575	1,461
Other construction aggregate and road stone	819	2,295	733	2,020
Riprap and jetty stone	153	509	271	736
Railroad ballast	2,216	5,449	1,548	3,636
Filter stone	22	90	173	492
Lime manufacture	5	19	--	--
Other[2]	571	1,206	256	779
Total[3]	8,606	21,731	6,995	18,438

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

[1]Includes granite, limestone, quartzite, and traprock.

[2]Includes stone used for poultry grit and mineral food, manufactured fine aggregate (stone sand, 1981), terrazzo and exposed aggregate, asphalt filler, other fillers or extenders (1981), other uses not specified, and uses indicated by symbol W.

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

Table 10.—Minnesota: Dimension stone[1] sold or used by producers, by use

Use	1980			1981		
	Short tons	Cubic feet (thousands)	Value (thousands)	Short tons	Cubic feet (thousands)	Value (thousands)
Rough stone:						
Other rough stone	1,766	22	$34	1,770	22	$36
Dressed stone:						
Cut stone	19,916	241	8,203	20,013	242	8,694
Sawed stone	704	9	154	W	W	W
House stone veneer	4,011	50	421	W	W	W
Monumental	12,234	147	4,869	11,935	144	4,749
Other[2]	5,833	65	509	7,478	85	818
Total[3]	44,464	534	14,189	41,196	494	14,298

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes granite, limestone, and quartzite.
[2]Includes stone used for rough blocks, rubble, rough monumental, rough and dressed flagging, other uses not specified, and uses indicated by symbol W.
[3]Data may not add to totals shown because of independent rounding.

Table 11.—Minnesota: Crushed limestone sold or used by producers, by county

County	1980			1981		
	Number of quarries	Quantity (thousand short tons)	Value (thousands)	Number of quarries	Quantity (thousand short tons)	Value (thousands)
Blue Earth	3	478	$1,158	2	W	W
Dakota	2	292	739	2	W	W
Fillmore	10	402	1,205	5	328	$1,085
Goodhue	7	161	322	9	114	246
Hennepin	--	--	--	1	3	21
Le Sueur	--	--	--	1	6	12
Mower	1	82	159	1	92	269
Olmsted	11	673	1,564	13	436	1,200
Rice	1	43	76	--	--	--
Scott	4	1,090	2,653	4	1,333	3,636
Wabasha	8	182	408	7	105	244
Washington	5	1,192	2,766	5	1,056	2,534
Winona	14	398	912	13	257	695
Undistributed[1]	19	804	2,351	22	1,187	3,353
Total[2]	85	5,797	14,314	85	4,918	13,295

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Includes Dodge, Houston, Steele, and Wright (1981) Counties and data indicated by symbol W.
[2]Data may not add to totals shown because of independent rounding.

Crushed limestone, marketed most extensively for use as a dense-graded road base material, was produced at 85 sites in 16 south-central and southeastern counties. The quantity and value of the 1981 crushed limestone output fell 15% and 7%, respectively, compared with those in 1980. Scott County was the leader in production, followed by Washington and Olmsted Counties, respectively; these counties collectively accounted for 57% of the State's entire output. Dimension limestone was produced in four quarries in Blue Earth, Le Sueur, and Winona Counties, with approximately 81% of the total output marketed as cut stone and house stone veneer.

Six companies quarried granite from 13 sites in 6 counties. Output of dimension granite, used for monumental and cut stone purposes, decreased 9% in quantity and 3% in value compared with those of 1980.

Crushed granite, marketed principally for use as railroad ballast, decreased 26% in quantity and 31% in value compared with those of 1980.

The State's output of quartzite in 1981 was from quarries operated by the Jasper Stone Co. in Rock County and New Ulm Quartzite Quarries, Inc., in Nicollet County. Output decreased 24% in quantity and value. The material produced in Rock County was quarried primarily as dimension stone used in manufacturing grinding pebbles and tube-mill liners. The Nicollet County

production was used most extensively as an aggregate in concrete and bituminous mixtures and as riprap.

Traprock—quarried for use in bituminous aggregate, dense-graded road base material, riprap, and railroad ballast—was obtained at a single site in St. Louis County by Arrowhead Blacktop Co.

Production from individual quarries varied widely. In 1981, 63% of the quarries produced less than 25,000 tons; 13% between 25,000 and 50,000 tons; 8% between 50,000 and 100,000 tons; 13% between 100,000 and 500,000 tons; and the remainder over 500,000 tons.

Sulfur (Recovered Elemental).—Elemental sulfur was recovered as a byproduct of the petroleum refining operations of Koch Refining Co., a division of Koch Industries, Inc., near Pine Bend in Dakota County, and by Northwestern Refining Co., a division of Ashland Oil Co., near St. Paul Park in Washington County.

Vermiculite.—Two companies, at plants in Hennepin County, exfoliated crude vermiculite obtained from other States. The expanded material was used principally for insulation and fireproofing, accounting for 80% of the output. The remainder was used for concrete and plaster aggregate and horticultural purposes. The quantity and value of the expanded material marketed decreased 31% and 26%, respectively, compared with those of 1980.

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[1]State Liaison Officer, Bureau of Mines, Minneapolis, Minn.

[2]Vadis, M. K., L. W. Gladen, and D. G. Meineke. Geological, Geophysical, and Geochemical Surveys of Lake, St. Louis, and Cook Counties, Minnesota for the 1980 Drilling Project. Minn. Dept. of Nat. Res., Div. of Minerals, Rept. 201, 1981, 13 pp.

[3]U.S. Geological Survey. Minnesota Permit Requirements for Natural Resources Development. October 1981, 135 pp.

[4]Schluter, R. B., and W. M. Mahan. Flotation Responses of Two Duluth Complex Copper-Nickel Ores. BuMines RI 8509, 1981, 24 pp.

Haas, L. A., R. B. Schluter, and R. H. Nafziger. Low-Pressure Leaching of Duluth Complex Matte. BuMines RI 8522, 1981, 12 pp.

[5]Peterson, R. E., and A. F. Colombo. Reduction Roasting and Beneficiation of a Hematitic-Geothitic Taconite. BuMines RI 8549, 1981, 20 pp.

Jacobs, H. D. Beneficiation of Western Mesabi Range Oxidized Taconites. A Comparison of the Anionic and Cationic Flotation Systems and an Evaluation of Potential Iron Ore Reserves. BuMines RI 8552, 1981, 21 pp.

Peterson, R. E., and A. F. Colombo. Beneficiation of a Hematitic Taconite by Reduction Roasting, Magnetic Separation, and Flotation. BuMines RI 8572, 1981, 13 pp.

[6]Beltrame, R. J., R. C. Holtzman, and T. E. Wahl. Manganese Resources of the Cuyuna Range, East-Central Minnesota. Minn. Geol. Surv., RI 24, 1981, 22 pp.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasive stone:			
Jasper Stone Co	14575 Garden Rd. Golden, CO 80401	Quarry and plant	Rock.
Clay and shale:			
Aglite, Inc	4901 West Medicine Lake Dr. Minneapolis, MN 55442	Pit and plant	Hennepin.
Ochs Brick & Tile Co	Box 106 Springfield, MN 56087	do	Brown.
Iron ore:			
Cleveland-Cliffs Iron Co.: Canisteo.	1460 Union Commerce Bldg. Cleveland, OH 44115	Mine and concentrator.	Itasca.
The Hanna Mining Co.:	100 Erieview Plaza Cleveland, OH 44114		
Butler Taconite Project		Mine, concentrator, agglomerator.	Do.
National Steel Pellet Project		do	Itasca and St. Louis.
Whitney		Stockpile shipments	St. Louis.
Inland Steel Mining Co.: Minorca	30 West Monroe St. Chicago, IL 60603	Mine, concentrator, agglomerator.	Do.
Jones & Laughlin Steel Corp. Northwest Ore Div.:			
McKinley		Mine and concentrator.	Do.
Oglebay Norton Co.:	1200 Hanna Bldg. Cleveland, OH 44115		
Thunderbird		Mine	Do.
Fairlane plant		Concentrator and agglomerator.	Do.
Pickands Mather & Co.:	1100 Superior Ave. Cleveland, OH 44114		
Erie Commercial		Mine, concentrator, agglomerator.	Do.
Hibbing Taconite		do	Do.

Table 12.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Iron ore —Continued			
Pittsburgh Pacific Co.:	2521 1st Ave. Hibbing, MN 55746		
Connie	----------	Mine	St. Louis.
Julia plant	----------	Concentrator	Do.
Pittsburgh Pacific Fee, Rouchleau, Sauntry, Wyoming, and others.	----------	Stockpile shipments	Do.
Reserve Mining Co.:	Silver Bay, MN 55614		
Peter Mitchell	----------	Mine and primary crusher.	Do.
Silver Bay plant	----------	Concentrator and agglomerator.	Lake.
Rhude & Fryberger, Inc.:	Box 66 Hibbing, MN 55746		
Gross-Nelson, Hull-Rust, Sharon-Culver, and others.	----------	Stockpile shipments	St. Louis.
United States Steel Corp. Minnesota Ore Operations:	Box 417 Mountain Iron, MN 55768		
Minntac	----------	Mine, concentrator, agglomerator.	Do.
Plummer Group	----------	Mine and concentrator.	Itasca.
Sherman Group	----------	Stockpile shipments	St. Louis.
Lime:			
American Crystal Sugar Co	101 North 3d St. Moorhead, MN 56560	Quicklime and shaft kilns.	Clay and Polk.
Southern Minnesota Sugar Coop	Box 500 Renville, MN 56284	----do	Renville.
Manganiferous ore:			
Pittsburgh Pacific Co.:	2521 1st Ave. Hibbing, MN 55746		
Algoma-Zeno	----------	Mine and concentrator.	Crow Wing.
Peat:			
Michigan Peat	Box 3006 Houston, TX 77001	Bog and processing plant.	Carlton.
Northern Peat Co	Box 416 Grand Rapids, MN 55744	----do	Aitkin.
Power-O-Peat Co	Box 956 Gilbert, MN 55741	----do	St. Louis.
Tamarack Peat Moss Co	Underwood, MN 56586	----do	Otter Tail.
Perlite, expanded:			
Conwed Corp	332 Minnesota St. St. Paul, MN 55110	Plant	Carlton.
Sand and gravel, construction (1980):			
Ames Sand & Gravel, Inc	Box 2702 Fargo, ND 58102	Pits and plants	Clay.
Arsenal Sand & Gravel Co	Box 12707 New Brighton, MN 55112	Pit and plant	Ramsey.
Barton Contracting Co	10633 89th Ave. North Maple Grove, MN 55369	Pits and plants	Dakota, Hennepin, Sherburne, Washington, Wright.
Cemstone Products Co	1520 Minnehaha Ave. St. Paul, MN 55106	Pit and plant	Washington.
Duininck Bros. & Gilchrist	Prinsburg, MN 56281	Pits and plants	Kandiyohi and Renville.
Fischer Sand & Aggregate, Inc	6801 West 150th St. Apple Valley, MN 55124	----do	Dakota.
H & S Asphalt Co	700 Industry Ave. NW. Anoka, MN 55303	----do	Anoka and Sherburne.
Komatz Construction, Inc	Box 498 St. Peter, MN 56082	Pit and plant	Le Sueur.
Kost Bros, Inc	Box 499 Moorhead, MN 56560	Pits and plants	Clay and Otter Tail.
C. S. McCrossan, Inc	Box 322 Osseo, MN 55369	Pit and plant	Hennepin.
William Mueller & Sons Co	Hamburg, MN 55339	Pits and plants	Carver, McLeod, Sibley.
North Star Concrete Co	Box 167 Mankato, MN 56001	----do	Le Sueur and Nicollet.
Northwestern Aggregates, Inc., a division of Model Stone Co.	Box 1248 Burnsville, MN 55337	Pit and plant	Dakota.
J. L. Shiely Co	1101 North Snelling Ave. St. Paul, MN 55108	----do	Washington.

Table 12.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand, industrial:			
Minnesota Frac Sand Co., a division of J. L. Shiely Co.	1101 North Snelling Ave. St. Paul, MN 55108	Pit and plant	Scott.
Twin City Silica, Inc	Lake Elmo, MN 55042	do	Washington.
UNIMIN Corp	Greenwich Office Park 4 Greenwich, CT 06830	do	Le Sueur.
Stone:			
Granite:			
Cold Spring Granite Co	Cold Spring, MN 56320	Quarries	Big Stone, Mille Lacs, Renville.
Do		Quarries and plant	Stearns.
The Green Co., Inc	200 14th Ave. Granite Falls, MN 56241	Quarry and plant	Yellow Medicine.
Ortonville Stone Co., a subsidiary of L. G. Everist.	Box 829 Sioux Falls, SD 57102	do	Big Stone.
J. L. Shiely Co	1101 North Snelling Ave. St. Paul, MN 55108	do	Stearns.
Limestone:			
Biesanz Stone Co., Inc	Box 768 Winona, MN 55987	do	Winona.
Bryan Rock Products, Inc	Box 215 Shakopee, MN 55379	Quarries and plants	Scott and Washington.
Hector Construction Co	Box 410 Caledonia, MN 55921	do	Fillmore, Houston, Winona.
Edward Kraemer & Sons, Inc	1000 West 122d St. Burnsville, MN 55378	Quarry and plant	Dakota.
Lundin Construction Co., Inc	1905 3d Ave. Mankato, MN 56001	Quarries and plants	Blue Earth, Le Sueur, Steele.
Mankato Aglime & Rock Co	Box 254 Mankato, MN 56001	Quarry and plant	Blue Earth.
Mankato Stone Center, a division of the Babcock Co.	Box 3088 Mankato, MN 56001	do	Do.
Mathy Construction Co., Patterson Quarries Div.	Route 3, Box 15 St. Charles, MN 55972	Quarries and plants	Olmsted, Wabasha, Winona.
Midwest Asphalt Corp., River Warren Aggregates, Inc.	Box 338 Hopkins, MN 55343	Quarry and plant	Scott.
Quarve & Anderson Co	2430 Marion Rd. SE. Rochester, MN 55901	Quarries and plants	Dodge, Goodhue, Olmsted, Wabasha, Winona.
J. L. Shiely Co	1101 North Snelling Ave. St. Paul, MN 55108	do	Scott and Washington.
Stussy Construction, Inc	Box 187 Mantorville, MN 55955	do	Dodge.
Vetter Stone Co	Route 5 Mankato, MN 56001	do	Blue Earth and Le Sueur.
Quartzite:			
New Ulm Quartzite Quarries, Inc.	Route 5, Box 21 New Ulm, MN 56073	Quarry and plant	Nicollet.
Traprock (basalt):			
Arrowhead Blacktop Co	Box 6568 Duluth, MN 55806	do	St. Louis.
Sulfur, recovered elemental:			
Koch Refining Co., a division of Koch Industries, Inc.	Box 2302 Wichita, KS 67201	Elemental sulfur recovered as a by-product of oil refining.	Dakota.
Northwestern Refining Co., a division of Ashland Oil, Inc.	Drawer 9 St. Paul Park, MN 55071	do	Washington.
Vermiculite, exfoliated:			
W. R. Grace & Co., Construction Products Div.	62 Whittemore Ave. Cambridge, MA 02140	Processing plant	Hennepin.
P & H, Inc	459 Harding St. NE. Minneapolis, MN 55413	do	Do.

The Mineral Industry of Mississippi

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

By James R. Boyle[1] and Alvin R. Bicker[2]

The value of Mississippi's nonfuel mineral production in 1981 was $91.8 million, a decrease of $12.1 million from that of 1980, continuing a downward trend that started in mid-1979. Total value does not indicate the true decline of production because the selling price of many mineral commodities increased, which somewhat offset the decline in production. Mississippi ranked second nationally in the production of recovered sulfur and third in ball clay, bentonite, and fuller's earth. Major commodities produced were cement, clays, and sand and gravel; production of these commodities declined from that of 1980. Recovery of magnesium compounds from seawater and lime production ceased; high energy costs and market oversupply were cited as reasons for the shutdown.

Most of the nonfuel minerals produced in the State were utilized in the construction and automotive industries, both of which have been adversely affected by the national economic slowdown. This, in turn, led to reduced output from mineral operations supplying these industries. Crushed stone and sand and gravel operations were also adversely affected by reduced road maintenance programs throughout the State.

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

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	thousand short tons	1,596	$21,714	1,218	$23,309
Lime	do.	31	707	--	--
Sand and gravel[2]	do.	11,710	31,606	[p]10,400	[p]28,800
Stone, crushed	do.	W	W	[3]1,984	[3]5,451
Combined value of cement, magnesium compounds (1980), sand and gravel (industrial), and stone (crushed)		XX	49,913	XX	34,231
Total		XX	103,940	XX	91,791

[p] Preliminary. W Withheld to avoid disclosing company proprietary data; included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes industrial sand; value included in "Combined value" figure.

[3]Excludes some crushed stone; value included in "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Adams	W	W	Sand and gravel.
Benton	W	W	Clays.
Bolivar	$229	$204	Sand and gravel.
Carroll	W	W	Sand and gravel, clays.
Chickasaw	119	--	
Clay	W	W	Stone, sand and gravel.
Copiah	6,403	6,333	Sand and gravel.
De Soto	2,445	1,939	Do.
Forrest	W	W	Do.
George	60	53	Do.
Grenada	W	--	
Hancock	W	W	Sand and Gravel.
Harrison	134	116	Do.
Hinds	W	W	Clays, stone.
Holmes	2,065	W	Sand and gravel.
Itawamba	W	952	Do.
Jackson	W	W	Magnesium compounds, lime.
Jasper	--	W	Sand and gravel, stone.
Jefferson Davis	W	W	Sand and gravel.
Jones	W	W	Clays.
Kemper	W	W	Do.
Lee	W	--	
Lincoln	W	W	Sand and gravel, clays.
Lowndes	26,614	32,846	Cement, sand and gravel, stone, clays.
Marion	1,034	W	Sand and gravel.
Marshall	W	W	Clays.
Monroe	9,937	8,579	Clays, sand and gravel.
Newton	W	W	Sand and gravel.
Noxubee	W	W	Clays, stone.
Panola	W	W	Clays, sand and gravel.
Pearl River	504	449	Sand and gravel.
Perry	W	196	Do.
Pike	W	W	Do.
Prentiss	W	--	
Quitman	W	W	Clays.
Rankin	W	W	Cement, stone, clays.
Smith	W	10	Stone.
Stone	876	797	Sand and gravel.
Sunflower	18	18	Clays.
Tate	W	W	Sand and gravel.
Tippah	W	W	Clays.
Tishomingo	1,889	1,923	Stone, sand and gravel.
Walthall	195	174	Sand and gravel.
Warren	W	W	Do.
Washington	W	W	Do.
Wayne	W	W	Stone.
Winston	W	W	Clays.
Yalobusha	879	W	Sand and gravel.
Yazoo	2,472	1,278	Do.
Undistributed[2]	51,814	48,072	
Total[3]	107,689	103,940	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]The following counties were not listed because no nonfuel mineral production was reported: Alcorn, Amite, Attala, Calhoun, Choctaw, Claiborne, Clarke, Coahoma, Covington, Franklin, Greene, Humphreys, Issaquena, Jefferson, Lafayette, Lamar, Lauderdale, Lawrence, Leake, Leflore, Madison, Montgomery, Neshoba, Oktibbeha, Pontotoc, Scott, Sharkey, Simpson, Tallahatchie, Tunica, Union, Webster, and Wilkinson.

[2]Includes mineral production 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 Mississippi business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	1,015.0	1,022.9	+0.8
Unemployment	do	75.5	95.3	+26.2
Employment (nonagricultural):				
Mining[1]	do	10.8	12.6	+16.7
Manufacturing	do	221.8	221.3	-.2
Contract construction	do	43.5	41.9	-3.7
Transportation and public utilities	do	40.8	40.5	-.7

See footnotes at end of table.

Table 3.—Indicators of Mississippi business activity —Continued

		1980	1981[p]	Change, percent
Employment and labor force, annual average —Continued				
Employment (nonagricultural) —Continued				
Wholesale and retail trade	thousands	164.0	163.4	-.4
Finance, insurance, real estate	do.	32.8	33.0	+.6
Services	do.	121.1	120.8	-.2
Government	do.	194.5	187.4	-3.7
Total nonagricultural employment	do.	829.3	[2]820.8	-1.0
Personal income:				
Total	millions	$16,567	$18,364	+10.8
Per capita		$6,557	$7,256	+10.7
Construction activity:				
Number of private and public residential units authorized		9,516	5,742	-39.7
Value of nonresidential construction	millions	$160.5	$130.2	-18.9
Value of State road contract awards	do.	$69.5	$111.8	+60.9
Shipments of portland and masonry cement to and within the State	thousand short tons	926	892	-3.7
Nonfuel mineral production value:				
Total crude mineral value	millions	$103.9	$91.8	-11.6
Value per capita, resident population		$41	$36	-12.2
Value per square mile		$2,178	$1,924	-11.7

[p]Preliminary.
[1]Includes oil and gas extraction.
[2]Data do not add to total shown because of independent rounding.

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

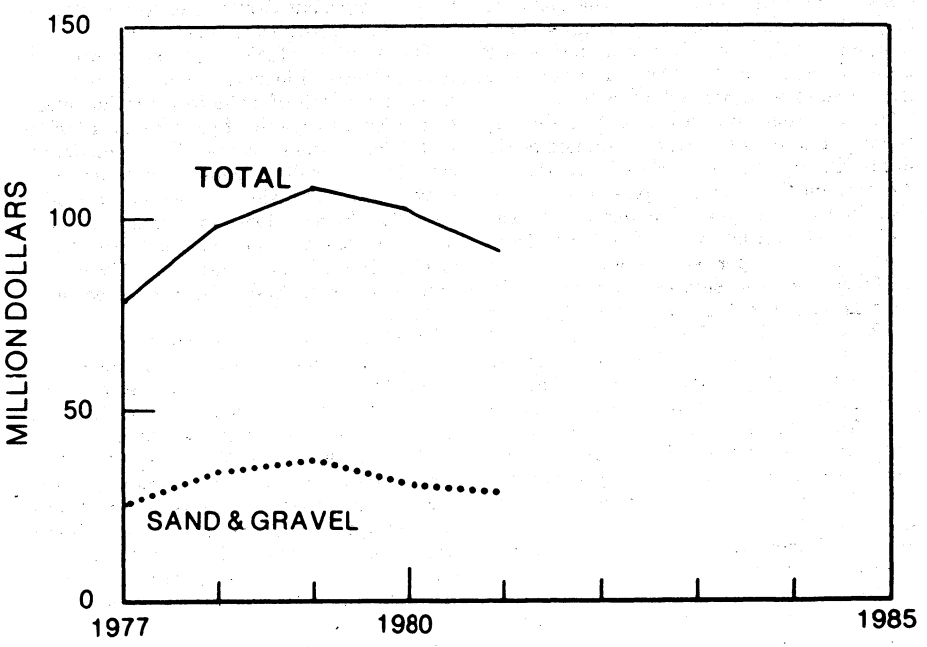

Figure 1.—Value of sand and gravel and total value of nonfuel mineral production in Mississippi.

Trends and Developments.—During the year, crushed stone and sand and gravel operators providing materials for the requirements of the Tennessee-Tombigbee Waterway in the northeastern part of the State were faced with the uncertainty of possible suspension of construction activities. The L & N Railroad, along with the Environmental Defense Fund as plaintiffs, challenged the development because of insufficient information in the original Environmental Impact Statement (EIS) and requested that all construction activity be stopped. The challenge centered on certain changes in construction details that the plaintiffs felt merited a supplemental EIS. The court basically agreed with the plaintiff but with only limited suspension of construction activities and required the Corps of Engineers to prepare a supplemental EIS. Although work continued on most elements of the waterway, the areas affected by the suspension were primarily in Mississippi, which affected mineral producers in the area. By yearend, navigational facilities were about 75% complete on the 232-mile project; 5 of the 10 major structures were complete, with 3 over 70% complete and 2 about 20% complete. The waterway was scheduled to be completed by 1986.

Output from the two titanium dioxide pigment plants in the State remained fairly stable during the year. Rated capacity of the two chloride process plants was over 200,000 tons per year. During fiscal year 1981, nearly 110,000 tons of ilmenite from Australia was imported through the Port of Gulfport and was shipped to the E.I. du Pont de Nemours & Co., Inc., pigment plant at Pass Christian. Kerr-McGee Chemical Corp., Hamilton, received synthetic rutile from its plant in Mobile for use at its pigment plant. Raw material was imported from Australia through the Port of Mobile and converted into synthetic rutile. Kerr-McGee also operated an electrolytic manganese plant at Hamilton, with an output of approximately 10,000 tons per year. Pyrolusite from Gabon, West Africa, was imported through the Port of Mobile and shipped by rail to Hamilton.

Armco, Inc., announced plans to build a $343 million seamless tubular finishing operation near Gulfport. This will be the third largest manufacturing investment ever made in Mississippi. The plant, to employ about 700 people, was scheduled to begin operations in 1984 and reach full capacity by 1985. Products will include high-quality seamless pipe tubing and casings for drilling oil and gas wells. The Gulfport facility will be the finishing plant for pipes manufactured in the company's plant in Ashland, Ky. Materials from the Kentucky plant will be shipped via the Mississippi River to Gulfport. Semifinished pipe from Ashland will be shipped to Gulfport for heat treating, threading, and other finishing operations. The facility will be able to finish pipe ranging from 2 3/8 inches to 13 3/8 inches in diameter.

Legislation and Government Programs.—During the year, the Mississippi Bureau of Geology and Energy Resources continued investigating the geology and mineral resources of the State. The Bureau also administered reclamation activities and the leasing of State-owned lands for mineral exploration. In addition to its energy and mineral-related activities, the Bureau conducted geological assessments for sanitary landfills. Statewide groundwater data were compiled in conjunction with an underground waste injection study. A study of the Cretaceous System geology was completed and scheduled for publication.

The Bureau of Geology purchased its fourth electrical logger, which can log boreholes to a depth of 4,000 feet and has electrode spacing capable of providing a 16-inch and 6-foot lateral curve. The solid-state module unit will increase reliability and provide for expansion of logging capabilities. The Bureau logs an average of two holes per day and has recorded over 4,700 electrical logs in all counties of Mississippi and in areas of Alabama, Tennessee, and Louisiana.

The Bureau of Geology continued quarterly publication of "Mississippi Geology." Contents included research articles pertaining to Mississippi, geology news items, and listings of recent geologic literature.

The U.S. Bureau of Mines reported that the apparent consumption of industrial explosives and blasting agents in the State used in quarrying and nonmetal mining was 327,000 pounds in 1981. Of that total, the top two types, water gels and slurries and other high explosives, accounted for 94% of the explosives used.

During the year, the U.S. Geological Survey conducted fieldwork to locate, study, and sample deposits of nonswelling bentonites. Studies were also underway on the Upper Cretaceous geology of the Tennessee-Tombigbee Waterway in east Mississippi.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Cement.—Mississippi's cement industry, composed of two companies, was located in the central and eastern parts of the State. Cement was the leading commodity in value produced in the State. Marquette Co., in Rankin County, produced portland and masonry cement, and United Cement Co. in Lowndes County, produced only portland cement. Portland and masonry cement shipments decreased from that of 1980. Principal consumers of portland cement included ready-mix concrete companies, building-materials dealers, concrete-products manufacturers, highway contractors, and other contractors. Raw materials used by cement producers were limestone, marl, chalk, sand, gypsum, and iron ore; nearly all raw-material resources were adjacent to the plantsite. Cement was shipped within the State and to contiguous States.

At the end of 1981, Marquette officials announced it will cease making cement at its plant in Rankin County. The plant will be converted to a cement distribution facility for use by the company's new cement plant at Cape Giradeau, Mo. Increased operating costs and poor market conditions forced closure of the 32-year-old plant. The market area for the plant, which produced up to 235,000 tons of cement per year, was limited to a radius of about 200 miles.[3]

Clays.—Mississippi's clay industry consisted of 20 companies operating 23 mines in 15 counties in the north and northeastern part of the State. Total clay output decreased. Common clay, ball clay, bentonite, and fuller's earth were produced in Mississippi; the State ranked third nationally in the production of the latter three clays. Clays produced in the State were used in the automotive, construction, and agricultural and animal-feed industries. Because of continued depressed markets, sales for all clay types remained low. Delta Macon Brick Co., Macon, had only two of four kilns in operation during the year. Production capacity was about 600,000 bricks per day, but a slump in the housing market had adversely affected operations.

Common clay was mined by 14 companies operating 17 pits in 12 counties, centering in Hinds, Winston, and Noxubee Counties. Major uses were brick, concrete, and concrete-block manufacturers. Output was 649,000 tons compared with 1.1 million tons in 1980; continued high interest rates resulted in decreased home construction, which severely depressed the demand for common clay products.

One company, Ky.-Tenn. Clay Co., produced ball clay from a surface mine in Panola County. Clay was trucked about 10 miles to the plant where it was processed for use in animal feed, wallboard, and ceiling tile. Demand increased slightly over that of 1980.

Mississippi's bentonite producers, Filtrol Corp., American Colloid Co., and International Minerals & Chemical Corp. (IMC), operated three surface mines in three counties. Overburden of up to 130 feet was removed to recover 6 to 8 feet of clay. The bentonite was trucked to nearby plants where it was processed for sale to the automotive industry as a foundry binder and to the agricultural industry for use in fertilizer manufacture. Demand increased slightly but was still not at 1979 levels.

Two companies, IMC and Oil-Dri Production Co., mined fuller's earth from open pits in Tippah County. Fuller's earth deposits averaged up to 25 feet thick with less than 20 feet of overburden. The clay was processed at nearby plants for sale to the agricultural industry. Market conditions were depressed slightly during parts of the year, with production slightly ahead of that of 1980 but not up to 1979 levels.

Table 4.—Mississippi: Clays sold or used by producers, by kind

(Thousand short tons and thousand dollars)

Year	Bentonite		Ball clay, fire clay, and fuller's earth		Common clay		Total[1]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1977	340	6,389	W	W	1,143	2,452	1,483	8,841
1978	358	7,742	W	W	1,356	3,034	1,960	19,623
1979	318	7,128	W	W	1,221	3,162	1,820	21,841
1980	275	6,234	W	W	1,054	3,292	1,596	21,714
1981	285	7,060	W	W	649	2,028	1,218	23,309

W Withheld to avoid disclosing company proprietary data; included with "Total."
[1]Data may not add to totals shown because of independent rounding.

Lime.—Corning Glass Works, Ceramic Products Div., had produced dolomitic quicklime from stone at its plant in Pascagoula. Early in the year, the company ceased production of lime. Reasons for cessation were overproduction in the industry and high energy costs.

Magnesium Compounds.—Corning Glass Works, Ceramic Div., had recovered magnesium compounds from seawater at its plant in Pascagoula. Early in the year, the company ceased production of magnesium compounds. Reasons for cessation were overproduction in the industry and high energy costs. The plant is now part of the Refractories Division of Corning Glass Works and receives magnesite from Brazil and chrome ore from the Republic of South Africa for producing refractories.

Peat.—Mississippi Peat Co. mined peat from the Powell pit at Preston, about 50 miles north of Meridian. The peat was solar dried, bagged, and shipped for use as potting soil and in general soil improvement. Production in 1981 reportedly increased from that of 1980.

Perlite.—Johns-Manville Corp., Natchez, and United States Gypsum Co., Greenville, expanded perlite shipped in from New Mexico. The product was used in roof insulation and for formed products. Although depressed construction adversely affected sales, unit prices increased.

Sand and Gravel.—To reduce reporting burden and costs, the U.S. Bureau of Mines implemented new canvassing procedures for its 1981 surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but contains complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Sand and gravel continued as the second leading commodity in value among the nonfuel minerals produced in Mississippi. Production decreased from that of 1980 mainly because of the general slowdown in construction and road maintenance programs throughout the State. In addition, construction curtailments on the Tennessee-Tombigbee Waterway also had an adverse impact on producers in the northeast part of the State.

Table 5.—Mississippi: Sand and gravel sold or used by producers, by use

Use	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	4,421	$10,379	$2.35	NA	NA	NA
Gravel	7,289	21,227	2.91	NA	NA	NA
Total or average	11,710	31,606	2.70	p10,400	p$28,800	p$2.77
Industrial sand	W	W	8.00	W	W	8.61
Grand total or average	W	W	2.71	W	W	2.78

pPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.

Stone.—In 1981, 9 companies produced crushed limestone and marl at 11 quarries in 9 counties. Local market demand strongly influenced individual operations. Reductions in road maintenance programs and limited construction curtailments in the Tennessee-Tombigbee Waterway kept production at reduced levels. Operations supplying crushed limestone for agricultural use also experienced fluctuating market conditions. Although no one quarry produced in excess of 750,000 tons of stone, the leading three producers mined nearly 70% of the stone produced in the State.

Sulfur.—Four companies recovered sulfur from refinery and natural gases. Production was reported by Shell Oil Co. in Clarke and Rankin Counties; Chevron, USA, Inc., in Jackson County; Amerada Hess Corp. in Lamar County; Pursue Gas Processing & Petrochemical Co. in Rankin County; and Koch Hydrocarbon Co. in Clarke County. Sulfur sold or used in 1981 totaled 677,247 metric tons, valued at $78.9

million, an increase of 14.2% in shipments and 30.6% in value from that of 1980.

[1]State Liaison Officer, Bureau of Mines, Tuscaloosa, Ala.

[2]State geologist, Bureau of Geology and Energy Resources, Jackson, Miss.

[3]The Clarion-Ledger. Jackson, Miss., Jan. 13, 1982, p. 1.

Table 6.—Mississippi: Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Marquette Co	1 Commerce Place Nashville, TN 37239	Plant	Rankin.
United Cement Co	Box 185 Artesia, MS 39736	____do	Lowndes.
Clays:			
International Minerals & Chemical Corp	Box 346A Aberdeen, MS 39730	Mine	Monroe.
Jackson Ready Mix Concrete, a division of Delta Industries, Inc.	Box 1292 Jackson, MS 39205	____do	Hinds.
Ky.-Tenn. Clay Co	Box 160 Crenshaw, MS 38621	____do	Panola.
Oil-Dri Production Co	Box 476 Ripley, MS 38663	Mine and plant	Tippah.
Tri-State Brick and Tile Co., Inc	Box 9787 Jackson, MS 39206	____do	Hinds.
Sand and gravel:			
American Sand & Gravel Co	Box 272 Hattiesburg, MS 39401	Stationary plant	Forrest.
Blain Gravel Co	Box 268 Crystal Springs, MS 39059	Stationary plants	Copiah, Marion, Jefferson Davis.
Green Bros. Gravel Co., Inc	Route 4, Box 17 Franklinton, LA 70438	Stationary plant	Copiah.
Hammett Gravel Co	Box 207 Lexington, MS 39095	Mine and plant	Holmes and Pike.
Stone:			
Marquette Co	1 Commerce Place Nashville, TN 37239	Quarry	Rankin.
Mississippi Stone Products	Box 338 Iuka, MS 38852	____do	Tishomingo.
State Department of Agriculture and Commerce.	Box 352 West Point, MS 39773	Quarries	Clay, Noxubee, Wayne.
United Cement Co	Box 185 Artesia, MS 39736	Quarry	Lowndes.

The Mineral Industry of Missouri

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By Jane P. Ohl,[1] Heyward M. Wharton,[2] and Ardel W. Rueff[2]

Nonfuel mineral production in Missouri during 1981 was valued at $870 million, a 17.5% decrease from the value of the previous year; nevertheless, the State again ranked 8th among the 50 States. The sharp decline in production was attributed to labor interruptions at five major mines and two smelters in the southeast Missouri lead district. Among the metallic minerals, copper declined 48.5% in total value, lead 32.6%, and silver 60.3%. Only zinc, iron ore, and iron oxide pigments increased in total value, 0.1%, 3.7%, and 82.6%, respectively. Copper, lead, zinc, and silver output decreased 38%, 21.6%, 15.9%, and 22.1%, respectively. Iron ore shipments were the same as those of 1980 but output was less; iron oxide pigment output rose 12.9%.

Among the nonmetallic minerals, barite, masonry and portland cements, clays, and lime increased in total value.

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

Mineral	1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Barite thousand short tons	117	$5,570	185	$9,725
Cement:				
Masonry do	62	3,117	103	5,495
Portland do	3,515	156,368	3,732	168,567
Clays do	1,817	16,798	1,747	18,414
Copper (recoverable content of ores, etc.) metric tons	13,576	30,655	8,411	15,783
Gem stones	NA	15	NA	10
Gold (recoverable content of ores, etc.) troy ounces	W	W	--	--
Lead (recoverable content of ores, etc.) metric tons	497,170	465,393	389,721	313,870
Lime thousand short tons	1,667	63,733	W	W
Sand and gravel do	8,900	26,753	[p]8,778	[p]18,702
Silver (recoverable content of ores, etc.) thousand troy ounces	2,357	48,653	1,837	19,322
Stone: Crushed thousand short tons	48,296	130,254	40,910	116,297
Zinc (recoverable content of ores, etc.) metric tons	[r]62,886	[r]51,893	52,904	51,966
Combined value of asphalt (native, 1980), iron ore, iron oxide pigments (crude), stone (dimension), and values indicated by symbol W	XX	55,633	XX	132,175
Total	XX	[r]1,054,835	XX	870,326

[p]Preliminary [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Andrew	W	W	Stone.
Atchison	W	W	Sand and gravel.
Audrain	$2,931	$3,266	Clays.
Barry	672	743	Stone.
Barton	W	W	Stone, asphalt.
Bates	W	613	Stone.
Benton	W	W	Do.
Bollinger	38	W	Sand and gravel.
Boone	W	W	Stone, sand and gravel, clays.
Buchanan	W	W	Stone.
Butler	W	W	Sand and gravel, clays.
Caldwell	W	311	Stone.
Callaway	W	W	Stone, clays, sand and gravel.
Camden	W	W	Sand and gravel, stone.
Cape Girardeau	W	W	Cement, stone, sand and gravel, clays.
Cass	1,600	1,562	Stone.
Cedar	W	W	Do.
Christian	1,176	1,266	Do.
Clark	W	W	Stone, sand and gravel.
Clay	7,384	6,530	Do.
Clinton	509	444	Stone.
Cole	W	W	Stone, sand and gravel.
Cooper	W	W	Do.
Crawford	1,606	W	Sand and gravel, stone, clays.
Dade	79	144	Stone.
Dallas	W	W	Stone, sand and gravel.
Daviess	W	W	Do.
De Kalb	449	W	Stone.
Dent	W	102	Do.
Douglas	W	356	Stone, sand and gravel.
Franklin	W	W	Clays, stone, sand and gravel.
Gasconade	W	W	Do.
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	Do.
Howard	W	W	Stone, sand and gravel.
Howell	W	W	Do.
Iron	W	353,395	Lead, zinc, silver, iron ore, copper, stone, gold.
Jackson	W	W	Cement, stone, sand and gravel, clays.
Jasper	W	W	Stone, sand and gravel.
Jefferson	W	W	Cement, stone, sand and gravel, clays, barite.
Johnson	491	530	Stone.
Knox	W	W	Do.
Laclede	1,031	W	Do.
Lafayette	415	418	Stone, sand and gravel.
Lewis	W	W	Sand and gravel.
Lincoln	W	W	Stone, sand and gravel.
Livingston	W	W	Stone, clays, sand and gravel.
McDonald	W	W	Stone, sand and gravel.
Macon	—	W	Sand and gravel.
Madison	W	W	Stone, sand and gravel.
Maries	W	W	Clays, stone.
Marion	W	W	Stone, sand and gravel.
Mercer	655	543	Stone.
Miller	W	W	Sand and gravel, stone.
Moniteau	W	144	Stone.
Monroe	W	W	Stone, clays.
Montgomery	W	3,379	Clays, stone, sand and gravel.
Morgan	W	302	Stone.
Newton	W	439	Do.
Nodaway	W	W	Stone, sand and gravel.
Oregon	W	397	Sand and gravel, stone.
Osage	W	W	Stone, sand and gravel, clays.
Ozark	W	W	Sand and gravel.
Pemiscot	W	W	Do.
Perry	W	W	Stone, sand and gravel.
Pettis	W	W	Stone.
Phelps	1,253	W	Stone, sand and gravel.
Pike	W	W	Cement, stone, clays, sand and gravel.
Platte	W	W	Stone, clays.
Polk	W	W	Stone.
Pulaski	W	W	Stone, sand and gravel.
Putnam	W	W	Stone.
Ralls	W	W	Cement, stone, clays.
Randolph	W	W	Stone.
Ray	490	436	Do.
Reynolds	234,505	206,112	Lead, zinc, silver, copper, stone, gold.
Ripley	W	W	Sand and gravel.
St. Charles	W	W	Stone, sand and gravel.

See footnotes at end of table.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
St. Clair	W	W	Stone.
St. Francois	W	W	Lime, stone, sand and gravel.
Ste. Genevieve	W	W	Lime, stone, sand and gravel.
St. Louis	W	W	Cement, stone, sand and gravel, clays.
St. Louis City	W	W	Sand and gravel.
Saline	$2,118	$1,814	Stone.
Scotland	W	1,504	Do.
Scott	W	W	Do.
Shannon	136	64	Do.
Shelby	1,001	1,036	Do.
Stoddard	628	W	Sand and gravel.
Stone	W	120	Stone.
Sullivan	370	W	Do.
Taney	W	W	Stone, sand and gravel.
Texas	W	W	Do.
Vernon	W	1,710	Stone.
Warren	W	W	Clays, stone.
Washington	89,886	100,540	Lead, iron ore, barite, copper, silver, zinc, iron oxide pigments, sand and gravel, gold.
Wayne	3,613	3,813	Stone.
Webster	W	W	Stone, sand and gravel.
Worth	333	337	Stone.
Wright	W	W	Do.
Undistributed[2]	807,190	362,465	
Total	1,160,559	1,054,835	

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, Carter, Chariton, Dunklin, Lawrence, Linn, Mississippi, New Madrid, and Schuyler.

[2]Includes value of gem stones and values indicated by symbol W.

Table 3.—Indicators of Missouri business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	2,272.2	2,279.3	+0.3
Unemployment	do	154.5	177.1	+14.6
Employment (nonagricultural):				
Mining[1]	do	7.6	6.8	-10.5
Manufacturing	do	437.0	427.3	-2.2
Contract construction	do	82.1	86.7	+5.6
Transportation and public utilities	do	138.9	138.0	-.6
Wholesale and retail trade	do	462.0	466.3	+.9
Finance, insurance, real estate	do	108.1	108.9	+.7
Services	do	394.9	404.6	+2.5
Government	do	339.2	332.6	-2.0
Total nonagricultural employment[1]	do	1,969.8	1,971.2	+.1
Personal income:				
Total	millions	$43,698	$48,794	+11.7
Per capita		$8,865	$9,876	+11.4
Construction activity:				
Number of private and public residential units authorized		13,736	10,144	-26.2
Value of nonresidential construction	millions	$604.8	$761.8	+26.0
Value of State road contract awards	do	$135.0	$190.0	+40.7
Shipments of portland and masonry cement to and within the State	thousand short tons	1,468	1,460	-.6
Nonfuel mineral production value:				
Total crude mineral value	millions	$1,054.8	$870.3	-17.5
Value per capita, resident population		$215	$177	-17.7
Value per square mile		$15,165	$12,489	-17.6

[p]Preliminary.

[1]Includes bituminous coal and oil and gas extraction.

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

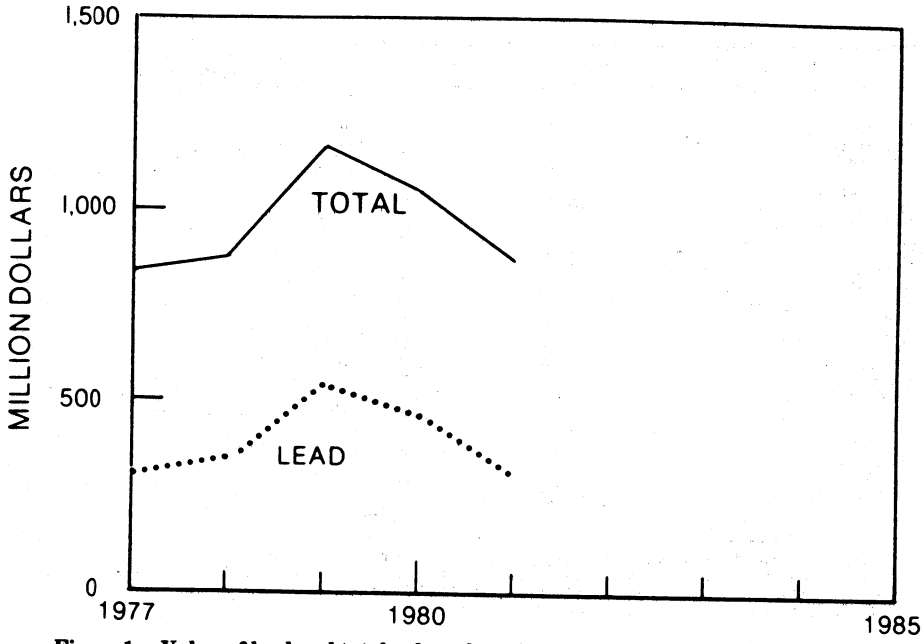

Figure 1.—Value of lead and total value of nonfuel mineral production in Missouri.

According to the February 1982 Missouri Area Labor Trends, 7,600 were employed in the mining industry in December 1981, compared with 7,700 in December 1980.[3]

Industrial mineral production, mainly from stone and sand and gravel quarries, was scattered across Missouri, generally as near to markets as the natural occurrences of usable rock allowed and communities would agree to. Metallic ore production of copper, iron, lead, silver, and zinc was geographically and geologically confined to southeastern Missouri, in Iron, Reynolds, and Washington Counties. Cobalt and nickel resources were known to occur in the general vicinity of Madison County (also in southeastern Missouri); economic conditions, however, have not encouraged extraction of these two important metals.

Trends and Developments.—The primary nonferrous smelters serving the lead and zinc mining industry in southeastern Missouri were the subject of an article on the need for a flexible environmental policy.[4]

A geochemical survey of Missouri, undertaken by the U.S. Geological Survey, resulted in a report on unusual or "anomalous" samples of minerals from the Bonneterre, Potosi, Gasconade, Roubidoux, and Jefferson City Formations[5]—sources of much of Missouri's mineral wealth.

On December 2, 1981, St. Joe Lead Co.'s chief geologist broke ground for the company's new Geological Engineering and Geological Research Building at Viburnum. The building is to be completed in August 1982.[6]

Legislation and Government Programs.—In January 1981, the Missouri Supreme Court upheld the rate-determination methodology the Labor and Industrial Relations Commission uses under the prevailing wage act. The maximum 8-hour day allowed in any mining, mechanical, chemical manufacturing, or smelting business was amended to permit additional hours, with the employee's consent.[7]

On May 20, 1981, results of the completed study of the Rolla 1° by 2° quadrangle Conterminous United States Mineral Appraisal Program, also known as CUSMAP, were announced in Rolla. The study identified a high potential for large, undiscovered deposits of lead, zinc, silver, copper, nickel, cobalt, and iron, and also a high potential for smaller deposits of barite, tin, tungsten, and uranium. A potential may exist for important deposits of thorium, chromium, platinum, rare-earth minerals, and diamonds.[8]

REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Aluminum.—By August 1981, about 35% of the $240 million expansion of the Noranda Aluminum, Inc., reduction plant in New Madrid County had been completed. The firm was adding a third 85,000-ton-per-year potline and associated carbon-baking and ancillary facilities. The additional capacity to the potlines will bring the total yearly rated capacity to 225,000 tons, a 60% increase. At startup, in September 1982, employment was to increase from 1,000 to 1,300.

Cobalt.—A solvent extraction process to increase the purification of cobalt, which was tested by AMAX Nickel, Inc., a subsidiary of AMAX Inc., was expected to be usable in the recovery and treatment of cobalt raw materials in Missouri lead-zinc ores. In the process, a chemical strips cobalt from nickel in a sulfate medium. An estimated 2.5 million pounds per year of cobalt has been lost because no economical method existed for its recovery.[9]

Because of funding problems, Anschutz Mining Corp. postponed opening its Madison Mine beyond the originally planned 1984 date. No funding was made available for Anschutz's request under the Defense Production Act to support cobalt prices and to aid in developing and mining the Missouri cobalt.

Copper.—Missouri ranked 7th nationally of 14 copper-producing States. Copper was recovered from the lead-zinc ores of all eight mines in the New Lead Belt in Iron, Reynolds, and Washington Counties. The combined copper production from Brushy Creek, Fletcher, Indian Creek, Viburnum No. 28, and Viburnum No. 29 Mines made St. Joe Lead the State's leading copper producer. Other producers were AMAX Lead Co. of Missouri and Homestake Mining Co. (Buick Mine); Cominco American Incorporated and Dresser Industries, Inc. (Magmont Mine); and Ozark Lead Co., a subsidiary of Kennecott Minerals Corp. (Milliken Mine). The 1981 average price for the base metal was 85 cents per pound, down 12 cents per pound from the 1980 average price.

Iron Ore.—Missouri ranked 5th of 15 States in iron ore production.

The Pea Ridge Mine in Washington County was the State's only iron ore producer in 1981. St. Joe Lead, operator of Pea Ridge, sold the iron ore produced for use in the iron and steel industry (92.9%), in the heavy-media industry such as coal processing (4.3%), and for ferromagnets and other uses (2.8%).

Although the Pilot Knob Mine was closed in November 1980, the joint owners, Hanna Mining Co. and the Granite City Steel Div. of National Steel Corp., sold some stockpiled material in 1981 to the iron and steel industry. Hanna and National Steel were to convey about 31 acres of Pilot Knob land to the Iron County Improvement Association for developing an industrial park.[10] The firms donated about 20 acres for Fort Davidson Park expansion and access roads. Earlier in the year, the firms sold a 51-acre parcel occupied by Pilot Knob buildings to a machinery equipment company; Hanna and National Steel retained about 35 acres of the former mining property, including the main and ventilating shafts of the iron mine, for possible future commercial use of the mined-out space. Also early in 1981, Hanna sold 1,188 acres to the Missouri Conservation Department, which announced plans to develop the property as a multiple-use recreation site.

Iron Oxide Pigments.—Missouri ranked second in the Nation in shipments of crude iron oxide pigment materials, and third in production of finished iron oxide pigments.

Lead.—The quantity of lead produced in the Nation's foremost lead-producing State declined 21.6% in 1981 from that of 1980. Missouri, nevertheless, accounted for 87.5% of the domestic output, compared with 90.3% in 1980. Strikes at some Missouri lead-zinc mines reduced the output of crude ore during 1981. Nevertheless, St. Joe Lead was again the leading producer of crude ore, followed by Ozark Lead, AMAX Lead, and Cominco American. Missouri lead mines supplied about 33% of the total U.S. demand for lead metal during 1981.

St. Joe Lead's Viburnum No. 35 Mine was planned to provide feed for the Viburnum mill in 1983. The $25 million underground mine and mill expansion was projected to add 4,000 tons per day production capacity to the Viburnum complex.[11]

St. Joe Lead completed a $500,000 changehouse and cafeteria at the Herculaneum smelter in late July 1981.

St. Joe Minerals Corp., including its subsidiary, St. Joe Lead, was acquired by Fluor Corp. on August 3, 1981, but retained its name and is expected to continue as a strong natural resources producer. Fluor's 1981 annual 10K report to the Securities and Exchange Commission stated that St. Joe Lead had proven ore reserves in Missouri of approximately 64.1 million tons,

with an average grade of approximately 5.08% lead.

According to AMAX Inc.'s 10K report, their total recoverable ore in Missouri, as of December 31, 1981, was estimated to be 43.9 million tons, with an average grade of 5.9% lead and 1.6% zinc.

A $77 million mine development was underway at ASARCO Incorporated's West Fork Mine to produce 3,800 tons per day of lead ore that will be additional feed for the company smelter at Glover beginning in 1984.[12]

Ozark Lead's Milliken Mine produced 6,500 tons per day of lead and zinc ore. The ore was moved by load-haul-dump units to a rail system and then hoisted 1,400 feet to the surface. The operation also produced minor, but recoverable, amounts of cadmium, copper, and silver.[13]

In early December 1981, Ozark Lead announced a substantial reduction in production rates because of operating problems, including the inability to complete a new shaft planned to provide access to better-grade ore. The change in operating plans resulted in the layoff of 41 employees in December.[14]

The continuing development of new lead-ore deposits in Missouri resulted in augmenting the domestic reserve base of recoverable lead metal to about 44 million metric tons for the United States,[15] of which Missouri's share was more than one-third.

The U.S.-producer price of lead during 1981 averaged 36.5 cents per pound, but by December 31 had declined to 31 cents per pound, according to Metals Week delivered quotations.

Because of strikes at southeast Missouri lead mines, and a consequent slowdown at smelting and refining plants, about one-half of the U.S. primary lead-smelting capacity was not operating during the second quarter of 1981.

On April 1, miners struck at St. Joe Lead's Viburnum, Brushy Creek, Fletcher, and Indian Creek Mines. The strike was called to settle three main issues: a 7-day split workweek, cost-of-living raises, and job assignments. Workers returned to the mines on June 25 after United Steelworkers of America Local 6242 ratified a new 3-year contract that gave the workers wage increases and fringe benefits totaling $4.48 per hour.

Workers at St. Joe Lead's Herculaneum smelter were represented by a St. Louis local whose contract was to expire at the end of April 1981, but the smelter was eventually shut down owing to the shortage of lead concentrates resulting from the strike at the mines, and the smelter worker's contract was renewed until April 1983 without a strike being called. Herculaneum, the Nation's largest lead smelter, had an annual capacity of 225,000 tons, and usually operated at 18,500 tons per month.[16]

On May 31, about 1,000 AMAX Lead workers walked off their jobs at the Buick Mine and smelter, halting both operations. A new union agreement, retroactive to June 1, was signed later in the summer, and workers were scheduled to report for work on August 18. The new AMAX Lead union pact covered about 720 workers, giving them wage and fringe benefit increases totaling 80 cents per hour over the 3-year life of the contract. The strike halted work at the mine, mill, and smelter complex AMAX Lead and Homestake Mining own jointly.

Before the second week of July, Cominco American and Dresser Industries stopped shipping lead concentrates from their jointly controlled Magmont Mine to the nearby AMAX Lead-Homestake smelter at Boss; when that smelter closed for the duration of a strike, Magmont's 8,000-ton-per-month production was shipped to St. Joe Lead's smelter at Herculaneum. A gradual slowdown at Herculaneum occurred about the middle of July, because of a lack of feed from St. Joe Lead's mines (also on strike), and Magmont production was shipped to the Bunker Hill Co. smelter at Kellogg, Idaho.

Table 4.—Missouri: Tenor of lead ore milled and concentrates produced in 1981

Total material	metric tons	7,729,301
Metal content of ore:[1]		
Copper	percent	.12
Lead	do	5.17
Zinc	do	.78
Concentrates produced and average content:		
Copper	metric tons	13,956
Average copper content	percent	29.36
Lead	metric tons	525,630
Average lead content	percent	75.60
Zinc	metric tons	96,782
Average zinc content	percent	57.86

[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)
1977	453,824	$307,156	84.4	537,499	$363,789
1978	461,762	343,070	87.2	529,661	393,516
1979	472,054	547,824	89.8	525,569	609,929
1980	497,170	465,393	90.3	550,366	515,189
1981	389,721	313,870	87.5	445,535	358,821

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

		1979	1980	1981
Mines producing: Lode		8	8	8
Material sold or treated: Lead ore	thousand metric tons	8,263	9,092	7,729
Production:				
Quantity:				
Gold	troy ounces	32	W	--
Silver	do.	2,201,112	2,357,236	1,837,011
Copper	metric tons	13,021	13,576	8,411
Lead	do.	472,054	497,170	389,721
Zinc	do.	61,682	r62,886	52,904
Value:				
Gold	thousands	$10	W	--
Silver	do.	$24,410	$48,653	$19,322
Copper	do.	$26,705	$30,655	$15,783
Lead	do.	$547,824	$465,393	$313,870
Zinc	do.	$50,723	r$51,893	$51,966
Total	do.	$649,672	W	1$400,942

rRevised. W Withheld to avoid disclosing company proprietary data.
1Data do not add to total shown because of independent rounding.

Silver.—Missouri, seventh among the States in silver production in 1981, produced 1,837,011 troy ounces recovered in the smelting of Missouri lead and zinc concentrates, a 22% decline from 1980 production. During the year, four companies recovered silver-bearing concentrates from eight mines in Iron, Reynolds, and Washington Counties. The largest producer was the Buick Mine. AMAX Inc.'s annual report stated that its share (50%) of silver production at the Buick Mine amounted to 398,000 troy ounces.

The average annual unit price of silver decreased 49% from $20.64 per troy ounce in 1980 to $10.52 in 1981. By December 31, the price had declined to $8.25, as quoted by Handy & Harman.

Zinc.—Among the 16 zinc-producing States in 1981, Missouri's output of zinc was exceeded nationally only by that of Tennessee. All but one (Indian Creek Mine) of the eight operating lead mines in Iron, Reynolds, and Washington Counties extracted coproduct zinc from their ores. AMAX Lead's Buick Mine produced a significant percentage of the total zinc recovered from the southeast Missouri mines, but declined 10% from that of 1980. Other zinc producers were St. Joe Lead's Brushy Creek, Fletcher, Viburnum No. 28, and Viburnum No. 29; Cominco American's Magmont; and Ozark Lead's Milliken.

Prices for zinc during the year averaged 44.56 cents per pound, 19% higher than 1980 prices.

NONMETALS

Barite.—Missouri's barite production was the second largest of the eight barite-producing States, 6.5% of the national total. The 1981 production of primary barite from the State's 12 major mines or pits increased 58% over that of 1980 to 184,579 tons worth $9.7 million. Leading producers were De Soto Mining Co., Inc. (Richwoods Mine and Kingston No. 1 Mine and plant); Dresser Industries, Inc., Magcobar Minerals Div. (mines at Fletcher, Bellefontaine, and Blackwell, and mill at Mineral Point); NL Industries, Inc., NL Baroid Div. (Cadet Mine and Blackwell pit); General Barite Co. (Old

Mines pit, Blackwell pit, and plants); and Halliburton Co., IMCO Services Div. (mine at Mineral Point). Agers Bros., Inc., operated two pits and two barite-processing plants that are under contract for De Soto; annual plant capacity was about 60,000 tons. Ten pits and plants were in Washington County and two pits and washer plants were in, or partly in, Jefferson County. The new mines and plants of De Soto Mining and IMCO Services were largely responsible for the increased 1981 output.[17]

The potential for recovering high-grade barite from waste pond materials obtained from several States, including Missouri, was reported in a U.S. Bureau of Mines publication.[18]

Cement.—Among nonmetallic nonfuel minerals produced in the State, cement manufacture again generated the largest value. Portland and masonry cement total values increased 7.8% and 76.3%, respectively. Of the five cement plants operating in Missouri at yearend, three were controlled by foreign investors: (1) Industri AB Euroc, of Malmo, Sweden, parent company of Cementa, Inc., of Wilmington, Del., whose newly formed subsidiary, Continental Cement Co., purchased the cement plant at Hannibal, Mo., November 1, 1981, from Lehigh Portland Cement Co., a subsidiary of Heidelberger Zement A.G. of the Federal Republic of Germany; (2) Holderbank Financiere Glarus A.G. of Switzerland (Dundee Cement Co.); and (3) IFI International of Italy (River Cement Co.).

At yearend, the Missouri Portland Cement Co. shut down its 60-year-old St. Louis cement-manufacturing operation and transferred its 200 employees to Joppa, Ill. A reduction in areawide construction activities was cited as the principal reason for closing this older plant; a second reason was the inefficiency of the wet process of cement production used at the old plant. The firm intended to use part of the facility as a cement terminal, and cement made at the company's Joppa plant will be shipped to the St. Louis facility by barge and stored in existing silos.[19]

On December 6, Alpha Portland Cement Co. shut down three 450-foot rotary kilns at its 75-year-old plant in St. Louis, claiming poor economic conditions and the excessive cost of modernizing as the reasons.[20] About 160 employees lost their jobs during the last 3 months of 1981.

In May, Marquette Co. made its first shipment from the extensively rebuilt, 1-million-ton-per-year cement plant at Cape Girardeau. The new plant culminated 5 years of planning and construction and cost $102 million. Shipments were loaded on specially designed barges for transport on the Mississippi, Ohio, and Cumberland Rivers to the company's Nashville, Tenn., terminal. Each quick-loading and unloading barge has a 3,200-ton capacity and cost $1.25 million.[21]

Marquette also embarked on the major quarry-development program deemed necessary to supply limestone for the new manufacturing facility at Cape Girardeau. To augment the stone inventory for the new plant, quarrying crews removed the many 200-foot-high pillars remaining from the underground mining operation carried out years ago by a former site owner.[22]

Table 7.—Missouri: Portland cement salient statistics

(Short tons unless otherwise specified)

	1980	1981
Number of active plants	7	7
Production	3,606,186	3,621,309
Shipments from mills:		
Quantity	3,515,362	3,731,566
Value	$156,367,824	$168,566,558
Stocks at mills, Dec. 31	495,763	460,482

Table 8.—Missouri: Masonry cement salient statistics

(Short tons unless otherwise specified)

	1980	1981
Number of active plants	3	4
Production	71,591	96,289
Shipments from mills:		
Quantity	61,507	103,257
Value	$3,117,448	$5,495,467
Stocks at mills, Dec. 31	19,429	21,955

Clays.—Missouri ranked 8th in the Nation in clay and shale production, a rise from 10th rank in 1980, but a 3.9% decrease in quantity from that of 1980. About 75% of all clay and shale output in Missouri during the year came from the mines of five firms: Dundee Cement Co., Kaiser Aluminum & Chemical Corp., A. P. Green Refractories Co., Harbison-Walker Refractories Div., and Allied Chemical Corp. The combined output from Audrain, Gasconade, Montgomery, and Pike, the leading counties, exceeded 67% of the State's total clay production. The largest tonnages were from common

clay deposits, followed by fire clay and kaolin.

Common clays were recovered from 13 pits near the larger cities and towns in the well-populated counties of Boone, Butler, Cape Girardeau, Crawford, Jackson, Jefferson, Livingston, Pike, Platte, Ralls, and St. Louis. About 83% of the common clay and shale was used in portland cement production, 9% was used in manufacturing common and face brick, and the rest was used to make flower pots or expanded for use as aggregates in concrete blocks, highway surfacing, and structural concrete products.

Fire clays were recovered from 67 pits in Audrain, Callaway, Franklin, Gasconade, Maries, Monroe, Montgomery, St. Charles, and Warren Counties, all within 85 miles of St. Louis. More than 78% of the fire clay was used to manufacture fire brick, blocks, and shapes; other items manufactured from fire clay were high-alumina refractories, refractory grogs, and refractory mortar and cement.

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

(Thousand short tons and thousand dollars)

Year	Fire clay		Common clay		Kaolin		Total[1]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1977	872	12,529	1,432	3,190	69	1,173	2,373	16,892
1978	773	12,190	1,434	3,817	51	873	2,258	16,880
1979	799	15,194	1,497	4,350	55	978	2,351	20,522
1980	700	12,808	1,041	2,540	77	1,451	1,817	16,798
1981	669	13,397	974	2,797	104	2,220	1,747	18,414

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

A. P. Green Refractories, a subsidiary of United States Gypsum Co., announced a 2-year modernization program for the company's plant at Mexico in Audrain County. A new ground raw materials storage system, with modern materials-handling equipment, will be installed in three phases to minimize production interference.

Allied Chemical Corp. mined kaolinite from 16 pits in Gasconade County for manufacturing aluminum sulfate. Southern Clay, Inc., mined nonswelling bentonitic clays in Stoddard County that were used for pet waste absorbent, agricultural purposes, and other uses.

All clays averaged $10.53 per ton, representing an increase of nearly 14% from 1980 prices.

Iodine.—Although crude iodine was not produced in Missouri, five companies in the State imported more than 1 million pounds of domestic and foreign crude iodine to produce various organic and inorganic compounds. The five companies, in decreasing order of consumption, were Mallinckrodt, Inc., St. Louis County; West Argo-Chemical, Inc., of Shawnee Mission, Kans., Jackson County; Warner Jenkinson Co., St. Louis County; Syntex Agribusiness, Inc., Greene County; and Chemical Products, St. Joseph area, Buchanan County. Unspecified organic compounds comprised the largest crude iodine consumption, followed by potassium iodide, resublimed iodine, sodium iodide, and other inorganic compounds.

Lime.—Missouri ranked second in the Nation as a chemical and industrial lime producer. The lime was calcined from limestone and dolomites mined in Greene, St. Francois, and Ste. Genevieve Counties by Ash Grove Cement Co., North American Refractories Co. (which bought Valley Mineral Products Corp. in late 1981), and Mississippi Lime Co.

Perlite (Expanded).—Brouk Co., in St. Louis, and Georgia Pacific Corp., at Cuba in Crawford County, expanded perlite obtained from out-of-State sources in 1981. Brouk, the larger of the two producers, received an average of $186.79 per ton on sales of expanded perlite. The principal product uses were in preparing concrete and plaster aggregates, filters, horticultural aggregates, and low-temperature and cavity-fill insulation, as well as other unspecified products.

Sand and Gravel.—To reduce the burdens and costs of reporting, the U.S. Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. This chapter, therefore, contains

only preliminary estimates for construction sand and gravel production but contains complete data on industrial sand and gravel. The preliminary estimates of construction sand and gravel production for odd-numbered years will be revised and completed the following year.

Pennsylvania Glass Sand Corp. was the largest of the State's four industrial sand producers, followed by UNIMIN Corp., Martin Marietta Aggregates, and Masters Bros. Silica Sand Co., according to the Missouri Department of Natural Resources, Div. of Geology and Land Survey. Of the five pits and plants the four firms operated, none produced more than 400,000 tons of industrial sand during 1981. Pennsylvania Glass operated pits and plants near Labadie in St. Charles County and near Pacific in St. Louis County; and Martin Marietta and Masters Bros. had pits and plants in Jefferson County near Festus and Pevely, all within 35 miles of St. Louis.

In decreasing order of quantity, industrial sand was used for glass and ceramic products; foundry (molding and core) and refractory materials; cleansers and abrasives; ground fillers (used in rubber, paints, glazes, acid-proof cement, etc.); chemicals; flux for metal smelting; and as hydraulic fracturing sand for oil and gas recovery.

More than 68% of industrial sand production was shipped to customers by rail; the remainder was shipped by truck.

The ground fillers commanded the highest unit price, $47.02 per ton. Industrial sand used as flux for metal smelting brought the lowest price per ton, $7. The average unit value for all industrial sand uses was $11.06.

Table 10.—Missouri: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	5,456	$12,549	$2.30	NA	NA	NA
Gravel	2,722	6,706	2.46	NA	NA	NA
Total or average	8,178	19,255	2.35	p8,000	p$10,100	p$1.26
Industrial sand	722	7,498	10.39	778	8,602	11.06
Grand total or average	8,900	26,753	3.01	p8,778	p18,702	p2.13

pPreliminary. NA Not available.

Stone.—Missouri ranked 5th in the Nation in crushed and dimension stone output and 11th in value in 1981, dropping from 8th in value in 1980; tonnage also decreased from that of 1980. In decreasing order of quantity used, crushed stone was produced from limestone, dolomite, granite (rhyolite), sandstone, and marble. Stone was quarried for crushing in 93 of Missouri's 114 counties by 144 firms, 3 county highway departments, and 2 military units. In decreasing order of output, Ste. Genevieve, St. Louis, Jefferson, Jackson, and Wayne Counties were the leading sources of stone, each yielding more than 1.8 million tons. Output from these five counties was about 41% of the State's crushed stone for the year. Unit values for crushed stone ranged from $1.97 per ton for crushed sandstone to $48.00 per ton for crushed marble; and unit values for dimension stone ranged from $55 to $72.90 per ton. Dimension stone cut from marble and sandstone constituted a small fraction of the total value of output.

Stone output from individual quarries ranged from about 100 tons to more than 1 million tons. During the year, 153 quarries individually yielded less than 100,000 tons, accounting for 15.1% of the output; 77 quarries yielded between 100,000 and 500,000 tons, accounting for about 38.7% of the production; and 17 quarries each yielded more than 500,000 tons, accounting for about 46.2% of the stone production. Ten stone quarries each yielded from 500,000 to 900,000 tons, and seven quarries exceeded 900,000 tons.

The largest quantities of stone were produced in counties bordering the Mississippi River, just north and south of St. Louis, and in the vicinity of Cape Girardeau. Quantities larger than 1 million tons also were quarried in counties near Kansas City and Springfield, and in northern Wayne Coun-

ty. These cities and their home counties contain 44.6% of the State's population.

Limestone quarries yielded 94.4% of Missouri's 1981 stone production. The stone was used for unspecified aggregates (15.7% of total limestone production), dense-graded road base (14.4%), cement manufacture (13.0%), bituminous aggregate (9.5%), and concrete aggregate (8.9%). In continuing decreasing order of volume, limestone also was used for lime manufacture, agricultural limestone, riprap and jetty stone, surface-treatment aggregate, macadam aggregate, etc. The use of limestone in removing sulfur oxides from stack gases (mainly from coal-burning powerplants) declined 78% in quantity (probably due to the closure of a Bates County quarry) but increased 61% in unit value in 1981.

The president of the Missouri Limestone Producers Association stated that 1981 was the second, and for some firms, the third year of poor sales for crushed stone products in Missouri, owing to a decline in all types of construction, particularly road building and maintenance.[23]

From Iron County, GAF Corp. produced granite (rhyolite) that was crushed for use as roof aggregates and chips. Missouri Pacific Corp. produced crushed granite for riprap and jetty stone and railroad ballast from its quarry in Wayne County.

In Camden County, Beaver Natural Stone Co. quarried sandstone for use as flag stone, irregular-shaped stone, and cut stone. In Jefferson County, River Cement Co., produced crushed sandstone for use in cement manufacture.

The Georgia Marble Co. of Festus, Jefferson County, and the former Weiler Marble Co. quarry in Ste. Genevieve County (which became the property of World Plan Executive Council U.S.A., October 8, 1981) produced marble. Georgia Marble quarried rock used in making terrazzo and exposed aggregate; World Plan quarried rough-block dimension stone.

More than 84% of all types of crushed stone was transported by truck, 6% by rail, and the remainder by other methods.

Table 11.—Missouri: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	4,009	11,679	3,051	9,363
Poultry grit and mineral food	W	W	207	1,794
Concrete aggregate	4,529	14,823	3,448	12,420
Bituminous aggregate	4,514	13,126	3,657	11,505
Macadam aggregate	2,329	4,569	1,945	4,055
Dense-graded road base stone	7,104	18,432	5,553	15,459
Surface-treatment aggregate	2,680	8,933	2,321	8,203
Other construction aggregate and road stone	7,799	22,850	6,082	18,028
Riprap and jetty stone	3,826	9,125	3,148	8,072
Railroad ballast	1,288	2,425	1,663	3,389
Filter stone	201	537	69	214
Manufactured fine aggregate (stone sand)	93	330	W	W
Terrazzo and exposed aggregate	4	197	4	191
Cement manufacture	5,604	11,802	5,130	11,238
Lime manufacture	2,902	5,635	3,107	6,116
Roofing granules	W	W	524	1,737
Asphalt filler	75	246	101	314
Other[2]	1,339	5,544	901	4,198
Total[3]	48,296	130,254	40,910	116,297

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

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

[2]Includes stone used for dead-burned dolomite, flux stone, mine dusting, whiting or whiting substitute, chemicals, fill (1981), glass manufacture, sulfur removal from stack gases, other uses not specified, and items indicated by symbol W.

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

Vermiculite (Exfoliated).—The W. R. Grace & Co. and Brouk Co. plants in St. Louis County produced exfoliated vermiculite from out-of-State sources of crude vermiculite. In decreasing order of quantity, the product was sold for use as concrete aggregate, horticulture and soil conditioning, block insulation, loose-fill insulation, fertilizer carrier, fireproofing, filler, and plaster aggregate. Brouk sold exfoliated vermiculite, for an average value of $298.82 per ton, a 12% increase in value from that of 1980.

[1]State Liaison Officer, Bureau of Mines, Denver, Colo.
[2]Geologist, Missouri Department of Natural Resources, Division of Geology and Land Survey, Rolla, Mo.
[3]Missouri Department of Labor and Industrial Relations, Division of Employment Security. Missouri Area Labor Trends. February 1982, p. 6.
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[6]Quad-County Star. New Engineering-Research Building Underway. Dec. 3, 1981, p. 1.
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[17]Missouri Limestone News. Mineral Production Drops. V. 38, No. 4, July-August 1982, p. 5.
[18]Lamont, W. E., and G. V. Sullivan. Recovery of High-Grade Barite From Waste Pond Materials. BuMines RI 8673, 1982, 13 pp.
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[20]Baker, M. St. Louis Cement Business is on the Rocks. St. Louis Business J., Nov. 23, 1981.
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[22]Pit & Quarry. Old Mine Workings Removed in Quarry Development. V. 73, No. 10, April 1981, pp. 82-84.
[23]Buhs, R. G. President's Message. Missouri Limestone News, v. 37, No. 6, November-December 1981, p. 3.

Table 12.—Principal producers

Commodity and company	Address	Type of activity	County
Barite:			
Agers Bros., Inc	402 South 2d St. De Soto, MO 63020	Plants	Washington.
Dresser Industries, Inc	Box 8 Potosi, MO 63664	Mine and mill	Jefferson and Washington.
NL Industries, Inc	Box 2808 St. Louis, MO 63111	do	Washington.
Cement:			
Alpha Portland Cement Co.[1]	Box 20140 St. Louis, MO 63123	Plant and quarry	St. Louis.
Dundee Cement Co.[1 2]	Box 67 Clarksville, MO 63336	do	Pike.
Marquette Co. of Gulf & Western Natural Resources Group.[1 2]	Foot of Haven St. St. Louis, MO 63111	Plants and quarries	Cape Girardeau, Jackson, St. Louis.
Missouri Portland Cement Co.[2]	7711 Carondelet Ave. St. Louis, MO 63105	do	Jackson and St. Louis.
River Cement Co., a subsidiary of IFI International of Italy.[2]	Box 14545 Festus, MO 63028	Plant and quarry	Jefferson.
Clays:			
Allied Chemical Corp., Industrial Chemicals Div.	Box 517 Owensville, MO 65066	Mine and plant	Gasconade.
A. P. Green Refractories Co., a subsidiary of United States Gypsum Co.	1018 East Breckenridge St. Mexico, MO 65265	Mines	Audrain, Franklin, Gasconade.
Harbison-Walker Refractories Div., Dresser Industries, Inc.	2 Gateway Center Pittsburgh, PA 15222	Mine and plant	Callaway, Gasconade, Maries, Montgomery, Warren.
Kaiser Aluminum & Chemical Corp	Box 499 Mexico, MO 65265	do	Audrain, Callaway, Gasconade, Montgomery, Osage.
The Carter Waters Corp	Box 19676 Kansas City, MO 64141	Pit and plant	Platte.
Industrial sand:			
Martin Marietta Aggregates[2]	Two Cross Roads of Commerce Rolling Meadows, IL 60008	do	Jefferson.
Masters 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.
UNIMIN Corp	Box 109 Crystal City, MO 63019	Mine and plant	Jefferson.
Iron:			
St. Joe Minerals Corp., Pea Ridge Iron Ore Co.	Route 4 Sullivan, MO 63080	Underground mine and plant.	Washington.

See footnotes at end of table.

Table 12.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Lead:			
AMAX Lead Co. of Missouri & Homestake Mining Co.[3]	Boss, MO 65440	Underground mine and plant.	Iron.
Cominco American Incorporated[3]	Bixby, MO 65439	do	Do.
Kennecott Minerals Corp., Ozark Lead Co.[3]	Sweetwater, CPO Ellington, MO 63680	do	Reynolds.
St. Joe Lead Co., a subsidiary of St. Joe Minerals Corp.[3]	Box 500 Viburnum, MO 65566	Underground mines and plants.	Iron, Reynolds, Washington.
Lime:			
Ash Grove Cement Co.[2]	920 Main St., Suite 1000 Kansas City, MO 64105	Plant	Greene.
Mississippi Lime Co.[2]	7 Alby St. Alton, IL 62002	Plant and quarry	Ste. Genevieve.
North American Refractories Co., a division of Allied Chemical Corp.	Locus St. Farber, MO 63345	Plant	St. Francois.
Perlite, expanded:			
Brouk Co	1367 South Kingshighway Blvd. St. Louis, MO 63110	do	St. Louis.
Stone:			
Missouri Pacific Corp	210 North 13th St. St. Louis, MO 63103	Quarry	Wayne.
Moline Consumers Co.[4]	313 16th St. Moline, IL 61265	Quarries	Jefferson, Knox, Lewis, Marion, Monroe, Pike, Ralls, St. Louis, Shelby.
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	13570 St. Charles Rock Rd. Bridgeton, MO 63044	do	Cape Girardeau, Cole, Jefferson, St. Louis, Scott.
Vermiculite, exfoliated:			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plant	St. Louis.

[1]Also clays.
[2]Also stone.
[3]Also silver, copper, and zinc.
[4]Also sand and gravel in Lewis County.

The Mineral Industry of Montana

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

By G. T. Krempasky,[1] E. C. Bingler,[2] and D. C. Lawson[3]

The value of nonfuel mineral production in Montana was $305 million in 1981. The value of produced metals—antimony, copper, gold, iron ore, lead, silver, tungsten, and zinc—accounted for 57% of the total State nonfuel mineral production in 1981. The value of nonmetals produced—barite, cement, clays, gem stones, gypsum, lime, peat, phosphate rock, sand and gravel, stone, talc, and vermiculite—accounted for the remainder. The nonfuel mineral production value in 1981 was 18% more than the average value for the 5-year period (1977-81).

Compared with those of other States, the value of Montana's production ranked in the top five in 1981 for the following commodities: copper, silver, talc, and vermiculite.

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

Mineral	1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Antimony short tons	260	W	214	W
Clays thousand short tons	626	$22,200	601	$23,111
Copper (recoverable content of ores, etc.) metric tons	37,749	85,236	62,485	117,257
Gem stones	NA	90	NA	100
Gold (recoverable content of ores, etc.) troy ounces	48,366	29,627	54,267	24,943
Lead (recoverable content of ores, etc.) metric tons	295	276	194	157
Lime thousand short tons	223	9,001	194	7,621
Sand and gravel[2] do	6,639	16,057	p6,100	p14,900
Silver (recoverable content of ores, etc.) thousand troy ounces	2,024	41,773	2,989	31,437
Stone (crushed) thousand short tons	1,962	6,302	1,582	5,137
Talc do	312	11,310	W	W
Zinc (recoverable content of ores, etc.) metric tons	71	59	25	24
Combined value of barite, cement, gypsum, iron ore (1981), peat, phosphate rock, sand and gravel (industrial), stone (dimension), tungsten, vermiculite, and values indicated by symbol W	XX	57,619	XX	80,384
Total	XX	279,550	XX	305,071

pPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes industrial sand; value included with "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Beaverhead	$964	$1,119	Silver, stone, sand and gravel, gold, lead, zinc, copper.
Big Horn	W	567	Sand and gravel, stone.
Broadwater	W	41	Gold, silver.
Carbon	4,061	W	Clays, stone, sand and gravel.
Carter	W	W	Clays.
Cascade	W	W	Sand and gravel, stone.
Chouteau	162	W	Do.
Custer	111	--	
Daniels	8	28	Sand and gravel.
Dawson	449	618	Do.
Deer Lodge	8,178	9,021	Lime, stone, sand and gravel, clays.
Fergus	1,123	W	Gypsum, sand and gravel, stone.
Flathead	3,997	2,778	Sand and gravel, stone.
Gallatin	20,681	17,736	Cement, stone, sand and gravel, clays.
Garfield	2	--	
Glacier	W	--	
Golden Valley	1	--	
Granite	7,625	6,646	Silver, copper, gold, stone, lead.
Hill	19	W	Sand and gravel.
Jefferson	15,024	18,900	Cement, stone, silver, sand and gravel, gold, lead, zinc, clays, copper, tungsten.
Judith Basin	W	W	Gypsum.
Lake	W	W	Sand and gravel, peat.
Lewis and Clark	1,077	1,718	Sand and gravel, stone.
Liberty	W	W	Sand and gravel.
Lincoln	W	W	Sand and gravel, vermiculite.
McCone	9	--	
Madison	6,883	12,183	Talc, gold, silver, lead, sand and gravel.
Meagher	W	4	Gold.
Mineral	612	W	Silver, sand and gravel, gold, lead, copper, stone.
Missoula	W	W	Barite, stone, sand and gravel.
Musselshell	42	48	Sand and gravel.
Park	W	621	Silver, sand and gravel, stone, copper, lead.
Petroleum	31	35	Sand and gravel.
Phillips	3	29,908	Gold, clays, silver, sand and gravel.
Pondera	W	W	Sand and gravel, stone.
Powell	W	W	Phosphate rock, sand and gravel, copper, gold, stone, silver.
Ravalli	765	W	Sand and gravel, peat, stone.
Richland	W	W	Lime, sand and gravel.
Rosebud	W	345	Sand and gravel, stone.
Sanders	W	W	Antimony.
Sheridan	57	48	Sand and gravel.
Silver Bow	178,215	126,035	Copper, silver, gold, sand and gravel.
Stillwater	W	W	Sand and gravel.
Sweet Grass	123	--	
Teton	--	9	Stone.
Toole	146	168	Sand and gravel.
Valley	W	W	Clays, sand and gravel.
Wibaux	8	9	Sand and gravel.
Yellowstone	W	W	Sand and gravel, lime, clays.
Undistributed[2]	40,915	50,959	
Total[3]	291,287	279,550	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]Blaine, Fallon, Powder River, Prairie, Roosevelt, Treasure, and Wheatland Counties and Yellowstone National Park are not listed because no nonfuel mineral production was reported.

[2]Includes stone (1979) that cannot be assigned to specific counties, gem stones, and values indicated by symbol W.

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

The Anaconda Copper Co. (which announced a name change in December 1981 to Anaconda Minerals Co., effective January 1, 1982) was the leading producer of nonfuel minerals and continued to impact the State economy. The company's work force was reduced in the Butte area, with output from the Berkeley Pit declining from 59,000 to 44,000 short tons of ore per day. The pit was on a 6-day workweek schedule, while the Weed Concentrator in Butte continued a 7-day workweek. In January 1981, shipments of Anaconda's copper concentrates to Japan began; shipments continued through the year. The company also activated its concentrator in Anaconda to process copper-slag containing 1.25% copper and put into operation an $18 million molybdenum extraction circuit at the Weed Concentrator. A permit was granted by the State that will allow the disposal of waste from the Berkeley Pit. This should ensure

Table 3.—Indicators of Montana business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	364.8	384.9	+5.5
Unemployment	do	22.6	27.8	+23.0
Employment (nonagricultural):				
Mining[1]	do	8.8	11.5	+30.7
Manufacturing	do	24.2	23.5	-2.9
Contract construction	do	14.5	13.4	-7.6
Transportation and public utilities	do	22.4	22.7	+1.3
Wholesale and retail trade	do	72.3	73.7	+1.9
Finance, insuranee, real estate	do	12.9	12.9	--
Services	do	55.1	56.7	+2.9
Government	do	70.2	70.7	+.7
Total nonagricultural employment[1]	do	280.4	[2]285.2	+1.7
Personal income:				
Total	millions	$6,822	$7,669	+12.4
Per capita		$8,652	$9,676	+11.8
Construction activity:				
Number of private and public residential units authorized		2,374	1,852	-22.0
Value of nonresidential construction	millions	$55.2	$85.6	+55.1
Value of State road contract awards	do	$64.0	$61.0	-4.7
Shipments of portland and masonry cement to and within the State	thousand short tons	294	302	+2.7
Nonfuel mineral production value:				
Total crude mineral value	millions	$279.6	$305.1	+9.1
Value per capita, resident population		$355	$388	+9.3
Value per square mile		$1,900	$2,073	+9.1

[p]Preliminary.
[1]Includes bituminous coal and oil and gas extraction.
[2]Data do not add to total shown because of independent rounding.

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

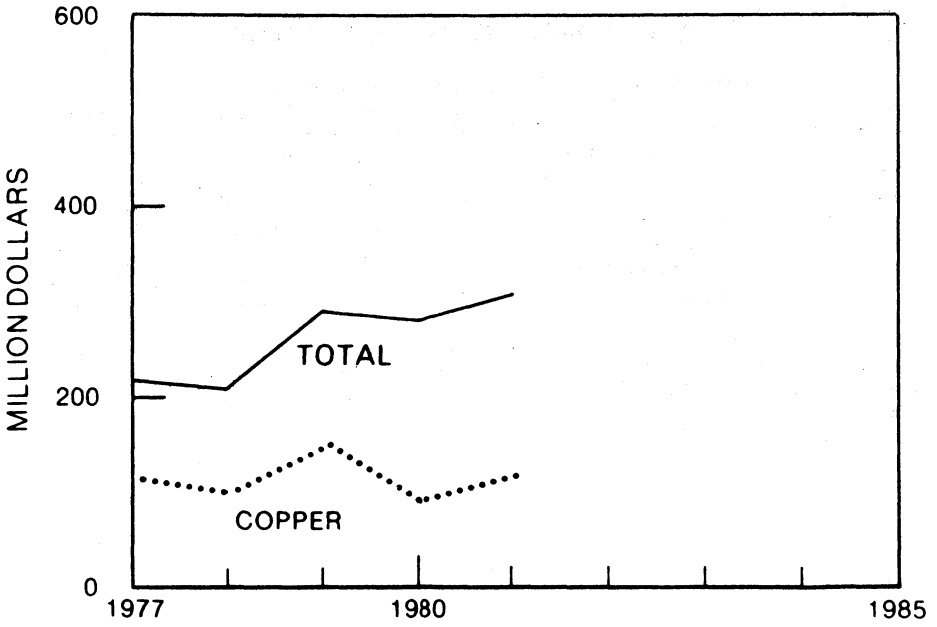

Figure 1.—Value of copper and total value of nonfuel mineral production in Montana.

operation of the pit, depending upon economic conditions, until at least the year 2000. The company submitted an application to the Montana Department of State Lands for an operating permit allowing a proposed mine-mill operation in the Stillwater Complex. The proposal is for the recovery of platinum-palladium ore. Anaconda's Heddeston property is being transferred to ASARCO Incorporated, based on a Federal Trade Commission directive. Anaconda continued its statewide exploration program. Of special interest was the search for diamonds on Williams Kimberlite, south of the Little Rockies.

Other developments include Asarco's Troy Project, a copper-silver mine-mill complex that started operation late in the year. Placer Amex Inc. obtained an operating permit for its Golden Sunlight gold property near Whitehall, and construction of a 5,000-ton-per-day mill was scheduled to commence in April 1982. Black Pine Mining Co. secured a State permit to construct a 1,000-ton-per-day mill to treat silver ore that was previously shipped as crude to the smelter in Anaconda. In the Philipsburg area, a mill, constructed by Antonioli Bros. to treat custom ores and ores from their own mining ventures, was processing Black Pine ore until that company's mill comes onstream. Sparrow Resources, Inc., was granted an operating permit for its Nellie Grant Mine, which was previously operated under a small miners' exclusion. Approximately 10 heap leach operations were either producing or in a research mode. The largest operation was in the Little Rockies.

Nonmetal mineral production developments included an expansion of processing capacity at Montana Barite Co., Inc.'s plant in Missoula, Continental Lime Inc.'s new 354-acre limestone quarry and 500-ton-per-day lime kiln under construction near Townsend, and Kaiser Cement Corp.'s bringing a new limestone quarry into production near Montana City.

The Mining and Mineral Resources and Research Institute at the Montana College of Mineral Science and Technology in Butte received a total of $191,093 in grants for research endeavors from the Office of Surface Mining, U.S. Department of the Interior.

Enactment of House Bill 718, which created an impact board to deal with anticipated impacts of new mines, was perhaps the State's most significant piece of nonfuel mineral industry legislation in 1981.

REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Metals accounted for 57% of the total value of nonfuel mineral production in Montana in both 1980 and 1981 compared with 65% in 1979.

Exploration activities continued at high rates, following trends of the past few years. A total of 1,248 small miners' exclusions were issued, 55 major exploration companies were active, and 140 exploration licenses were recorded. Areas of interest for precious metals exploration included Boulder, Basin, Cooke City, Crazy Mountains, German Gulch, Jardine, Marysville, Radersburg, Sapphire Mountains, Tobacco Root Mountains, and Virginia City. Placer activities were noted in the Nine Mile area near Missoula, on the Vermillion River, on Libby and Cherry Creeks in Lincoln County, Washington Gulch in Powell County, Hughes Creek in Ravalli County, Cedar Creek and Trout Creek in Mineral County, and in Meagher County near White Sulphur Springs. Complex ore (precious and base metals) targets included the Cabinet Mountains, Judith Mountains, John Long Mountains, Little Belt Mountains, Garnet Range, Highland Mountains, Neihart-Hughesville district, near White Sulphur Springs, and in Mineral and Fergus Counties. Base metal exploration activity continued strong, with emphasis on tungsten and molybdenum. Target areas included the Pioneer Mountains, Torrey Mountain, Soap Gold and Wickiup Creek region, Fleur Mountain, Hughesville-Barker-Neihart, Marysville, Bald Butte, Liver Peak, Big Belt Mountains, Flint Creek Range, Storm Lake, Browns Lake, Red Mountain, and the Tobacco Root Mountains.

Antimony.—U.S. Antimony Corp. mined and processed ore in Sanders County and continued as one of only two domestic sources of antimony. The plant produced a variety of products. Production in 1981 was approximately 93% of the 5-year average (1977-81); value was only 77% of the 5-year average.

Copper.—Copper was recovered from the ores of 20 mines in 11 counties in 1981, from retreatment of tailings, and from a leach operation in Silver Bow County. This compares with production from eight mines in

seven counties in 1980, plus the leach operation. Approximately 95% of the copper produced was from the Anaconda operations in Silver Bow County. Production in that county in 1981 was equal to the yearly average of the 5-year period (1977-81). Production in the State was 98% of the yearly average for the 5-year period. Montana ranked fourth nationally in the value of its copper production; it supplied about 4% of the primary copper production in 1981, and 3% in 1980.

Gold.—Gold was recovered from the ores of 26 mines in 11 counties in 1981, from retreatment of tailings at 2 sites in 2 counties, and from 1 placer operation in Meagher County. This compares with 1980 production from 20 mines in 9 counties and from 1 placer. Gold production in 1981 was 61% more than the yearly average for the 5-year period (1977-81), with the value about 80% more than the yearly average. Montana ranked sixth in 1981 and fifth in 1980 among the gold-producing States. Production in 1981 was approximately 4% of primary gold produced in the Nation compared with 5% in 1980.

Silver Bow County, where gold is recovered as a byproduct from copper mining, contributed 26% of the primary gold in 1981, compared with about 24% in 1980. The 5-year production average (1977-81) from Silver Bow County was 17,080 troy ounces; in 1981, about 84% of that average was produced.

Heap leaching activities by Zortman Mining, Inc., and Landusky Mining Co. confirmed Phillips County as first in State gold production for the second consecutive year.

Silver.—The principal source of silver was the ore from Anaconda's operations in Butte, accounting for approximately 68% of the total State output in 1981, and 79% in 1980. A total of 40 mines in 15 counties and 2 tailings retreatment operations recovered silver in 1981 compared with 26 mines in 10 counties in 1980. Statewide production of silver in 1981 was 2% more than the yearly average for the 5-year period (1977-81), with the value about 11% more than the average value for the 5-year period. Silver Bow County continued as the principal producing county; however, production in 1981 was only about 87% of the yearly average for the 5-year period (1977-81). Production of silver outside the Butte area amounted to 961,000 troy ounces in 1981 compared with 428,000 troy ounces in 1980. A major portion of the increase can be attributed to Asarco's Troy Project, a copper-silver mine complex that started production in 1981. Montana ranked fifth among silver-producing States in 1981 and sixth in 1980. About 7% of the Nation's primary silver during 1981 came from Montana mines; in 1980, Montana's share was approximately 6%.

Table 4.—Montana: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1981, by class of ore or other source material

Source	Number of mines[1]	Material sold or treated (metric tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode ore:							
Dry gold[2]	14	538,856	38,786	105,671	(3)	4	4
Gold-silver	4	4,111	414	[4]20,617	4	66	2
Silver	18	532,370	273	833,084	2,930	101	14
Total	36	1,075,337	39,473	959,372	2,934	171	20
Copper	3	13,729,771	14,403	2,029,438	52,136	1	--
Lead	2	549	8	(5)	(3)	21	4
Total[6]	5	13,730,319	14,411	2,029,438	52,137	22	4
Other lode material:							
Gold tailings	1	8,165	375	(5)	(3)	1	(3)
Copper precipitates	1	11,093	--	--	7,415	--	--
Total lode material[6]	41	14,824,914	54,259	2,988,810	62,485	194	25
Placer	1	--	8	--	--	--	--
Grand total[6]	42	14,824,914	54,267	2,988,810	62,485	194	25

[1]Details may not add to total because some mines produce more than one class of material. Operations from which gold, silver, copper, and zinc are recovered from tailings only are not counted as producing mines.
[2]Includes material that was leached.
[3]Less than 1/2 unit.
[4]Includes silver in lead ore and in gold tailings.
[5]Combined with silver in gold-silver ore to avoid disclosing company proprietary data.
[6]Data may not add to totals shown because of independent rounding.

Table 5.—Montana: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Mines producing		Material sold or treated[1] (metric tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1979, total	33	1	15,631,139	24,050	$7,395,381	3,301,928	$36,618,378
1980, total	26	1	8,760,354	48,366	29,627,079	2,023,893	41,773,150
1981:							
Beaverhead	3	--	1,951	7	3,217	22,845	240,293
Broadwater	6	--	3,063	226	103,879	972	10,223
Cascade	1	--	15	--	--	178	1,872
Deer Lodge	1	--	3,266	--	--	W	W
Granite	8	--	22,427	272	125,023	27,539	289,665
Jefferson	6	--	6,554	652	299,685	30,481	320,610
Lincoln	1	--	523,591	54	24,821	764,471	8,040,989
Madison	5	--	11,467	W	W	3,664	38,540
Meagher	--	1	--	8	3,677	--	--
Ravalli	1	--	48	W	W	852	8,962
Sanders	1	--	5	--	--	W	W
Silver Bow	1	--	13,728,889	14,394	6,616,058	2,027,529	21,326,300
Undistributed[2]	7	--	523,639	38,654	17,766,925	110,279	1,159,955
Total	41	1	[3]14,824,914	54,267	24,943,285	2,988,810	31,437,409

	Copper		Lead		Zinc		Total value
	Metric tons	Value	Metric tons	Value	Metric tons	Value	
1979, total	69,854	$143,268,088	258	$298,790	104	$86,112	$187,666,749
1980, total	37,749	85,236,299	295	276,441	71	58,758	156,971,727
1981:							
Beaverhead	2	3,460	7	5,764	3	3,351	256,085
Broadwater	W	W	W	W	4	3,748	121,596
Cascade	--	--	W	W	W	W	2,479
Deer Lodge	11	20,739	W	W	--	--	23,797
Granite	W	W	7	5,619	W	W	454,466
Jefferson	W	W	106	85,518	W	W	723,332
Lincoln	2,907	5,454,796	40	32,161	--	--	13,552,767
Madison	W	W	3	2,449	1	919	177,836
Meagher	--	--	--	--	--	--	3,677
Ravalli	W	W	5	3,861	6	5,581	20,129
Sanders	W	W	2	1,522	--	--	2,388
Silver Bow	59,477	111,612,502	--	--	--	--	139,554,860
Undistributed[2]	88	165,668	24	19,680	11	10,567	18,925,187
Total	62,485	117,257,165	194	156,574	25	24,166	173,818,599

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Does not include gravel washed.
[2]Fergus, Lewis and Clark, Park, and Phillips Counties and items indicated by symbol W combined to avoid disclosing company proprietary data.
[3]Data do not add to total shown because of independent rounding.

Table 6.—Montana: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1981, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode:					
Cyanidation	38,353	105,185	--	--	--
Smelting of concentrates from ore and tailings	15,149	2,818,002	55,061	69	8
Direct smelting of:					
Ore	757	65,623	9	125	16
Precipitates	--	--	7,415	--	--
Total	757	65,623	7,424	125	16
Total lode	54,259	2,988,810	62,485	194	[1]25
Placer	8	--	--	--	--
Grand total	54,267	2,988,810	62,485	194	25

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

Table 7.—Montana: Mine production (recoverable) of gold, silver, copper, lead, and zinc in Silver Bow County

Year	Mines producing	Material sold or treated (thousand metric tons)	Gold (troy ounces)	Silver (thousand troy ounces)
1977	1	14,054	21,181	3,081
1978	1	16,233	16,949	2,281
1979	1	15,545	21,336	2,655
1980	1	8,244	11,541	1,596
1981	1	13,729	14,394	2,028
1882-1981	--	[1]522,882	2,680,878	682,298

Year	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)	Total value (thousands)
1977	77,942	--	--	$132,163
1978	66,741	--	--	113,446
1979	69,133	--	--	177,800
1980	37,467	--	--	124,602
1981	59,477	--	--	139,555
1882-1981	8,635,992	415,442	2,406,823	5,911,023

[1]Complete data not available for 1882-1904.

NONMETALS

Nonmetals produced in Montana during 1981 were barite, cement (portland and masonry), clays (bentonite, fire, and common), gem stones, gypsum, lime, peat, phosphate rock, sand and gravel, stone (crushed and dimension), sulfur, talc, and vermiculite. Production increases were noted for barite, cement, gem stones, and talc. Production of clays, gypsum, lime, stone, and vermiculite was down, and the estimated production of sand and gravel was also down. Peat production remained constant.

Cement.—Two plants, at Trident and Montana City, produced portland cement in 1981. The plant at Montana City also produced masonry cement. Production in 1981 was equal to the average yearly production for the 5-year period (1977-81). Cement produced in the State was used by building-material dealers, concrete-products manufacturers, ready-mix concrete companies, highway and other contractors, government agencies, and others. Both plants used natural gas and coal as fuel sources. Raw materials consumed in manufacturing cement included limestone, clays, sandstone, sand, iron ore, gypsum, and additives. The product was transported to users by truck and rail.

Clays.—The State's output of clay and shale in 1981 came from 15 mines in 6 counties compared with the production from 16 mines in 8 counties in 1980. Production in 1981 was 44% more than the yearly average for the 5-year period (1977-81); however, production in 1981 was less than that of 1980. Growth in clay production can be attributed to increased demand for bentonite and subsequent increased production capacities commencing in 1979. The material produced was used for many purposes, but mainly for drill mud, iron ore pellets, and foundry sand.

Gypsum.—The United States Gypsum Co. produced gypsum at its Shoemaker Mine in Fergus County. Crude gypsum was calcined for the production of wallboard. This mine and plant complex is the single largest taxpayer in the county. Maronick Construction Co., Inc., operated a surface gypsum mine near Raynesford, in Judith Basin County, and shipped the product to cement plants in Montana. Production in 1981 was 62% of the yearly average for the 5-year period (1977-81); value was 73% of the yearly average for the 5-year period. The decline in production can be attributed to the economic slump.

Lime.—The Anaconda Co., Holly Sugar Corp., and Great Western Sugar Co. produced lime for use in metallurgical processes, pollution abatement, and sugar refining. Lime production in 1981 was 92% of the yearly average for the 5-year period (1977-81); value of production was 95% of the yearly average for the 5-year period. Anaconda shut down its lime kiln permanently in November 1981.

Phosphate Rock.—Phosphate rock was mined for the 52d consecutive year in Powell County. Production and value in 1981 were more than double the yearly average for the period 1977-81. The product was shipped to Canada for further processing. The Stauffer Chemical Co., Silver Bow County, continued to produce elemental phosphorus at its plant, with phosphate rock shipped from Idaho. The company

converted the plant firing methodology for its kiln from natural gas to coal. Approximately 30 short tons of coal per day will be consumed, which will be obtained from eastern Montana or Wyoming.

Sand and Gravel.—To reduce reporting burdens and costs, the U.S. Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary statistics for construction sand and gravel production but contains complete data on industrial sand and gravel. The preliminary statistics for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

The preliminary statistics for Montana construction sand and gravel production in 1981 indicate a decline in both production and value of 8% and 7%, respectively, from that of 1980.

Table 8.—Montana: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	1,364	$3,767	$2.76	NA	NA	NA
Gravel	5,275	12,290	2.33	NA	NA	NA
Total or average	6,639	16,057	2.42	p6,100	p$14,900	p$2.44
Industrial sand	W	W	32.32	W	W	11.96
Grand total or average	W	W	2.53	W	W	p2.52

pPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.

Stone.—Crushed stone was produced from 18 quarries in 10 counties in 1981 compared with production from 32 quarries in 19 counties in 1980. Quarry production ranged from less than 25,000 short tons per year to more than 500,000. More than 81% of State production came from quarries producing over 100,000 short tons. Production in 1981 was 61% of the yearly average for the 5-year period (1977-81); value of production was 74% of the yearly average for the period. Dimension stone was produced from one quarry.

Table 9.—Montana: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Bituminous aggregate	--	--	137	206
Surface-treatment aggregate	--	--	7	7
Other construction aggregate and road stone	423	1,281	--	--
Riprap and jetty stone	34	81	11	34
Railroad ballast	242	565	163	378
Cement manufacture	955	3,030	1,000	3,238
Lime manufacture	37	W	--	--
Flux stone	90	354	W	W
Sugar refining	138	651	131	627
Other[2]	43	341	133	646
Total[3]	1,962	6,302	1,582	5,137

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, granite, sandstone, and traprock.
[2]Includes manufactured fine aggregate (stone sand, 1980), ferrosilicon, and items indicated by symbol W.
[3]Data may not add to totals shown because of independent rounding.

Sulfur (Recovered).—Two companies, Montana Sulphur & Chemical Co. and Farmers Union Central Exchange, recovered sulfur as a byproduct from petroleum operations in Yellowstone County.

Talc.—Talc production continued at Cyprus Industrial Mineral Co.'s (AMOCO Minerals Co.) Beaverhead and Yellowstone Mines and from Pfizer, Inc.'s Treasure Mine, all in Madison County. Production in 1981 was 6% more than the yearly average for the 5-year period (1977-81), with the value of production increasing 73% over the yearly average for the 5-year period. Montana talc was used in ceramics, cosmetics, insecticides, paint, paper, plastics, roofing, rubber, and other uses.

Vermiculite.—W. R. Grace & Co. produced crude vermiculite from its Rainy Creek Mine in Lincoln County. The mine was the largest source of crude vermiculite in the Nation. Production in 1981 was about 92% of the yearly average for the 5-year period (1977-81), with the value of production 19% more than the yearly average for the 5-year period.

[1]Formerly State Liaison Officer, currently deputy chief, Western Field Operations Center, Bureau of Mines, Spokane, Wash.

[2]Director, Montana Bureau of Mines and Geology, Butte, Mont.

[3]Staff field agent, Montana Bureau of Mines and Geology, Butte, Mont.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum:			
The Anaconda Co., Aluminum Div	Columbia Falls, MT 59912	Reduction plant	Flathead.
Antimony:			
U.S. Antimony Corp	Box 643 Thompson Falls, MT 59873	Mine and plant	Sanders.
Barite:			
Montana Barite Co., Inc	Box 3296 Missoula, MT 59806	do	Missoula.
Cement:			
Ideal Basic Industries, Inc., Cement Div.[1]	Box 8789 Denver, CO 80201	Plant	Gallatin.
Kaiser Cement Corp.[1]	300 Lakeside Dr. Oakland, CA 94612	do	Jefferson.
Clays:			
American Colloid Co	Box 815 Glasgow, MT 59230	Pit and plant	Carbon and Phillips.
Federal Bentonite Div., Aurora Industries, Inc.	Glasgow, MT 59230	do	Valley.
International Minerals & Chemical Corp.	2315 Sanders Rd. Northbrook, IL 60062	Pit	Carter.
Copper:			
The Anaconda Copper Co.[2]	Box 689 Butte, MT 59701	Open pit mine and plant	Silver Bow.
Gold:			
Landusky Mining Co.[3]	Box 57 Zortman, MT 59546	Open pit mine and leach pad.	Phillips.
Zortman Mining, Inc.[3]	Zortman, MT 59546	do	Do.
Gypsum:			
Maronick Construction Co., Inc.[4]	East Helena, MT 59635	Open pit mine	Judith Basin.
United States Gypsum Co	Heath, MT 59457	Underground mine and plant.	Fergus.
Lime:			
Great Western Sugar Co	1530 16th St. Denver, CO 80217	Surface mine and plant	Yellowstone.
Holly Sugar Corp	Sidney, MT 59270	do	Richland.
Peat:			
Farmer's Plant Aid Corp	Hamilton, MT 59840	Surface mine	Ravalli.
Martins Peat, Inc	Swan Lake, MT 59911	do	Lake.
Phosphate rock:			
Cominco American, Incorporated	Garrison, MT 59731	Underground mine	Powell.
Silver:			
ASARCO Incorporated[5]	Box 868 Troy, MT 59935	Smelter, underground mine, plant.	Lewis and Clark and Lincoln.
Black Pine Mining Co.[5]	Box 724 Philipsburg, MT 59858	Underground mine	Granite.
Midnite Mines, Inc.[6]	601 Great Western Bldg. Spokane, WA 99201	Surface mine	Beaverhead.
Stone:			
DeAtley Corp	Box 648 Lewiston, ID 83501	Quarry	Flathead.
Janney Construction Co., Inc	Box 517 Deer Lodge, MT 59722	do	Missoula.
Weaver Construction Co	Drummond, MT 59832	Quarries	Carbon and Granite.

See footnotes at end of table.

Table 10.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sulfur (recovered):			
Montana Sulphur & Chemical Co	Box 31118 Billings, MT 59107	Plant	Yellowstone.
Talc:			
AMOCO Minerals Co., Cyprus	555 South Flower St. Los Angeles, CA 90017	Open pit mine and plant	Madison.
Pfizer, Inc	Box 1147 Dillon, MT 59725	do	Do.
Vermiculite:			
W. R. Grace & Co., Agricultural Chemicals Group.	Libby, MT 59923	do	Lincoln.

[1]Also clays and stone.
[2]Also gold, lime, and silver.
[3]Also silver.
[4]Also stone.
[5]Also copper, gold, and lead.
[6]Also copper, gold, lead, and zinc.

The Mineral Industry of Nebraska

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Conservation and Survey Division of the University of Nebraska, Nebraska Geological Survey, for collecting information on all nonfuel minerals.

By Jane P. Ohl[1]

The value of nonfuel minerals produced in Nebraska in 1981 was less than $74 million, an 8% decrease from that of 1980. Although portland cement and crushed stone increased in price per short ton during the year, no mineral commodity gained in either total value or quantity.

Excluding uncanvassed construction sand and gravel operations, Cass County ranked first in value of nonfuel minerals produced during 1981. In order of decreasing production value, Cass County was followed by Washington, Pawnee, and Saunders Counties.

The 1,500 employees on mining[2] payrolls in the State in January 1981 increased to 1,600 by yearend.[3]

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

Mineral	1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	154	$456	136	$409
Sand and gravel do.	10,538	22,981	p10,319	p22,844
Stone (crushed) do.	3,775	16,301	3,139	14,024
Combined value of cement, gem stones, and lime	XX	40,736	XX	36,718
Total	XX	80,474	XX	73,995

pPreliminary. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Antelope	$437	$342	Sand and gravel.
Banner	126	--	
Brown	W	W	Sand and gravel.
Buffalo	995	835	Do.
Burt	2	1	Do.
Butler	605	338	Do.
Cass	W	W	Cement, stone, sand and gravel, clays.
Cedar	368	W	Sand and gravel.
Chase	126	123	Do.
Cherry	W	--	
Cheyenne	55	45	Sand and gravel.
Clay	W	W	Do.
Colfax	231	766	Do.
Cuming	1,268	W	Do.
Custer	836	556	Do.
Dawson	656	1,082	Do.
Deuel	W	100	Do.
Dixon	W	W	Sand and gravel, stone.
Dodge	2,403	644	Sand and gravel.
Douglas	W	W	Sand and gravel, clays.
Dundy	5	W	Sand and gravel.
Fillmore	W	W	Do.
Franklin	318	327	Do.
Frontier	W	W	Do.
Furnas	92	70	Do.
Gage	1,368	W	Stone, sand and gravel.
Garden	W	W	Sand and gravel.
Garfield	24	--	
Grant	1	9	Sand and gravel.
Greeley	W	--	
Hall	1,426	1,135	Sand and gravel.
Hamilton	W	W	Do.
Hayes	W	W	Do.
Hitchcock	W	125	Do.
Holt	745	543	Do.
Howard	235	W	Do.
Jefferson	W	W	Sand and gravel, clays.
Kearney	62	53	Sand and gravel.
Keith	105	152	Do.
Kimball	5	--	
Knox	265	344	Sand and gravel.
Lancaster	478	W	Stone, clays.
Lincoln	703	251	Sand and gravel.
Loup	80	W	Do.
Madison	786	894	Do.
Merrick	554	226	Do.
Morrill	W	W	Sand and gravel, lime.
Nance	320	201	Sand and gravel.
Nemaha	W	W	Stone, sand and gravel.
Nuckolls	W	W	Cement, sand and gravel, stone.
Otoe	W	--	
Pawnee	W	W	Stone.
Perkins	7	5	Sand and gravel.
Phelps	W	W	Do.
Pierce	98	382	Do.
Platte	1,201	703	Do.
Polk	245	111	Do.
Red Willow	256	239	Do.
Richardson	1	--	
Rock	W	W	Sand and gravel.
Saline	3	--	
Sarpy	977	W	Stone, sand and gravel, clays.
Saunders	W	W	Sand and gravel, stone.
Scotts Bluff	W	W	Lime, sand and gravel.
Seward	46	86	Stone.
Sheridan	221	W	Sand and gravel.
Stanton	W	387	Do.
Thayer	W	815	Do.
Thomas	W	W	Do.
Valley	722	569	Do.
Washington	W	W	Stone.
Webster	W	W	Sand and gravel.
York	W	173	Do.
Undistributed[2]	79,726	67,842	
Total	[3]99,181	80,474	

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: Adams, Arthur, Blaine, Boone, Box Butte, Boyd, Dakota, Dawes, Gosper, Harlan, Hooker, Johnson, Keya Paha, Logan, McPherson, Sherman, Sioux, Thurston, Wayne, and Wheeler.

[2]Includes gem stones, some sand and gravel that cannot be assigned to specific counties, and values indicated by symbol W.

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

Table 3.—Indicators of Nebraska business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	765.3	786.0	+2.7
Unemployment	do	34.4	36.9	+7.3
Employment (nonagricultural):				
Mining[1]	do	1.9	1.7	-10.5
Manufacturing	do	96.4	95.0	-1.5
Contract construction	do	29.1	26.3	-9.6
Transportation and public utilities	do	47.9	47.1	-1.7
Wholesale and retail trade	do	163.6	162.6	-.6
Finance, insurance, real estate	do	42.0	41.2	-1.9
Services	do	116.0	120.6	+4.0
Government	do	130.8	130.5	-.2
Total nonagricultural employment[1 2]	do	627.6	624.8	-.4
Personal income:				
Total	millions	$14,300	$16,234	+13.5
Per capita		$9,086	$10,296	+13.3
Construction activity:				
Number of private and public residential units authorized		6,906	4,548	-34.1
Value of nonresidential construction	millions	$160.9	$132.3	-17.8
Value of State road contract awards	do	$97.5	$70.7	-27.5
Shipments of portland and masonry cement to and within the State	thousand short tons	842	679	-19.4
Nonfuel mineral production value:				
Total crude mineral value	millions	$80.5	$74.0	-8.1
Value per capita, resident population		$51	$47	-7.8
Value per square mile		$1,042	$958	-8.1

[p]Preliminary.
[1]Includes oil and gas extraction.
[2]Data may not add to totals shown because of independent rounding.

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

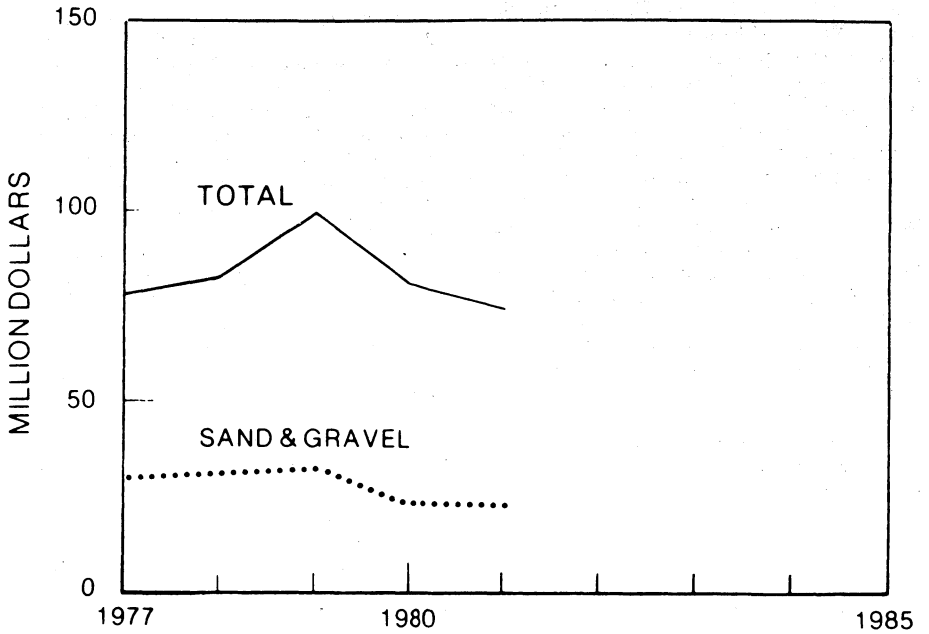

Figure 1.—Value of sand and gravel and total value of nonfuel mineral production in Nebraska.

Legislation and Government Programs.—On April 10, 1981, Governor Charles Thone approved legislative bill (LB) 59, relating to revenue and taxation. The act provides for mineral interests (mines, minerals, quarries, mineral springs and wells, oil and gas wells, and overriding royalty interests and production payments with respect to oil or gas leases) to be filed with the county assessor. The Act distinguishes between, and separately treats, surface estate and mineral interests: "Any owner of the surface estate from which a mineral interest has been severed or the owner of the mineral interest which has been severed may file an application with the county assessor of the county where such surface estate is located to place such severed mineral interest on the tax list of the county..."

LB 550, introduced on March 31, 1981, proposed establishing a system to regulate mining and exploration for uranium and other mineral deposits, and for providing reclamation and restoration of land and water resources affected by exploration, development, and mining. The measure also provided penalties for or enabled the authorities to declare an emergency if it were found that mining activities contaminated ground water. LB 550 did not emerge from committee.[4]

In their deliberations, State legislators disagreed as to whether they would lose jurisdiction to Federal control if a State law were to be delayed for 3 or 4 years. November 8, 1981, was the deadline for States to enact laws and write rules that comply with Federal mining and reclamation laws.

In May 1981, the Nebraska Geological Survey published a review of Nebraska mineral operations in 1980.[5]

Permit requirements for energy and other natural resources for the State of Nebraska were listed in a U.S. Geological Survey Open-File Report.[6]

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Cement.—Ash Grove Cement Co. and Ideal Basic Industries, Inc., produced cement at plants in Louisville (Cass County) and Superior (Nuckolls County).

Both firms produced gray portland cement types I and II (general moderate heat) and type III (high early strength). Ash Grove also produced masonry cement.

In decreasing order of quantity, finished portland cement was sold to ready-mix concrete companies, concrete-product manufacturers, highway contractors, building-materials dealers, other contractors, miscellaneous customers, and government agencies. Except in the categories of "other contractors," which rose 59%, and "miscellaneous customers," which rose 102.8%, all quantities sold declined compared with those of 1980: Ready-mix companies declined 9.6%; concrete-product manufacturers, 20.9%; highway contractors, 50.5%; building-materials dealers, 21.4%; and government agencies, 81.4%. Finished portland cement was shipped to customers either in bulk (95%) or containers (5%), by truck (94.4%), railroad (5.6%), or other (0.01%).

In addition to the usual raw materials, Ash Grove used fly ash in its cement. All but one of the two companies' kilns used the wet-process method, and both firms used electrostatic precipitators for pollution control. Natural gas was the main fuel used to operate the kilns; the remainder of the fuel was either bituminous coal or a small amount of fuel oil.

Construction of a new production line at Ash Grove, begun in March 1981, was to be completed by mid-1982. More than $20 million was to be spent to replace three old kilns with a new energy-efficient, 600,000-ton-per-year, rotary kiln, suspension preheater with precalciner and grate cooler. The new kiln, designed to cut coal use in half, will emit 284 fewer tons of particulates each year.

Clays.—Only common clay was produced in the State during 1981; quantity declined 11.7% and value declined 10.3% from those of 1980. Nearly 90% of the clay was used to make common and face brick; the remainder was used in manufacturing portland cement.

Producing counties, in descending order of quantity, were Jefferson, Lancaster, Cass, Douglas, and Sarpy, all in Nebraska's most densely populated southeastern area. Endicott Clay Products Co., the largest producer, operated a pit in Jefferson County that provided common clay for face brick. Omaha Brick Works, Inc., also made face brick from clays extracted in Douglas and Sarpy Counties; and Yankee Hill Brick Manufacturing Co. produced face brick from clays mined from a pit in Lancaster County.

Ash Grove used common clays mined in Cass County in the manufacture of portland cement.

Lime.—Great Western Sugar Co. prepared quicklime for use in manufacturing and refining sugar at its beet sugar plants in Morrill and Scotts Bluff Counties, western Nebraska.

Sand and Gravel.—To reduce the burdens and costs of reporting, the Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. This chapter, therefore, contains only preliminary estimates for construction sand and gravel production but complete data on industrial sand and gravel. The preliminary estimates of construction sand and gravel production for odd-numbered years will be revised and completed the following year.

During 1981, both construction sand and gravel and industrial sand were produced in Nebraska. The estimated total production of construction sand and gravel decreased about 2% from that of 1980; total value decreased an estimated 0.4%.

About 19,090 tons of industrial sand, valued at about $143,900, was produced during 1981, 19.1% and 21.5% decreases, respectively, from the 1980 figures. Value per ton also decreased, but only about 3%, to $7.54. Western Sand & Gravel Co., Saunders County, east-central Nebraska, was the State's sole industrial sand producer. Western's product was used for blasting (7%) and traction (93%); all output was sold or used at the quarry site, and none was shipped.

Stone.—Crushed limestone and a small amount of crushed sandstone were produced in 1981. Crushed limestone comprised 99.9% of the total quantity and the total value of the State's quarried rock; however, quantity and value decreased 17% and 14%, respectively, from 1980 levels. Average unit value was $4.47.

The county road department extracted 765 tons of crushed sandstone valued at $2 per ton from two quarries in Box Butte County; the product was used for dense-graded road base. These two operations were the only crushed stone quarries in western Nebraska.

Crushed limestone was produced from 18 quarries in 10 counties, all in southeastern Nebraska. In descending order of tonnage produced, the leading counties were Cass (64% of total tonnage), Washington, and Pawnee. Martin Marietta Aggregates, Central Div., was the largest producer of crushed limestone in the State, operating six quarries in Cass, Nemaha, Pawnee, and Saunders Counties. The largest producer in Cass County, and the largest producer in the State from a single quarry, however, was Kerford Limestone Co., near Weeping Water. Kerford production, in descending order, was used for concrete aggregate, asphalt and other fillers, poultry grit, surface treatment, agricultural limestone, flux stone, roof aggregates and chips, railroad ballast, riprap and jetty stone, and filter stone.

Table 4.—Nebraska: Crushed limestone sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	204	806	186	801
Poultry grit and mineral food	221	2,636	247	1,690
Concrete aggregate	883	3,900	492	2,524
Dense-graded road base stone	W	W	413	1,785
Surface-treatment aggregate	654	2,961	335	1,729
Other construction aggregate and road stone	447	2,211	442	2,319
Riprap and jetty stone	77	388	115	686
Filter stone	88	425	5	25
Manufactured fine aggregate (stone sand)	--	--	W	13
Lime manufacture	11	41	W	83
Flux stone	3	16	16	81
Asphalt filler	W	W	8	31
Other filler	--	--	87	438
Roofing granules	20	97	13	68
Other[1]	1,168	2,818	778	1,752
Total[2]	3,775	16,301	3,138	14,023

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

[1]Includes stone used in bituminous aggregate, railroad ballast, cement manufacture, fill (1981), and items indicated by symbol W.

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

Ash Grove, the sole producer of crushed limestone for cement manufacture, and Fort Calhoun Stone Co. were also among the State's leading producers. In addition to uses listed above for Kerford output, Nebraska limestone was used for bituminous aggregate, dense-graded road base, lime manufacture, and manufactured fine aggregate.

About 87% of the crushed stone was shipped by truck, nearly 9% by rail, and the remainder by waterways and other methods. Cass County, midway between Omaha and Lincoln, was the source of nearly two-thirds of the shipped stone.

Vermiculite.—W. R. Grace & Co. produced exfoliated vermiculite at its plant in Douglas County, near Omaha. Crude vermiculite was imported from Grace's mining and beneficiating operations at Libby, Mont. The exfoliated product was sold to the construction community, in descending order of quantity used, as block insulation, loose-fill insulation, concrete aggregate, fireproofing material, and plaster aggregate; and to the horticultural community as aggregate. Although production and total value declined from 1980 levels, the average price per ton rose about 7% in 1981.

[1]State Liaison Officer, Bureau of Mines, Denver, Colo.

[2]The term "mining," as used in the Employment and Earnings report, may or may not include oil and gas extraction and construction work.

[3]Bureau of Labor Statistics. Employment and Earnings, Table B-8, Employees on Nonagricultural Payrolls for States and Selected Areas by Industry Division. V. 29, No. 3, March 1982, pp. 66-77.

[4]Burchett, R. R., research geologist, Nebraska Geological Survey. Written communication, Sept. 27, 1982, available for consultation at the Intermountain Field Operations Center, Bureau of Mines, Denver, Colo.

[5]Burchett, R. R., and D. A. Eversoll. Nebraska Mineral Operations Review. Nebraska Geol. Survey, May 1981, 19 pp.

[6]Smith, J. K. Permit Requirements for Energy and Other Natural Resources for the State of Nebraska. U.S. Geol. Survey Open-File Rept. 81-1268, 1981, 57 pp.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Ash Grove Cement Co.[1]	920 Main St. Suite 1000 Kansas City, MO 64105	Plant	Cass.
Ideal Basic Industries, Inc., Ideal Cement Co.	Box 8789 Denver, CO 80201	do	Nuckolls.
Clays:			
Endicott Clay Products Co	Box 17 Fairbury, NE 68352	Open pit and plant	Jefferson.
Yankee Hill Brick Manufacturing Co	Route 1 Lincoln, NE 68502	do	Lancaster.
Lead, refined:			
ASARCO Incorporated	5th and Douglas Sts. Omaha, NE 68102	Refinery	Douglas.
Sand and gravel (industrial):			
Western Sand & Gravel Co	Box 28 Ashland, NE 68003	Pit	Saunders.
Stone:			
Fort Calhoun Stone Co	1255 South St. Blair, NE 68008	Quarries and plants.	Washington.
Kerford Limestone Co	Box 449 Weeping Water, NE 68463	Quarry and plant	Cass.
Martin Marietta Aggregates, Central Div.	Box 789 Cedar Rapids, IA 52406	Quarries and plants.	Cass, Nemaha, Pawnee, Saunders.

[1]Also produces limestone and clays in Cass County.

The Mineral Industry of Nevada

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

By D. W. Lockard[1] and John H. Schilling[2]

The total value of nonfuel mineral production in Nevada was $504 million in 1981, an increase of 28% over that of 1980. In terms of value, gold was the leading commodity produced, accounting for $241 million, or 48% of the total mineral value produced in the State. Nevada was the leading gold producer in the Nation, accounting for 38% of the total produced in 1981. Nevada also led the Nation in barite and mercury production.

An increase in production over the previous year was most notable for gold. The increase resulted from several new mines becoming operational during the year; three yielded a total of more than 160,000 ounces of gold in their first year of production.

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

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Barite	thousand short tons	1,918	$47,800	2,482	$79,716
Clays	do.	64	2,082	73	2,948
Gem stones		NA	900	NA	1,000
Gold (recoverable content of ores, etc.)	troy ounces	r278,495	r170,595	524,802	241,220
Gypsum	thousand short tons	852	8,276	778	6,914
Iron ore	thousand long tons	W	W	99	1,490
Lead (recoverable content of ores, etc.)	metric tons	26	24	W	W
Mercury	76-pound flasks	30,431	11,851	27,819	11,514
Perlite	thousand short tons	6	92	W	W
Sand and gravel[2]	do.	8,439	18,360	p6,000	p12,800
Silver (recoverable content of ores, etc.)	thousand troy ounces	r940	r19,402	3,039	31,970
Stone (crushed)	thousand short tons	rW	rW	1,343	5,664
Zinc (recoverable content of ores, etc.)	metric tons	2	2	W	W
Combined value of cement (portland), copper, diatomite, fluorspar, lime, lithium compounds, magnesite, salt, sand and gravel (industrial), tungsten, and values indicated by symbol W		XX	r114,846	XX	108,413
Total		XX	r394,230	XX	503,649

pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes industrial sand and gravel; value included with "Combined value" figure.

Table 2.—Value of nonfuel mineral production in Nevada, by county

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Carson City	W	$409	Stone, sand and gravel.
Churchill	$1,903	W	Diatomite, sand and gravel, salt, gold, silver, tungsten, copper, lead, zinc.
Clark	36,779	37,178	Sand and gravel, lime, gypsum, stone, silver, copper, gold, tungsten.
Douglas	1,488	W	Sand and gravel, silver, gold, stone.
Elko	6,427	17,098	Barite, copper, gold, silver, sand and gravel, tungsten, stone.
Esmeralda	17,917	21,591	Lithium, diatomite, silver, gold, clays, talc, tungsten.
Eureka	40,864	W	Gold, iron ore, silver, stone, barite, sand and gravel, lead, mercury, copper, zinc.
Humboldt	8,526	12,089	Mercury, stone, sand and gravel, clays.
Lander	49,082	87,335	Gold, barite, copper, silver, sand and gravel.
Lincoln	12,131	13,282	Tungsten, gold, lime, silver, sand and gravel, perlite, clays.
Lyon	25,254	27,695	Cement, stone, sand and gravel, gypsum, diatomite, silver.
Mineral	40	6,468	Silver, gold, tungsten, sand and gravel.
Nye	22,492	45,566	Gold, barite, magnesite, clays, sand and gravel, silver, fluorspar, stone.
Pershing	17,731	18,495	Diatomite, gypsum, iron ore, sand and gravel, stone, perlite, gold, silver, clays.
Storey	12,389	21,043	Silver, gold, diatomite, sand and gravel.
Washoe	4,659	2,793	Sand and gravel, stone, clays, silver, gold.
White Pine	W	W	Sand and gravel, tungsten, stone.
Undistributed[1]	2,567	83,186	
Total[2]	260,246	394,230	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Includes sand and gravel (1980) that cannot be assigned to specific counties, gem stones, and values indicated by symbol W.
[2]Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Nevada business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	381.3	411.1	+7.8
Unemployment	do	26.7	33.5	+25.5
Employment (nonagricultural):				
Mining[1]	do	6.2	7.9	+27.4
Manufacturing	do	19.2	20.4	+6.2
Contract construction	do	26.2	25.7	-1.9
Transportation and public utilities	do	24.1	25.1	+4.1
Wholesale and retail trade	do	80.3	84.6	+5.4
Finance, insurance, real estate	do	17.9	18.4	+2.8
Services	do	169.1	175.0	+3.5
Government	do	57.0	56.9	-.2
Total nonagricultural employment[1]	do	400.0	414.0	+3.5
Personal income:				
Total	millions	$8,594	$9,831	+14.4
Per capita		$10,723	$11,633	+8.5
Construction activity:				
Number of private and public residential units authorized		11,993	10,634	-11.3
Value of nonresidential construction	millions	$478.4	$417.1	-12.8
Value of State road contract awards	do	$66.2	$112.6	+70.1
Shipments of portland and masonry cement to and within the State	thousand short tons	565	574	+1.6
Nonfuel mineral production value:				
Total crude mineral value	millions	$394.2	$503.6	+27.8
Value per capita, resident population		$483	$630	+30.4
Value per square mile		$3,493	$4,556	+30.4

[p]Preliminary.
[1]Includes oil extraction.

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

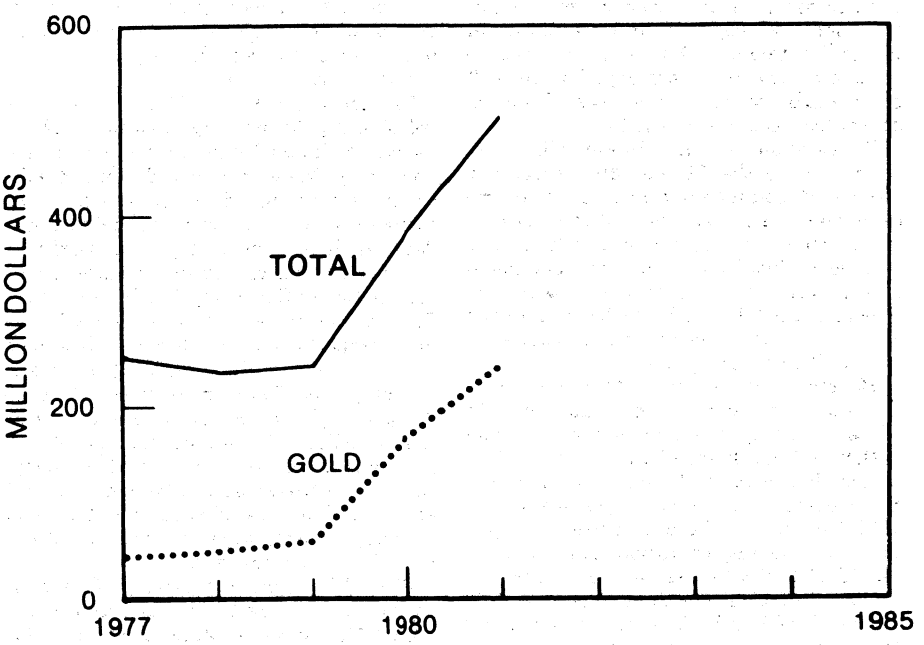

Figure 1.—Value of gold and total value of nonfuel mineral production in Nevada.

Trends and Developments.—Exploration and development of mineral deposits have increased markedly in recent years. When compared with the 1980 record year of activity, however, in terms of the numbers of individuals or companies, money spent, variety of minerals sought, and deposits developed, the level was not as high in 1981. The curtailment from the 1980 level was due mainly to lower prices received for mineral commodities as a result of decreased demand.

Newmont Mining Corp. quadrupled its estimate of probable gold reserves at its Gold Quarry property to 8 million ounces, making the Eureka County site potentially one of the largest gold mines in the Nation. Mining should begin about 1984, at a production rate of 150,000 to 200,000 troy ounces per year. Continued drilling is expected to increase the current reserve estimate.

Freeport Gold Co. completed construction in mid-June of its $95 million mill and complex at the Jerritt Canyon Mine in northern Elko County. The mill has two parallel circuits—one to treat the oxide ore and the other carbonaceous ore. Rated capacity is 2,750 tons of ore per day. The mine is expected to produce 200,000 ounces of gold per year.

Falcon Explorations Co. reopened the Gold Hill Mine near Tonopah, in Esmeralda County. About 1,000 tons of silver-gold ore is surface-mined daily and heap-leached at the site.

Amselco Minerals, Inc., in a joint venture with Occidental Petroleum Co., began production at the Alligator Ridge Mine in White Pine County. The operation is expected to produce 100,000 ounces of gold each year for the next 6 or 7 years. During the first year of production in 1981, the company produced over 60,000 ounces of gold.

Silver King Mines, Inc., began operations at its Taylor silver mine and mill in White Pine County. Development of the surface mine and mill construction began in 1979. Production is expected to be from 1 to 1.5 million ounces of silver per year. Known reserves are 7 to 10 million tons, averaging 3 ounces of silver per ton.

Bullion Monarch was producing 50 tons of

ore per day from its development work at the Adelaide copper-gold-silver mine in Humboldt County. Output is expected to reach 200 tons of ore per day. The ore will be treated at the company's flotation-concentration plant in Austin.

Construction at the Pinson Mine was completed by the Pinson Mining Co. The Humboldt County mine and mill will produce from 124 to 164 ounces of gold per day. In addition, the company constructed a heap-leach facility to treat low-grade material. Pinson also has reserves at its nearby Preble deposit that will be trucked to the Pinson mill. Minable reserves are expected to be sufficient for 9 years.

Houston International Minerals Corp. reopened the historic Borealis gold mine in Mineral County. The company began exploration and development in 1977, feasibility studies began in 1980, and the U.S. Forest Service issued the necessary permits in May 1981. The Borealis Mine and mill is an open pit, heap-leaching operation that will process 780,000 tons of ore per year. Reserves are 2.5 to 3.0 million tons averaging 0.08 ounce of gold and 0.62 ounce of silver per ton. Exploration was continuing to expand the reserves.

Sunshine Mining Co. completed its new "16 to 1" silver mine in Esmeralda County. A 500-ton-per-day mill was scheduled for completion in time to handle the first ore in March 1982. The mine was expected to yield 1 million ounces of silver per year for the next 9 years.

Veta Grande, Inc., in a joint venture with Nevada Resources and Development, Inc., was developing the Argus silver-gold property in the Pilot Mountain district in Mineral County. In another joint venture, Veta Grande and Nevada Resources are developing the Hasbrouck and adjacent Quartz Mountain metal mines at Quartz Mountain in Nye County. Reserves were estimated at 160,000 tons of ore with 15 ounces of silver per ton.

Veta Grande, Inc., also began mining silver ore at the Mohawk Mine near Silver Peak, Esmeralda County. Production was expected to reach 200 tons per day. A mill is planned for the site, but at this time the ore is being treated at the company's mill near Minden.

Bell Mountain Mining Co., a subsidiary of American Pyramid Resources, Inc., started construction of a 250-ton-per-day cyanide mill and leach pads at the Bell Mountain Mine in Churchill County. Approximately 1 million metric tons of gold-silver ore have been blocked out with an additional several million tons of low-grade ore present. Mining will be by open pit.

Universal Gas Co. of Montana was developing a gold property adjacent to Newmont's Carlin gold mine in northern Eureka County. More than 100,000 tons of gold ore have been mined, which will feed the company's newly constructed 200-ton-per-day cyanide concentration plant at Carlin.

Victor Industries purchased placer property at Barrel Springs in Pershing County. The site encompasses 23,000 acres of minable property and a 10,000-yard-per-day processing plant. Reportedly, there are 3 million yards of proven reserves valued at $15 per yard. The company also developed four benches that opened the top of the mineralized zone on the Lucky 4 property. Assays run from 0.08 to 0.96 ounce of gold and 1 to 2 ounces of silver per ton. The property was reported to have 12 million tons of indicated reserves.

River Mountain Resources, a Canadian company, was developing its recently acquired New Reveille Mine in Nye County. Reserves were estimated at 20,000 tons of oxide material. Assays indicated 5 ounces of silver per ton and 7.5% lead.

Flowery Gold Mines Co. acquired all outstanding shares of Tenabo Gold Placers, Inc. Tenabo controls 13 lode and 9 placer claims at Tenabo, Bullion mining district, Lander County; the property consists of 1,460 acres. A portion of the property has probable reserves of 1 million yards averaging 100 milligrams of gold per yard. Further work will be undertaken to enlarge the reserve base.

Some of the many exploration targets being examined in Nevada during 1981, mostly for silver and gold, follow: (1) Silver Strike Resources of Canada completed 21 drill holes at the Wonder Mine property in Churchill County for gold and silver; (2) Pacific Gold and Uranium in a joint venture with Noranda Exploration, Inc., examined drill core taken from 151 holes in the main section of the Goldfield district of Esmeralda County; (3) Kordex was doing exploratory drilling for gold and silver at the Hasbrouck Mine at Divide in Esmeralda County; (4) U.S. Minerals Exploration announced results from its Tokin gold property in the Antelope district of Eureka County; (5) American Copper and Nickel, a subsidiary of International Nickel Corp.,

did extensive drilling for gold and copper around the Ashdown Mine in Humboldt County; (6) Klondex Gold and Silver Co. was doing exploratory drilling at Fire Creek in Lander County; (7) Electra North West Resources drilled on the Aurora gold-silver property in Mineral County; (8) Hawthorne Gold Corp. and E & B Explorations announced potential open pit reserves of gold and silver on their Mindora property in Mineral County; (9) Victor Industries was drilling its Doc gold claims in the Seven Troughs district, Pershing County; (10) Ventures West Minerals, a Canadian company, completed drilling 38 holes for gold and silver in the Santa Fe district, Mineral County; (11) The Anaconda Company signed an agreement with Flowery Gold Mines Co. to perform exploratory work on the Flowery Claims in Storey County (this property is parallel to the Comstock Lode); (12) Suneva Resources Ltd. announced exploration plans for a gold deposit adjacent to the Alligator Ridge Mine in White Pine County; (13) Goldera Resources Inc., signed a joint venture agreement with Normac Explorations, Ltd., and commenced drilling on the Mary Anne, Motherlode, and Exchequer-New Century properties in White Pine County; (14) Duval Corp. announced discovery of an ore deposit containing 2.4 million ounces of gold and 9.2 million ounces of silver near Battle Mountain, about 1 mile from its existing Tom Boy open pit gold mine; (15) Freeport Exploration Co. was drilling on company claims east of Lovelock for gold and silver; (16) Carlin Gold Mining Co. announced a new gold discovery on its Gold Quarry Claims in Elko County. Preliminary drilling results indicated an ore body containing 13 million tons with 1.0 million ounces of gold.

Exxon Minerals Co., a division of Exxon Corp., announced a substantial molybdenum deposit in the Mount Hope mining district in Eureka County. Exploratory drilling began in 1978, and the announcement came in August 1981 that the deposit consists of 450 million tons at grades of 0.13% to 0.32% MoS_2. The company anticipated it will take 3 more years to fully delineate the deposit.

AMAX Inc. continued exploration drilling at the Buckingham molybdenum deposit in Lander County. No results were announced.

Conoco, Inc., was drilling for possible copper deposits at Pumpkin Hollow in Lyon County. The feasibility drilling target is believed to be small but may contain high-grade copper deposits at depths of 1,500 to 2,000 feet on claims leased from United States Steel Corp.

Exploration for barite was at a high level in 1981, but somewhat subdued from that of 1980 owing to increased imports of cheaper barite into the United States. Most of the decline was noted in small company efforts. Major companies continued or even increased their exploration efforts. Significant discoveries were made, but none were publicly announced.

Only a few new barite operations were started during the year. Minerals Unlimited, Inc., opened a mine in the northern Osgood Mountains in Humboldt County. Unichem Minerals, Inc., built a jig plant to process ore from the Coyote Mine in Elko County. Petro-Chem, Inc., moved its plant to the Taylor Canyon Mine in Elko County and started producing barite. Peabody Colada purchased the Bird Mine in Lander County, but the property remained inactive.

Legislation and Government Programs.—The 1981 session of the State Legislature passed, and the Governor signed into law, Senate Joint Resolution 21 (SJR) which provides for the taxation of minerals at a rate of not more than 5% of their value as net proceeds. As the legislation is an amendment to the Nevada State Constitution, it must be reenacted by the 1983 Legislature and ratified by a statewide general election. If approved, SJR 21 will permit an increase in the tax on net proceeds from the average of 2% to 2-1/2% paid by mining companies to a constitutional cap of 5%. The mining industry supported SJR 21 because it provides for a constitutional cap on the tax rate.

The Nevada State Legislature has enacted legislation that limits the power of mining companies—and all other private businesses—to exercise the right of eminent domain to acquire property within a historic district in Nevada. Under Assembly Bill 112, as amended, the County Commissions, not the historic districts, have the power to approve a mining company's request to use eminent domain within a historic district. Approval may not be withheld if the party seeking to exercise the right of eminent domain shows that (1) the property will be put to a public use (mining has been ruled by the Nevada State Supreme Court to be a public use), (2) the property is necessary for that public use, and (3) the intended public use will be of great benefit to the immediate community or area in which the real

property is situated, and not significantly harmful to historic landmarks or features.

Under Nevada law, county commissioners can create historic districts to protect any artifact, building, or other evidence of man's activities that may be considered historic. All mining towns and camps in Nevada are prime targets for future classification as historic districts.

Nevada's revenue from the mineral industry was significant for the year. Federal royalties received under section 35 of the Mineral Leasing Act of 1920 amounted to $10,878,630. Net proceeds tax on the gross yield from mines was $1,912,754.

The University of Nevada at Reno was selected as one of the 31 Mineral Institutes under Title III of Public Law 95-87 (Surface Mining and Reclamation Act of 1977). Under this program the Office of Surface Mining allotted $110,000 for operating the Institute. It also allotted two research grants entitled "Geochemical Exploration for Precious Metals Using Manganese Iron Oxide Joint Coatings" for the amount of $17,566 and "Elucidation of the Fundamental Chemistry and Recovery of Gold From Carbonaceous Ore Bodies" for the amount of $90,939.

The Nevada Bureau of Mines and Geology (NBMG) published 21 reports and maps on mineral resources during the year. In addition, 35 projects were underway at yearend or had been submitted for publication. Several grants were underway from the Department of Energy, the U.S. Geological Survey (USGS), and the Bureau of Land Management (BLM). The BLM project entails compiling information on ore deposits in northeastern and central Nevada. The USGS project is a cooperative effort with the NBMG for topographic quadrangle mapping, isotopic dating, and geologic mapping. The 1:250,000 scale geologic map of the Walker Lake Sheet and the Elko and Northern Nye Geologic County studies were near completion at yearend.

Employment.—Employees directly involved in Nevada's mining industry were estimated to be 8,500 at yearend. Construction workers at new mine sites pushed the total figures to nearly 13,000. Yearend mine shutdowns and closures will result in lower mineral employment in 1982.

REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Copper.—Copper was produced by 15 mines, although Duval Corp.'s Copper Basin Mine accounted for the bulk of the output. Production was up slightly compared with that reported in 1980.

Two primary copper mines, Copper Basin (Lander County) and Victoria (Elko County), were placed on inactive status—the Victoria in February and the Copper Basin in December.

Gold.—For 2 successive years Nevada has been the leading gold producing State, with 38% of the total primary gold production in the Nation for 1981. Value of gold produced was $241 million, nearly twice that of any other State and a 41% increase over the value for 1980. With the number of new operations coming onstream and the number of successful exploration activities underway, it is expected that Nevada will remain the leading gold producer for some years.

Production came from 49 mines, with the 6 leading companies accounting for 81% of the total gold produced. Leading in production were Carlin Gold Mining Co., Duval Corp., Amselco Minerals, Inc., Pinson Mining Co., Copper Range Co., and Freeport Gold Co. Carlin's production was from its three open pit mines—the Carlin, Maggie Creek, and the Blue Star Pits—and from the heap-leaching operation at the old Bootstrap Mine dump. Duval's production came from Battle Mountain. Although Duval suspended copper mining operations in December at the Copper Basin Mine between Copper Canyon and Battle Mountain, the gold-silver mining operation continued at Copper Canyon. Amselco began production in June, and by yearend exceeded production of over 60,000 ounces of gold for the year. All of Copper Range Co.'s production was from Round Mountain. After startup in mid-1981, Freeport Gold Co. became one of the six leading producers and could well be the leading producer in future years from its Jerritt Canyon Mine. Mine and mill capacity is 200,000 ounces of gold annually.

Table 4.—Nevada: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Mines producing		Material sold or treated[1] (metric tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1979, total	r17	2	r17,713,057	250,097	$76,904,831	560,435	$6,215,225
1980, total[r]	24	1	9,752,286	278,495	170,594,898	939,997	19,401,540
1981:							
Churchill	2	--	10,944	727	334,158	960	10,098
Clark	3	--	54,522	449	206,379	(2)	(2)
Elko	6	--	401,536	(2)	(2)	(2)	(2)
Esmeralda	2	--	18,374	36	16,547	(2)	(2)
Nye	6	--	561,185	85,112	39,120,880	185,167	1,947,655
White Pine	4	--	902,148	66,175	30,416,678	(2)	(2)
Undistributed[3]	26	1	8,811,694	372,303	171,125,352	2,853,353	30,012,624
Total	49	1	[4]10,760,404	524,802	241,219,994	3,039,480	31,970,377

	Copper		Lead		Zinc		Total value
	Metric tons	Value	Metric tons	Value	Metric tons	Value	
1979, total	W	W	24	$27,1863	W	W	$88,340,263
1980, total	W	W	26	24,016	2	$1,848	W
1981:							
Churchill	--	--	W	W	W	W	344,780
Clark	W	W	--	--	--	--	289,659
Elko	481	$903,047	W	W	W	W	22,229,892
Esmeralda	W	W	--	--	--	--	75,155
Nye	W	W	W	W	W	W	41,072,508
White Pine	W	W	W	W	W	W	37,327,808
Undistributed[3]	W	W	W	W	W	W	182,456,277
Total	W	W	W	W	W	W	283,796,079

rRevised. W Withheld to avoid disclosing company proprietary data.
[1]Does not include gravel washed.
[2]Included with "Undistributed" to avoid disclosing company proprietary data.
[3]Includes Douglas, Eureka, Humboldt, Lander, Mineral, Pershing, Storey, and Washoe Counties, and items indicated by footnote 2, combined to avoid disclosing company proprietary data.
[4]Data may not add to total shown because of independent rounding.

Table 5.—Nevada: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1981, by class of ore or other source material

Source	Number of mines[1]	Material sold or treated[2] (thousand metric tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode ore:							
Dry gold[3]	24	5,995	508,212	282,451	--	--	--
Gold-silver	4	44	[4]5,251	252,057	W	W	W
Silver[3]	17	2,305	10,927	2,484,636	1	35	4
Total	45	[5]8,343	[4]524,390	3,019,144	W	W	W
Copper	4	2,315	([6])	8,586	W	--	--
Total	49	[5]10,658	[7]524,390	3,027,730	W	W	W
Other lode material:							
Gold tailings, silver tailings, and copper cleanup[8]	--	102	412	11,750	W	W	W
Total lode material	49	[5]10,760	[7]524,802	3,039,480	W	W	W
Placer	1	--	([6])	--	--	--	--
Grand total	50	10,760	524,802	3,039,480	W	W	W

W Withheld to avoid disclosing company proprietary data.
[1]Operations from which gold, silver, copper, lead, and zinc are recovered from tailings or cleanup are not counted as producing mines.
[2]Does not include gravel washed.
[3]Includes material that was leached.
[4]Includes recovery from copper ore and placer ore to avoid disclosing company proprietary data.
[5]Data do not add to total shown because of independent rounding.
[6]Included with recovery from gold-silver ore to avoid disclosing company proprietary data.
[7]Includes recovery from placer ore to avoid disclosing company proprietary data.
[8]Combined to avoid disclosing company proprietary data.

Table 6.—Nevada: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1981, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode:					
Cyanidation	[1]524,064	[1]2,961,954	--	--	--
Smelting of concentrates and acid leaching (vat, tank, heap)[2]	[1]446	[1]64,680	W	W	W
Direct smelting of ore and cleanup[2]	[3]292	12,846	W	W	W
Total lode material	[3]524,802	3,039,480	W	W	W
Placer	([4])	--	--	--	--
Grand total	524,802	3,039,480	W	W	W

W Withheld to avoid disclosing company proprietary data.
[1]Includes small recovery from retreated tailings.
[2]Combined to avoid disclosing company proprietary data.
[3]Includes recovery from placer operation to avoid disclosing company proprietary data.
[4]Included with recovery by direct smelting of ore to avoid disclosing company proprietary data.

Iron Ore.—Three producers shipped iron ore in 1981; output and value both increased from those reported in 1980. Nevada-Barth Corp. in Eureka County was the State's largest shipper. Other shipments came from Churchill and Pershing Counties.

Lead.—Output and value increased slightly over those reported in 1980. Eight mines produced during the year, led by the Diamond Jim Mine (Elko County), operated by Gold Creek Silver Mines.

Mercury.—Placer Amex, Inc.'s McDermitt Mine JV (Humboldt County) accounted for nearly all of the Nation's mercury production in 1981. Carlin Gold Mining Co. supplied a small quantity of mercury as a byproduct from its gold mining operation in Eureka County.

Molybdenum.—There was no reported molybdenum output for the year. Anaconda Minerals Co. was onstream with its Nevada Moly Mine, but by yearend had made no shipments of concentrates from its Nye County operation. The 20,000-ton-per-day mill started processing ore late in the year. Plant capacity is 12 to 15 million pounds of molybdenum per year. Overburden was being removed from what will be a 1-1/2-square-mile surface mine. It was reported that this mine will be the largest in the State. The operation will eventually cover one-third of the 9,000 acres Anaconda owns at the site.

Silver.—Output and value of silver continued their upward surge for the second consecutive year. New mines coming into production accounted for the rapid escalation of output. Candelaria Partners' Candelaria Mine in Mineral County was the State's largest producer, accounting for over 1 million ounces of silver. The Taylor Mine (White Pine County) and the Gooseberry Mine (Storey County) each produced over 100,000 ounces. Mining operations at the Gooseberry Mine ceased in May because of sagging silver prices.

Titanium.—Titanium Metals Corp. (Timet) continued the $50 million renovation at its Henderson operation in Clark County, which reportedly will eliminate pollutants from the plant. Timet is the largest U.S. producer of titanium, with a production capacity of about 30 million pounds of titanium sponge per year. The renovation should cut chlorine emissions by 80% and save on future energy costs. Plant capacity will also be expanded to 32 million pounds of titanium sponge per year.

Tungsten.—Tungsten output rose slightly, but the value received declined 17% when compared with that reported in 1980.

Union Carbide Corp.'s Emerson Mine (Lincoln County) was the State's largest producer, accounting for over 90% of production. Because of depressed tungsten market conditions, the company decided to close the Emerson Mine at yearend. The milling operation was expected to run into 1982.

Utah International planned to have its Springer Tungsten Mine and mill and ammonium paratungstate plant onstream in early 1982; the Pershing County mine will be the deepest active mine in the State. Capital cost of the complex was in excess of $55 million; mill capacity is rated at 1,000 tons per day.

National Resources Development, Inc., of Canada completed a $2.8 million refurbishing of the Nevada Scheelite Mine and mill in Mineral County and became operational

in late spring.

Zinc.—A small increase in zinc output over that of 1980 was recorded, with eight mines reporting production in 1981. The Klondike Mine in Lander County was the State's leading producer.

NONMETALS

Barite.—Nevada remained the Nation's leading producer of primary barite and accounted for nearly one-fourth of world production. Production was reported from 20 open pit mines, most of them in Lander and Elko Counties. The Greystone Mine, operated by Dresser Minerals, Inc., was the State's largest producing property, followed by the Argenta Mine of Milchem, Inc. In recent years, more of the mine production has been treated within the State at either gravity or flotation mills.

Cement.—Cement output and value remained nearly constant in 1981 with those reported in 1980. Total production came from the Centex Corp.'s Fernley plant in Lyon County.

Las Vegas Portland Cement Co. announced plans to build a 1-million-ton-annual-capacity cement plant near Jean, southern Clark County. The $272 million plant was scheduled to be operational in July 1983.

Clays.—Industrial Mineral Ventures, Inc., was the State's largest clay producer from its Armagosa facility in Nye County. Output consisted of bentonite and fullers earth, mostly for use in drilling mud. Clay production was also recorded from operators in Esmeralda, Humboldt, Lincoln, and Washoe Counties.

Diatomite.—Recorded production rose slightly, and value received was 20% more than that reported in 1980. Eagle-Picher Industries, Inc., was the largest diatomaceous earth producer in the State, accounting for more than 80% of the total. The bulk of company production came from Pershing County and was used as a filtration medium. Production also was reported from Churchill, Esmeralda, Lyon, and Storey Counties.

Fluorspar.—The State's entire production came from the Daisy Mine in Nye County. Output and value were nearly the same as reported in 1980. The metallurgical-grade fluorspar was shipped to steel plants in California.

Gem Stones.—Individual collectors accounted for the estimated $1.0 million value of gem stones produced. Jade, jasper, agate, turquoise, and opals were the most sought after gems.

Gypsum.—Output and value both declined in 1981 when compared with the 1980 figures; production decreased for the third consecutive year. Four operators reported output for the year, two in Clark County and one each in Lyon and Pershing Counties. Pacific Coast Building Products, Inc., was the State's largest producer. Three companies operated calcining plants in Nevada in 1981.

All assets of The Flintkote Co. in Clark County, including a gypsum mine and calcining plant, were purchased by Genstar Corp.

Lime.—Output and value both declined in 1981. The State's total production came from Genstar Cement & Lime Co. (Clark County) and Sierra Chemical Co. (Lincoln County). The Genstar Corp. properties (Apex and Genstar) were part of the operations purchased from The Flintkote Co. in 1981. For the year, quicklime production nearly doubled that for hydrate.

Lithium Compounds.—Foote Mineral Co., a subsidiary of Newmont Mining Corp., was the State's sole producer of lithium compounds from brines near Silver Peak, Esmeralda County. Output and value rose slightly when compared with those reported in 1980.

Magnesite and Brucite.—Basic Incorporated operates the only magnesite mine in the United States at Gabbs, Nye County. Output and value were both 20% above those reported in 1980. The company completed a plant expansion in 1981 that will increase the capacity for production of chemical-grade magnesium oxide.

There was no reported production of brucite in 1981 from Nevada.

Perlite.—Delamar Perlite Co., Lincoln County, and United States Gypsum Co., Pershing County, were the only perlite producers in Nevada for 1981. Output was off slightly, but reported value increased when compared with that for 1980.

U.S. Gypsum operated its Empire plant (Washoe County) for expanding perlite; the entire output was used for plastic aggregates.

Salt.—Leslie Salt Co. was the State's only salt producer in 1981 from an operation in Churchill County. Output and value both declined from those reported in 1980.

Sand and Gravel.—To reduce reporting burden and costs, the Bureau of Mines implemented new canvassing procedures

for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary statistics for construction sand and gravel production. The preliminary statistics for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Simplot Silica Products' silica sand operation near Overton in Clark County was the State's only producer of industrial sand. Output and value nearly equaled those reported in 1980. An expansion was underway that will allow a tripling of capacity to 1 million tons annually; the expansion includes the installation of a slurry transport system from the mine to the mill and new drying and sizing systems. The company mainly ships sand to California glass plants.

Table 7.—Nevada: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	3,646	$7,795	$2.14	NA	NA	NA
Gravel	4,793	10,565	2.20	NA	NA	NA
Total or average	8,439	18,360	2.18	p6,000	p$12,800	p$2.13
Industrial:						
Sand	W	W	12.65	W	W	13.92
Gravel	W	W	11.87	--	--	--
Total or average	W	W	12.53	W	W	13.92
Grand total	W	W	2.66	W	W	2.86

pPreliminary. NA Not available. W Witheld to avoid disclosing company proprietary data.

Stone.—Crushed stone, including volcanic cinders and scoria, was produced from 10 operations in 7 counties. Output and value reported were both significantly below the levels reported in 1980. Centex Corp. was the State's largest producer; the product, which was limestone, was used in cement manufacture.

There were two producers of volcanic cinders: Savage Construction, Inc. (Carson City County), and Cind-R-Lite Co. (Nye County).

Talc.—Nevada had no reported production of talc in 1981.

[1]State Liaison Officer, Bureau of Mines, Spokane, Wash.
[2]Director and State geologist, Nevada Bureau of Mines and Geology, Reno, Nev.

Table 8.—Nevada: Crushed stone[1] sold or used by producers in 1981, by use

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Concrete aggregate (coarse)	W	W
Other construction aggregate and road stone	69	138
Manufactured fine aggregate (stone sand)	W	67
Terrazzo and exposed aggregate	W	W
Fill	W	W
Roofing granules	W	W
Other[2]	1,274	5,459
Total	1,343	5,664

W Witheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, granite, miscellaneous stone, and volcanic cinders and scoria.
[2]Includes stone used for poultry grit and mineral food, dense-graded road base stone, railroad ballast, cement manufacture, lime manufacture, and other uses not specified.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
Barite:			
Dresser Industries, Inc., Dresser Minerals Div.	Box 375 Battle Mountain, NV 89820	Surface mine and mill	Lander.
IMCO Sevices, Inc	Box 861 Battle Mountain, NV 89820	do	Elko and Lander.
Milchem, Inc	Box 272 Battle Mountain, NV 89820	do	Lander.
NL Industries, Inc., Baroid Div	Box 414 Battle Mountain, NV 89820	do	Eureka.
Cement:			
Centex Corp., Nevada Cement Co.[1]	Box 895 Fernley, NV 89408	Plant	Lyon.
Clays:			
Industrial Mineral Ventures, Inc	Box 549 Lathrop Wells, NV 89020	Surface mine and mill	Nye.
Copper:			
Duval Corp.[2]	Box 451 Battle Mountain, NV 89820	do	Lander.
Hecla-Day Mines Corp.[3]	Box 65 Wendover, UT 84083	Underground mine and mill.	Elko.
Diatomite:			
Cyprus Diatomite Co	Box 455 Fernley, NV 89408	Surface mine	Churchill.
Eagle-Picher Industries, Inc	Box 959 Lovelock, NV 89419	Surface mine and plants.	Pershing and Storey.
Fluorspar:			
J. Irving Crowell, Jr., & Son	Box 96 Beatty, NV 89003	Underground mine	Nye.
Gold:			
Amselco Minerals, Inc.[3]	Box 511 Ely, NV 89301	Surface mine	White Pine.
Carlin Gold Mining Co.[4]	Box 979 Carlin, NV 89822	Surface mines and mill.	Elko and Eureka.
Pinson Mining Co	Box 587 Winnemucca, NV 89445	do	Humboldt.
Gypsum:			
Pacific Coast Building Products, Inc	Box 43327 Las Vegas, NV 89104	do	Clark.
Iron Ore:			
Cooney Mining Co	Box 568 Lovelock, NV 89419	do	Pershing
Nevada-Barth Corp., Barth Div	Box 425 Carlin, NV 89822	do	Eureka.
Lead:			
Gold Creek Silver Mines, Inc.[5]	Mountain City Highway Elko, NV 89801	Surface mine	Elko.
Lime:			
Genstar Cement & Lime Co.[6]	107 Water St., Suite C Henderson, NV 89015	Surface mine and plant.	Clark.
Sierra Chemical Co	Box 67 Pioche, NV 89043	do	Lincoln.
Lithium:			
Foote Mineral Co	Silverpeak, NV 89047	Dry lake brines and plant.	Esmeralda
Magnesite:			
Basic Incorporated	Box 177 Gabbs, NV 89409	Surface mine and mill	Nye.
Mercury:			
Placer Amex, Inc., McDermitt JV	Box 497 McDermitt, NV 89421	do	Humboldt.
Perlite:			
Delamar Perlite Co	Box 217 Pioche, NV 89043	Underground mine	Lincoln.
United States Gypsum Co.[7]	Empire, NV 89405	Mine and mill	Pershing.
Salt:			
Leslie Hulk Salt Co	895 Harringan Rd. Fallon, NV 89406	Solar evaporation plant.	Churchill.
Sand and gravel (industrial):			
Simplot Silica Products	Box 308 Overton, NV 89040	Pits and mills	Clark.
Silver:			
Candelaria Partners[8]	Box 1246 Hawthorne, NV 89415	Surface mine	Mineral.
Silver King Mines, Inc.[8]	Box 324 East Ely, NV 89315	Surface mine and mill	White Pine.
Westcoast Oil & Gas Corp.[8]	Box 2267 Sparks, NV 89431	Underground mine and mill.	Storey.

See footnotes at end of table.

Table 9.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Titanium:			
Titanium Metals Corp. of America, Timet Div.	Box 2128 Henderson, NV 89015	Plant	Clark.
Tungsten:			
Union Carbide Corp., Metals Div	Box 307 Alamo, NV 89001	Underground mine and mill.	Lincoln.

[1]Also clays and stone.
[2]Also gold and silver.
[3]Also silver.
[4]Also mercury.
[5]Also gold, silver, and zinc.
[6]Also stone.
[7]Also gypsum.
[8]Also gold.

The Mineral Industry of New Hampshire

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the New Hampshire Department of Resources and Economic Development for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.[1] and Robert I. Davis[2]

The value of nonfuel mineral production in New Hampshire in 1981 was $25.5 million, about the same as in 1980. Sand and gravel and stone were the leading commodities produced and accounted for over four-fifths of New Hampshire's value of production. The State continued to rank fourth in the United States in dimension stone output.

Table 1.—Nonfuel mineral production in New Hampshire[1]

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Sand and gravel	thousand short tons	6,334	$15,837	[p]5,800	[p]$15,900
Stone:					
Crushed	do.	590	2,281	665	2,599
Dimension	do.	103	7,167	89	6,889
Combined value of other nonmetals		XX	121	XX	122
Total		XX	25,406	XX	25,510

[p]Preliminary. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of nonfuel mineral production in New Hampshire, by county

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Belknap	$977	$589	Sand and gravel.
Carroll	2,279	2,420	Do.
Cheshire	1,249	1,042	Do.
Coos	1,435	582	Do.
Grafton	W	W	Sand and gravel, stone.
Hillsborough	8,363	W	Stone, sand and gravel.
Merrimack	W	5,182	Sand and gravel, stone.
Rockingham	W	W	Do.
Strafford	W	W	Sand and gravel, clays.
Sullivan	595	991	Sand and gravel.
Undistributed[1]	8,361	14,597	
Total[2]	23,258	25,406	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Includes gem stones, some sand and gravel (1980) that cannot be assigned to specific counties, and values indicated by symbol W.
[2]Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of New Hampshire business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	468.2	471.4	+0.7
Unemployment	do	23.4	25.5	+9.0
Employment and labor force, annual average:				
Mining	do	(1)	(1)	--
Manufacturing	do	116.6	116.4	-.2
Contract construction	do	[2]19.8	[2]20.5	+3.5
Transportation and public utilities	do	14.0	14.4	+2.8
Wholesale and retail trade	do	85.5	89.2	+4.3
Finance, insurance, real estate	do	19.8	20.6	+4.0
Services	do	72.4	76.6	+5.8
Government	do	57.3	56.5	-1.4
Total nonagricultural employment	do	385.4	394.2	+2.3
Personal income:				
Total	millions	$8,414	$9,424	+12.0
Per capita		$9,119	$10,073	+10.5
Construction activity:				
Number of private and public residential units authorized		5,278	4,293	-18.7
Value of nonresidential construction	millions	$87.1	$87.9	+.9
Value of State road contract awards	do	$44.0	$58.1	+32.0
Shipments of portland and masonry cement to and within the State	thousand short tons	231	252	+9.1
Nonfuel mineral production value:				
Total crude mineral value	millions	$25.4	$25.5	+.4
Value per capita, resident population		$28	$28	--
Value per square mile		$2,731	$2,742	+.4

[p]Preliminary.
[1]Included with "Contract construction."
[2]Includes mining.

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

Legislation and Government Programs.—New Hampshire continued cooperative agreements, through the Office of the State Geologist, with two U.S. Department of the Interior agencies, the Bureau of Mines and the Geological Survey. Through these agreements, information on the minerals and geology of the State was collected and published. During the year, fieldwork was completed on the mineral potential of proposed wilderness areas in the White Mountains; structural and stratigraphic mapping of the Mahoosuc Range continued.

Among other activities, the Office of the State Geologist served as a source of information for mining companies considering exploration programs and State agencies involved in land use planning and resource management. State budget limitations, however, forced a 50% reduction in funding for the Office in 1981.

The U.S. Department of Energy (DOE)

decided against a proposed $80 million venture to develop a geothermal energy system from the Conway granite. The project was to have included geothermal wells drilled in the granite, a pumping station, and an energy extraction plant. DOE officials determined that the granite lacked sufficient energy potential considering the project's overall cost.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Clays.—Kane-Gonic Brick Corp. was New Hampshire's only clay producer again in 1981. The company was one of nine operations in the six-State New England region mining common clay for brick manufacture. Most of the brick produced in the region was shipped to the Boston, Mass., market areas. A bricklayers' strike in Boston from May through July temporarily affected business, but after the strike was settled, sales increased and were similar to those of 1980.

About 80% of the brick manufactured by Kane-Gonic was shipped to the Boston area. The firm's facilities are approximately 65 miles from Boston; the other eight brick companies in New England are located from 20 to 120 miles from the city.

During the year, Kane-Gonic continued work on a project to construct a synthetic gas plant. Fuel to fire the company's beehive kilns costs hundreds of thousands of dollars annually. The process to produce the synthetic gas involves heating hydrocarbon waste materials to generate methane and byproduct charcoal.

Gypsum.—National Gypsum Co. imported gypsum from the company's mines in Nova Scotia, Canada, for the manufacture of gypsum wallboard. The material, received through the Port of Portsmouth, is unloaded and transported by conveyor to a stockpile area near the plant. From the stockpile, the crude gypsum is crushed and conveyed to a rotary mill and pulverized. The company's patented calcining process produces stucco to which water is added forming a slurry. The slurry is discharged onto paper and naturally sealed. The material, in board form, is cut into 4- by 8-foot, 4- by 12-foot, and 4- by 16-foot sheets and packaged for shipment. The wallboard manufacturing process takes approximately 1 hour.

Mica.—The Essex Group (Macallen Operations) at Newmarket and Concord Mica Corp. at Penacook manufactured mica products. Both companies imported crude mica, primarily from India, through ports in Boston and New York. Mica was last mined in New Hampshire in 1970.

Sand and Gravel.—The U.S. Bureau of Mines, to reduce reporting burden and costs, implemented new sand and gravel canvassing procedures for the survey of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel operators will be conducted for even numbered years only. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production. The preliminary estimates for production of construction sand and gravel for odd numbered years will be revised and finalized the following year.

Output of sand and gravel in 1981 (based on preliminary data) dropped 534,000 tons compared with that of 1980. In the last 2 years, production declined from 7.1 million (1979) to 5.8 million (1981) tons. During that 2-year period, the average value of sand and gravel in New Hampshire increased from $2.16 to $2.75 per ton, the highest increase among the six New England States.

During the year, Alpine Aggregates purchased a 45-acre parcel in Conway, Carroll County, which previously had been mined, and resumed mining operations on an 8-acre site. In August, town selectmen, claiming violation of wetland, floodplain, and zoning ordinances, unsuccessfully sought a court injunction to halt mining. Subsequently, a compromise was negotiated between the company and town officials. Alpine Aggregates, wishing to avoid further court battles, reluctantly agreed to pay the town $5,000 for previously incurred expenses. Town officials agreed to withdraw plans to seek another injunction allowing the company to mine according to a schedule that calls for completion of all excavation and restoration by December 31, 1989.

Also in 1981, McKay & Wright Sand & Gravel and Ryder Concrete Co. merged, forming Granite State Concrete Co., Inc. McKay & Wright has been one of New Hampshire's leading sand and gravel producers. The new company is located in Milford, Hillsborough County, in the south-central part of the State.

Table 4.—New Hampshire: Construction sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Sand	3,143	$6,995	$2.23	NA	NA	NA
Gravel	3,192	8,842	2.77	NA	NA	NA
Total or average	[1]6,334	15,837	2.50	[p]5,800	[p]$15,900	[p]$2.75

[p]Preliminary. NA Not available.
[1]Data do not add to total shown because of independent rounding.

Stone.—The "Granite State" ranked 4th among the 38 States that produced dimension stone, but 47th among 48 States that extracted crushed stone. New Hampshire was one of only four States with dimension stone output that exceeded 85,000 tons (1,050,200 cubic feet).

Production of crushed stone increased 75,000 tons over that of 1980 and unit value remained about the same. Dimension stone output decreased about 14,000 tons with unit value increasing about 11% over that of 1980.

Stone was quarried in 5 of the State's 10 counties with Merrimack leading in output followed by Grafton and Rockingham Counties. Two types of stone were mined, traprock and granite. Traprock was extracted exclusively for crushed stone, while granite was mined for both crushed and dimension stone. Traprock quarries were located in Cheshire, Grafton, Merrimack, and Rockingham Counties, and granite operations were in Cheshire (crushed), Grafton (crushed), Hillsborough (dimension), and Merrimack (dimension) Counties.

[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]State geologist, New Hampshire Department of Resources and Economic Development, Durham, N.H.

Table 5.—New Hampshire: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Concrete aggregate (coarse)	116	460	126	514
Bituminous aggregate	173	817	162	718
Dense-graded road base stone	104	130	122	158
Other construction aggregate and road stone	166	793	208	1,069
Riprap and jetty stone	11	25	10	20
Other[2]	20	55	37	120
Total	590	[3]2,281	665	2,599

[1]Includes granite and traprock.
[2]Includes stone used in surface treatment aggregate, filter stone (1981), manufactured fine aggregate (stone sand), and other uses not specified (1980).
[3]Data do not add to total shown because of independent rounding.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
Kane-Gonic Brick Corp	Gonic, NH 03867	Pit	Strafford.
Gypsum (calcined):			
National Gypsum Co	4100 1st International Bldg. Dallas, TX 75270	Plant	Rockingham.
Sand and gravel:			
J. J. Cronin Co	Box 176 North Reading, MA 02368	Pit	Hillsborough.
Granite State Concrete Co., Inc	Box 185 Milford, NH 03055	Pit	Do.
Hudson Sand & Gravel Co	85 Greeley St. Hudson, NH 03051	Pit	Do.
James Pike Sand Co	Packers Falls Rd. Durham, NH 03824	Pit	Strafford.
F. W. Whitcomb Construction Corp	Box 429 Bellows Falls, VT 05101	Pit	Cheshire.
Stone:			
Boston S&G Cook Concrete Co	Hookset, NH 03106	Quarry	Merrimack.
Iafolla Industries, Inc	Peverly Hill Rd. Portsmouth, NH 03801	do	Rockingham.
Kitledge Granite Corp	Armory Rd. Milford, NH 03055	do	Hillsborough.
Lebanon Crushed Stone Inc	Plainfield Rd. West Lebanon, NH 03784	do	Grafton.

The Mineral Industry of New Jersey

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Geological Survey, Division of Water Resources, New Jersey Department of Environmental Protection, for collecting information on all nonfuel minerals.

By William Kebblish[1] and Robert J. Tuchman[2]

The value of nonfuel mineral production in New Jersey dropped to $142 million in 1981, which was $7.4 million below that of 1980 and $9.7 million below that of 1979, the record year. Nationally, New Jersey ranked 37th in value of total nonfuel mineral output and led in production of expanded perlite and ilmenite concentrate. The State ranked third in the production of industrial sand and fourth in magnesium compounds; it was the only State in which greensand was produced. In terms of value, leading mineral commodities were stone, sand and gravel, and zinc, accounting for more than 84% of New Jersey's total nonfuel mineral production value.

Table 1.—Nonfuel mineral production in New Jersey[1]

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	thousand short tons	63	$525	62	$563
Gem stones		NA	1	NA	1
Peat	thousand short tons	20	564	26	1,476
Sand and gravel	do	8,596	45,535	p8,105	p45,838
Stone, crushed[2]	do	11,830	61,886	10,434	57,819
Zinc (recoverable content of ores, etc.)	metric tons	28,859	23,814	16,198	15,911
Combined value of iron ore (1981), magnesium compounds, marl (greensand), stone (dimension), and titanium concentrate (ilmenite)		XX	17,123	XX	20,404
Total		XX	149,448	XX	142,012

pPreliminary. NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes dimension stone; value included with "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Atlantic	$714	$626	Sand and gravel.
Bergen	W	750	Do.
Burlington	706	25	Do.
Camden	2,381	3,121	Do.
Cape May	W	W	Magnesium compounds, sand and gravel.
Cumberland	W	W	Sand and gravel, clays.
Essex	W	W	Stone.
Gloucester	W	W	Greensand marl, sand and gravel.
Hudson	W	147	Stone.
Hunterdon	W	W	Do.
Mercer	W	W	Do.
Middlesex	W	W	Sand and gravel, clays.
Monmouth	590	527	Sand and gravel.
Morris	6,218	W	Sand and gravel, stone.
Ocean	W	W	Ilmenite, sand and gravel.
Passaic	7,826	W	Stone, sand and gravel, peat.
Somerset	26,325	26,749	Stone, clays.
Sussex	40,680	W	Zinc, stone, sand and gravel, peat.
Warren	W	W	Sand and gravel, peat.
Undistributed[2]	66,248	117,505	
Total[3]	151,689	149,448	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Salem and Union Counties are not listed because no nonfuel mineral production was reported.
[2]Includes gem stones and values indicated by symbol W.
[3]Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of New Jersey business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	3,585.0	3,515.6	-1.9
Unemployment	do	268.0	257.8	-3.8
Employment (nonagricultural):				
Mining	do	2.4	2.4	--
Manufacturing	do	780.9	771.0	-1.3
Contract construction	do	111.2	109.2	-1.8
Transportation and public utilities	do	193.4	192.5	-.5
Wholesale and retail trade	do	680.4	690.1	+1.4
Finance, insurance, real estate	do	158.1	161.4	+2.1
Services	do	602.8	635.2	+5.4
Government	do	528.8	524.2	-.9
Total nonagricultural employment	do	3,058.0	[1]3,085.9	+.9
Personal income:				
Total	millions	$80,799	$89,694	+11.0
Per capita		$10,935	$12,115	+10.8
Construction activity:				
Number of private and public residential units authorized		22,370	23,432	+4.7
Value of nonresidential construction	millions	$837.9	$915.5	+9.3
Value of State road contract awards	do	$128.3	$190.0	+48.1
Shipments of portland and masonry cement to and within the State	thousand short tons	1,543	1,324	-14.2
Nonfuel mineral production value:				
Total crude mineral value	millions	$149.4	$142.0	-5.0
Value per capita, resident population		$20	$19	-5.0
Value per square mile		$19,072	$18,123	-5.0

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

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

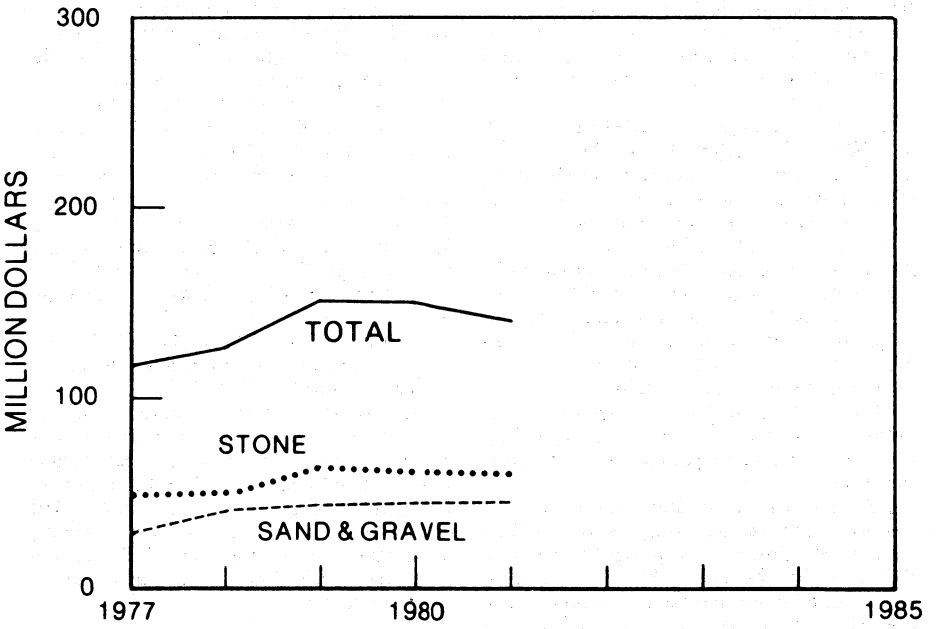

Figure 1.—Value of sand and gravel and stone, and total value of nonfuel mineral production in New Jersey.

Trends and Developments.—On January 16, 1981, the Secretary of the Interior approved the Comprehensive Management Plan for the Pinelands National Reserve. The reserve was established by the U.S. Congress in 1978 to protect approximately 1 million acres, or 20% of New Jersey's total land area, in Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, and Ocean Counties. The plan provides an overall framework for future growth in the region and protection of its natural resources. It divides the reserve into an inner Preservation Area, where development is limited, and a surrounding Protection Area, where development controls are less strict. Under the plan's Resource Extraction Program, municipalities shall incorporate within their ordinances provisions for registration, operation, reclamation, and safety of resource extraction sites.

Johnson Matthey & Co., a London-based precious metals company, planned to construct a $35 million chemical plant in West Deptford Township, near Camden. The plant is to recover precious metals, such as platinum, gold, and rhodium, from industrial scrap and refine chemical compounds containing precious metals.

To improve skid resistance on certain New Jersey roads, the State Department of Transportation began using two types of high-friction overlays—one consisting of 85% stone and 15% sand and the other composed of crushed gravel with a low carbonate rock content. The new overlays permit faster drainage, thereby reducing hazardously wet conditions.

Legislation and Government Programs.—Several laws impacting on New Jersey's mineral industry were enacted during 1981.

Chapter 89 appropriates monies for State projects and State matching grants to local governments for beach restoration, maintenance, and protection programs.

Chapter 96 establishes regulations for buying and selling precious metals.

Chapter 130 prohibits uranium exploration, mining, and milling for a 7-year period. After 6 years, a study by the State Department of Environmental Protection (DEP) will be conducted to determine further action.

Chapter 279 establishes a State Hazardous Waste Facilities Siting Commission. Local disposal sites approved by the commission could reduce metal platers' and finishers' waste transportation costs.

Chapter 293 established a Water Supply Authority to protect the State against future water shortages. In early 1981, water was pumped from the abandoned Mount Hope iron ore mine, north of Dover in Morris County, to nearby Boonton Reservoir to alleviate drought conditions.

Chapter 306 provides a supplement to the Solid Waste Management Act regarding taxation to insure proper closure of sanitary landfills.

DEP devised a $3 million master plan for restoration of beaches using gravel trucked from local mining sites to Strathmere and Sea Isle City beaches. Wind-driven tides have caused excessive beach erosion at the two Cape May County municipalities located south of Atlantic City.

The New Jersey Geological Survey conducted a number of mineral-related projects during 1981. Mapping continued on the Hamburg Quadrangle, Sussex County; the Waterloo Valley near Hackettstown, Warren County; and the Gladstone Quadrangle, Somerset County. The State Survey also evaluated uranium-thorium occurrences and asbestiform minerals in northern New Jersey. Other studies pertained to the Woodbury clay formation in southwestern New Jersey, the State's changing shorelines, and hydrogeochemistry of the Pinelands.

During fiscal year 1981, the U.S. Bureau of Mines awarded 13 contracts and grants totaling about $530,000 to 11 New Jersey organizations to study mineral resources and develop improved mine health and safety methods. Included in the studies were evaluations conducted by Ingersoll-Rand Research, Inc., on a remote drill-bolting system for metal and nonmetal mines and Stevens Institute of Technology on second-generation stability indicators for front-end loaders.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Clays.—Clay production in New Jersey in 1981 totaled 62,000 tons valued at $563,000. This represents a slight decrease in quantity but a 7% increase in value compared with those of 1980. Producers were New Jersey Shale Brick & Tile Corp. (common clay), Almasi Clay Co. (common and fire clays), and Jessie S. Morie & Son, Inc. (fire clay). Common clay was used for face brick and sewer pipe; fire clay, for firebrick and block, cement, refractory mortar, and sealing.

Gem Stones.—Value of gem stones and mineral specimens collected by mineral dealers and amateur collectors in New Jersey was estimated at $1,000 in 1981. Collection sites included abandoned quarries in northern New Jersey, as well as the Cape May area, where quartz crystals were collected.

Graphite (Synthetic).—New Jersey was 1 of 15 States in which synthetic graphite was produced in 1981. The State's only producer, Celanese Research Co., a subsidiary of Celanese Corp., produced high-modulus, synthetic graphite fiber at its plant in Summit, Union County. The fiber was used for lightweight, high-strength products, such as airplane and automobile components.

Greensand.—Inversand Co., a subsidiary of Hungerford & Terry, Inc., near Clayton, Gloucester County, was the only producer of greensand in the United States in 1981. Deposits of greensand, or glauconite, are found from Sandy Hook south to Delaware Bay near Salem. One newspaper reported that approximately 10,000 tons is mined from the company pit annually.[3] Greensand was sold for use mainly as a water purifier and as fertilizer.

Gypsum (Calcined).—Crude gypsum, imported from out of State, was calcined by National Gypsum Co., Burlington County, and Genstar Building Materials, formerly known as the Flintkote Co., Camden County. Production increased about 4% in quantity and 15% in value from 1980 to 1981. Calcined gypsum was used mainly in the manufacture of wallboard and sheeting.

Late in the year, United States Gypsum Co. purchased the idle Kaiser Gypsum Co. plant at Delanco, Burlington County. The plant will be used to supply local housing construction needs.

Iodine.—Crude iodine was shipped into New Jersey and used by eight chemical and pharmaceutical companies to manufacture various iodine-containing compounds. Iodine compounds produced were used as catalysts, food supplements, stabilizers, in inks and colorants, in pharmaceuticals, and for sanitary purposes. Leading producers of iodine compounds were J. T. Baker Chemical Co., Warren County; Cooper Chemical Co., Morris County; GAF Corp., Union County; and Troy Chemical Corp., Essex County.

Magnesium Compounds.—New Jersey ranked fourth of seven States in the production of magnesium compounds in 1981. Harbison-Walker Refractories Co., the only producer in the State, extracted magnesium compounds from seawater in Cape May County in southern New Jersey. From 1980 to 1981, production remained essentially the same, but value increased more than 9% owing to an increase in unit price. Magnesium compounds were used mainly in refractories, fertilizers, and pharmaceuticals.

Peat.—Peat sales in New Jersey in 1981 totaled 26,000 tons valued at nearly $1.5 million. Quantity increased 30% and value more than doubled compared with those of 1980. Peat was produced at five plants in two counties and sold in bulk and packaged form. Types of peat produced were reed-sedge and humus. Peat was used for soil improvement and as an ingredient in potting soil.

Perlite (Expanded).—Grefco, Inc., Jamesburg, and The Schundler Co., Edison, both in Middlesex County, expanded crude perlite imported from out-of-State sources. Expanded perlite was used in roof insulation, plaster, masonry products, and as a soil conditioner.

Quartz Crystal.—James M. Ronan Associates, Inc., Wayside, Monmouth County, used cultured quartz crystal during 1981. Major use was in the manufacture of electronic products.

Sand and Gravel.—In late 1980, the U.S. Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but complete data on industrial sand and gravel. Estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Production of construction sand and gravel in New Jersey was estimated to total 5.8 million tons valued at $19.4 million in 1981. In 1980, Morris County led in production, followed by Camden, Ocean, and Cape May Counties. Principal producers were New Jersey Pulverizing Co., Ocean County, and Saxon Falls Sand & Gravel Co., Inc., Morris County. Construction sand and gravel was used mainly for concrete aggregate.

Table 4.—New Jersey: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	4,064	$11,705	$2.88	NA	NA	NA
Gravel	1,765	6,873	3.89	NA	NA	NA
Total or average	5,829	18,578	3.19	[p]5,800	[p]$19,400	[p]$3.34
Industrial sand	2,766	26,957	9.75	2,305	26,438	11.47
Grand total or average	[1]8,596	45,535	5.30	[p]8,105	[p]45,838	[p]5.66

[p]Preliminary. NA Not available.
[1]Data do not add to total shown because of independent rounding.

New Jersey ranked third, behind Illinois and Michigan, in industrial sand production in 1981, with production amounting to 2.3 million tons valued at $26.4 million. Industrial sand was mined at 20 operations by 7 companies in 5 of New Jersey's 21 counties. Cumberland County, in the southern part of the State, was the leading producing county, accounting for nearly 86% of the State's total output. Principal uses of industrial sand were in the manufacture of glass products, foundry molds and cores, refractories, and in sandblasting and filtration.

Stone.—Crushed stone production in New Jersey in 1981 totaled 10.4 million tons valued at $57.8 million, reflecting decreases in both output and value compared with those of 1980. Crushed stone was produced in eight counties, all in the northern part of the State. Leading producing counties were Passaic, Somerset, and Sussex; these three counties accounted for more than 75% of New Jersey's total crushed stone output. Most of the stone was transported to market by truck. Major uses of crushed stone were for concrete aggregate, road base, and bituminous aggregate.

Dimension sandstone was produced by Delaware Quarries, Hunterdon County, in western New Jersey, and the output was sold for use as cut stone.

Table 5.—New Jersey: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Poultry grit and mineral food	20	403	W	W
Concrete aggregate	2,402	11,854	2,021	10,826
Bituminous aggregate	2,272	13,072	2,077	11,510
Macadam aggregate	579	2,885	410	2,068
Dense-graded road base stone	2,277	10,332	2,305	10,822
Surface-treatment aggregate	274	1,295	154	771
Other construction aggregate and road stone	2,972	14,076	2,300	11,816
Riprap and jetty stone	223	1,097	152	792
Railroad ballast	71	331	W	W
Filter stone	10	56	W	W
Manufactured fine aggregate (stone sand)	110	651	113	738
Terrazzo and exposed aggregate	37	768	W	W
Asphalt filler	48	371	276	2,240
Other[2]	533	4,697	625	6,235
Total[3]	11,830	61,886	10,434	57,819

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, granite, and traprock.
[2]Includes stone used for agricultural limestone, flux stone, abrasives (1981), whiting or whiting substitute (1981), other filler, acid neutralization, roofing granules, other uses not specified, and uses indicated by symbol W.
[3]Data may not add to totals shown because of independent rounding.

Sulfur.—Sulfur was recovered as a by-product at four oil-refining operations. From 1980 to 1981, shipments continued to remain at about 120,000 metric tons, but value increased 86% to $13.6 million. Gloucester County had two refineries; Middlesex and Union Counties, one each. Sulfur was used in the manufacture of sulfuric acid, fertilizers, plastics, and other products.

Talc.—Talc, mined in other States, was shipped into New Jersey and processed by Amoco Minerals Co. at a plant in South Plainfield, Middlesex County. Talc was used mainly in the production of ceramics.

Vermiculite.—Crude vermiculite was shipped into New Jersey and exfoliated by W. R. Grace & Co., Trenton, Mercer County, and The Schundler Co., Edison, Middlesex County. Both output and value declined from 1980 to 1981. The product was used for agricultural purposes, loose fill insulation, fireproofing, and lightweight aggregate.

METALS

Copper.—Triangle PWC, Inc., closed its hot-rolled copper rod mill at New Brunswick, Middlesex County, in late 1981, with plans to purchase copper rod from other sources. The company, which employs approximately 1,500 workers, produced wire cable, conduit copper, and noncurrent-carrying wire devices.

Phelps Dodge Corp. also closed its hot-rolled copper mill at Bayway, Union County. The company's new plant in Connecticut will supply copper rod to the Bayway plant, while other facilities at the mill remain open.

The AMAX Inc. United States Metals Refining Co. at Carteret, Middlesex County,

announced suspension of copper powder production. The company produced about 7,000 tons of copper powder annually, or about 18% of the national output. Two copper powder producers remain in the State: United States Bronze Powder, Inc., at Flemington, Hunterdon County, and Alcan Ingot & Powders, at Elizabeth, Union County.

Ferroalloys.—Shipments of ferroalloys in New Jersey increased in quantity but decreased in value from 1980 to 1981. Shieldalloy Corp., Newfield, Gloucester County, a subsidiary of Metallurg, Inc., produced ferroalloys of columbium, titanium, and vanadium. Ferroalloys were used in the manufacture of cast iron products, automobile parts, tool steel, and other products.

Iron Ore.—In 1981, Mount Hope Mining Co., which terminated underground mining operations in 1978, shipped from inventory 31,447 long tons of iron ore concentrates valued at about $786,000. The mine had been closed owing to competition from surface iron ore producers and foreign imports, coupled with a declining market for steel products.

Iron Oxide Pigments.—Production of finished iron oxide pigments in New Jersey in 1981 totaled 7,820 tons valued at nearly $7.6 million, representing a decrease in both quantity and value compared with those of 1980. Producers were Combustion Engineering, Inc., CE Minerals Div., Camden County; E. I. du Pont de Nemours & Co., Inc., Essex County; and Columbian Chemicals Co., Mercer and Middlesex Counties. Iron oxide pigments were used mainly in paint manufacture.

Iron and Steel.—Although no pig iron production was reported in New Jersey in 1981, small minimills used scrap iron to produce various steel products.

The Roebling Steel Corp., Roebling, Burlington County, operated two 45-ton electric furnaces using scrap metal during the year and planned to install a continuous caster if the economy improves.

New Jersey Steel Corp., Sayreville, Middlesex County, resumed steelmaking and casting operations after a 15-month shutdown. Two electric furnaces provided steel for the fabricating division.

Ingersoll-Rand Co. closed its gray iron foundry at Phillipsburg, Warren County. Opened in 1903, the foundry produced cast iron impellers for the company's pump division.

Selenium and Tellurium.—During 1981, New Jersey was one of three States in which selenium was produced and one of two States in which tellurium was produced. AMAX Copper, Inc., recovered selenium and tellurium as byproducts at its electrolytic copper refinery in Carteret. Selenium was sold for use in photocopier components, glass manufacturing, and chemicals and pigments; tellurium, for iron and steel products, nonferrous metals, chemicals, and rubber manufacturing.

Titanium.—Ilmenite was mined during the year by ASARCO Incorporated, Lakehurst, Ocean County. Titanium dioxide pigments were produced by NL Industries, Inc., Sayreville, Middlesex County, and Gulf + Western Natural Resources Group (G+W), Chemicals Div., Gloucester City, Camden County, and used in the manufacture of paints, paper, rubber, and plastic products.

Late in the year, Asarco announced it will cease dredging operations at its ilmenite mine in March 1982. Output from the mine has been sold exclusively to Du Pont. Under a settlement agreement with Asarco, Du Pont will terminate its purchase contract a year early owing to a national oversupply situation. The mine was opened in 1973, with production reaching 187,000 tons in 1981.[4]

G+W signed a consent order with DEP to treat waste water discharge from its plant in Gloucester City. Company officials estimated spending $34 million over the next 5 years on the project.

Zinc.—New Jersey ranked seventh of 16 States in zinc production in 1981. Output amounted to about 16,200 metric tons valued at $15.9 million, representing a significant decrease in both quantity and value from 1980 figures. In the latter part of 1981, G+W, the only producer in the State, sold its Sterling zinc mine at Ogdensburg, Sussex County, to a group of private investors formed up as The New Jersey Zinc Co., Inc.; the sale also included operations in Pennsylvania and Illinois. Zinc was used mainly for galvanizing, brass products, and zinc-base alloys.

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[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]Liaison program assistant, Bureau of Mines, Pittsburgh, Pa.
[3]Conlow, P. In the Good Earth of New Jersey Lie Beds of Marl, Layers of Greensand. Philadelphia Inquirer, Feb. 14, 1982, pp. 10-11-J.
[4]ASARCO Incorporated. 1981 Annual Report, p. 12.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
Almasi Clay Co	Metuchen Ave. Woodbridge, NJ 07095	Pit	Middlesex.
Jessie S. Morie & Son, Inc.[1]	1201 North High St., Millville, NJ 08322	Pit	Cumberland.
New Jersey Shale Brick & Tile Corp	Box 490 Somerville, NJ 08876	Plant	Somerset.
Greensand:			
Inversand Co., a subsidiary of Hungerford & Terry, Inc.	226 Atlantic Ave. Clayton, NJ 08312	Pit	Gloucester.
Gypsum, calcined:			
National Gypsum Co	4100 1st International Bldg. Dallas, TX 75270	Plant	Burlington.
Ilmenite:			
ASARCO Incorporated	Route 70, Mile 41 Lakehurst, NJ 08733	Dredge and plant.	Ocean.
Iron oxide pigments:			
Columbian Chemicals Co	Box 37 Tulsa, OK 74102	Plants	Mercer and Middlesex.
Combustion Engineering, Inc., CE Minerals Div.	901 East 8th Ave. King of Prussia, PA 19406	Plant	Camden.
E. I. du Pont de Nemours & Co., Inc	Pigments Dept. Wilmington, DE 19898	do	Essex.
Magnesium compounds:			
Harbison-Walker Refractories Co	2 Gateway Center Pittsburgh, PA 15222	do	Cape May.
Peat:			
Hyper-Humus Co	Lafayette Rd., Box 267 Newton, NJ 07860	Bog	Sussex.
Kelsey Humus Co	Kelsey Park Great Meadows, NJ 07838	Bog	Warren.
Mount Bethel Humus Co., Inc	315 West 57th St. New York, NY 10019	Bog	Sussex.
Netcong Natural Products	738 Route 10 Randolph, NJ 07801	Bog	Do.
Perlite, expanded:			
Grefco, Inc	3450 Wilshire Blvd. Los Angeles, CA 90010	Plant	Middlesex.
The Schundler Co.[2]	Box 251 Metuchen, NJ 08840	do	Do.
Sand and gravel:			
Construction:			
New Jersey Pulverizing Co	115 Hickory Lane Bayville, NJ 08721	Pit	Ocean.
Saxon Falls Sand & Gravel Co., Inc	R.D. 3 Stanhope, NJ 07874	Pit	Morris.
Industrial:			
New Jersey Silica Sand Co	Millville, NJ 08332	Dredge	Cumberland.
Pennsylvania Glass Sand Corp	Berkeley Springs, WV 25411	Pit	Do.
Whitehead Bros. Co	60 Hanover Rd. Florham Park, NJ 07932	Pit and dredge.	Do.
Stone:			
Granite, crushed and broken:			
Anthony Ferrante & Sons, Inc	Route 202, Mine Brook Rd. Bernardsville, NJ 07924	Quarry	Hunterdon.
Tri-County Asphalt Corp	Route 15 Hopatcong, NJ 07843	do	Sussex.
Traprock (basalt), crushed and broken:			
Stavola Construction Materials, Inc	Hamilton Rd. Red Bank, NJ 07701	do	Somerset.
Trap Rock Industries, Inc	Laurel Ave. Kingston, NJ 08528	Quarries	Hunterdon, Mercer, Somerset.
Union Building & Construction Corp	1111 Clifton Ave. Clifton, NJ 07013	Quarry	Passaic.
Sulfur:			
Chevron U.S.A., Inc	1200 State St. Perth Amboy, NJ 08861	Refinery	Middlesex.
Exxon Co., U.S.A	Box 23 Linden, NJ 07036	do	Union.
Mobil Oil Corp	Paulsboro, NJ 08066	do	Gloucester.
Texaco, Inc	Eagle Point, Box 52332 Houston, TX 77052	do	Do.
Vermiculite, exfoliated:			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plant	Mercer.

[1]Also industrial sand and gravel.
[2]Also exfoliated vermiculite.

The Mineral Industry of New Mexico

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the New Mexico Department of Energy and Minerals for collecting information on all nonfuel minerals.

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Total value of nonfuel minerals declined in 1981 to $695 million, from the record $766 million in 1980. Copper and potassium salts, again the State's two most valuable nonfuel minerals, accounted for 79% of the total value. Other leading minerals included gold, molybdenum, perlite, sand and gravel, and stone. New Mexico in 1981 was the Nation's leading producer of perlite and potassium salts, second in output of carbon dioxide and mica, and third in copper and manganiferous ores.

Table 1.—Nonfuel mineral production in New Mexico[1]

Mineral	1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2] thousand short tons	60	$114	64	$119
Copper (recoverable content of ores, etc.) metric tons	149,394	337,328	154,114	289,204
Gem stones	NA	150	NA	200
Gold (recoverable content of ores, etc.) troy ounces	r15,847	r9,707	65,749	30,221
Gypsum thousand short tons	182	1,688	166	2,256
Lead (recoverable content of ores, etc.) metric tons	--	--	W	W
Manganiferous ore (5% to 35% Mn) short tons	35,198	W	12,741	W
Peat thousand short tons	2	40	--	--
Perlite do.	539	14,404	489	14,983
Potassium salts thousand metric tons	1,869	289,011	1,601	261,200
Pumice thousand short tons	r84	r814	93	919
Sand and gravel do.	7,050	17,676	p7,300	p18,000
Silver thousand troy ounces	W	W	1,632	17,170
Stone:				
Crushed thousand short tons	r2,581	r9,473	4,162	12,485
Dimension do.	18	91	26	173
Combined value of barite (1980), carbon dioxide, cement, clays (fire clay), helium (high-purity), lime, mica (scrap), molybdenum, salt, vanadium, zinc, and values indicated by symbol W	XX	r85,113	XX	47,747
Total	XX	r765,609	XX	694,677

pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes fire clay; value included with "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Bernalillo	$26,660	$25,020	Cement, sand and gravel, stone, clays.
Catron	W	74	Stone.
Chaves	705	535	Sand and gravel.
Curry	W	W	Sand and gravel, stone.
De Baca	248	W	Sand and gravel.
Dona Ana	W	W	Sand and gravel, stone, clays.
Eddy	W	W	Potassium salts, salt, sand and gravel, stone.
Grant	r360,640	377,080	Copper, silver, gold, lime, manganiferous ore, stone, zinc.
Guadalupe	W	--	
Harding	W	W	Carbon dioxide.
Hidalgo	529	1,171	Stone, silver, gold, clays.
Lea	W	W	Potassium salts, sand and gravel, stone, salt.
Lincoln	W	W	Sand and gravel.
Luna	328	W	Sand and gravel, clays.
McKinley	W	W	Stone, molybdenum, sand and gravel.
Mora	3	--	
Otero	358	1,177	Sand and gravel, stone.
Quay	292	257	Sand and gravel.
Rio Arriba	W	W	Sand and gravel, pumice.
Roosevelt	33	--	
Sandoval	3,277	1,453	Gypsum, sand and gravel, stone, peat, pumice.
San Juan	W	4,889	Sand and gravel, vanadium, stone, helium, clays.
San Miguel	84	73	Sand and gravel.
Santa Fe	W	W	Sand and gravel, pumice, stone, gypsum.
Sierra	W	W	Sand and gravel, gold.
Socorro	W	2,215	Perlite, barite, sand and gravel, stone, pumice.
Taos	45,522	45,181	Molybdenum, perlite, stone, mica, sand and gravel.
Torrance	124	13	Stone.
Union	--	W	Do.
Valencia	W	W	Stone, sand and gravel, perlite.
Undistributed[2]	r251,107	306,473	
Total	r689,910	[3]765,609	

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]Colfax and Los Alamos Counties not listed because no nonfuel mineral production was reported.

[2]Includes some sand and gravel that cannot be assigned to specific counties, gem stones, and values indicated by symbol W.

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

Table 3.—Indicators of New Mexico business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	537.9	561.0	+4.3
Unemployment	do	40.8	39.0	-4.4
Employment (nonagricultural):				
Mining[1]	do	29.4	31.3	+6.5
Manufacturing	do	34.4	34.1	-.9
Contract construction	do	32.1	33.0	+2.8
Transportation and public utilities	do	28.3	29.0	+2.5
Wholesale and retail trade	do	103.4	106.6	+3.1
Finance, insurance, real estate	do	21.1	21.5	+1.9
Services	do	91.8	94.3	+2.7
Government	do	125.0	125.5	+.4
Total nonagricultural employment[1]	do	[2]465.4	475.3	+2.1
Personal income:				
Total	millions	$10,266	$11,491	+11.9
Per capita		$7,878	$8,654	+9.9
Construction activity:				
Number of private and public residential units authorized		8,665	7,935	-8.4
Value of nonresidential construction	millions	$250.4	$299.4	+19.6

See footnotes at end of table.

Table 3.—Indicators of New Mexico business activity —Continued

		1980	1981[p]	Change, percent
Construction activity —Continued				
Value of State road contract awards	millions	$78.0	$98.3	+26.0
Shipments of portland and masonry cement to and within the State	thousand short tons	611	672	+10.0
Nonfuel mineral production value:				
Total crude mineral value	millions	$765.6	$694.7	-9.3
Value per capita, resident population		$589	$534	-9.3
Value per square mile		$6,289	$5,710	-9.2

[p]Preliminary.
[1]Includes bituminous coal and oil and gas extraction.
[2]Data do not add to total shown because of independent rounding.

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

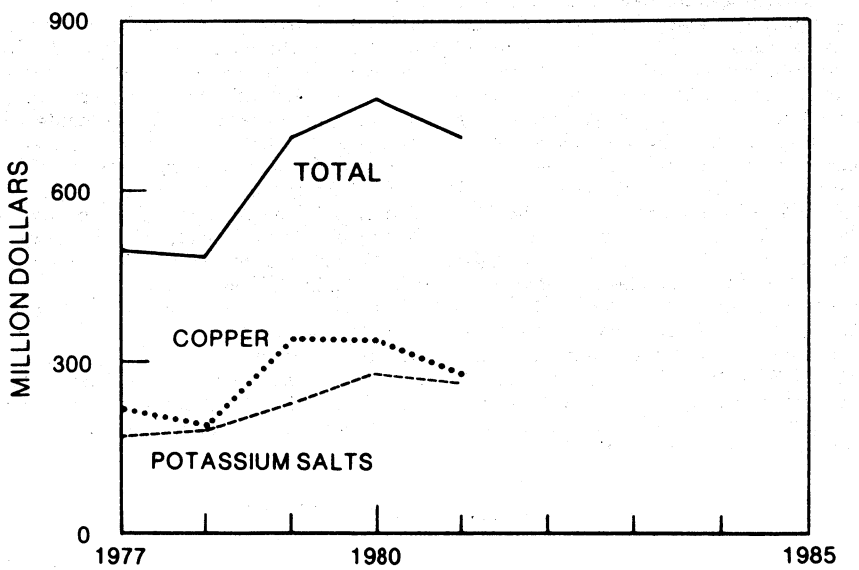

Figure 1.—Value of potassium salts, copper, and total value of nonfuel mineral production in New Mexico.

Metals accounted for 51% of nonfuel mineral value in 1981, down from 53% in 1980. Of the seven metals produced in New Mexico in 1980 and 1981, two increased in unit value in 1981 and five declined. Of the 13 nonmetals produced in both years, 9 rose in unit value and 4 fell. Quantity of minerals produced in both years closely paralleled unit value: Output of three metals was up and four down; output of eight nonmetals was up and five down.

Weak national markets were reflected in sharply curtailed output of potassium salts and molybdenum and a negligible increase in copper. For the second consecutive year, attributed largely to high interest rates, the in-State economy experienced reduced or nominal increases in construction-mineral

production. For example, sand and gravel was up only 3.5% in 1981, gypsum was off 8.8%, lime fell 23%, perlite was off 9.3%, and although cement output rose appreciably, cement stocks were up substantially at yearend.

Trends and Developments.—In a study, the New Mexico Energy and Minerals Department estimated that areas affected by mineral developments will need $175 million for community facilities through 1985. Carlsbad and the surrounding area will have to invest $36 million through 1985 to handle the estimated 5% increase in potash employment and the increase in employment from 65 in 1981 to an estimated 951 in 1984 at the Waste Isolation Pilot Plant (WIPP), a $1 billion nuclear repository under construction. (Direct employment in WIPP should stabilize at 440 in 1987.) To accommodate expected new copper facilities and expansion of established operations, the State foresees about $30 million in community investments in the southwest. Molybdenum developments in the Questa area are expected to require about $10 million in community needs. Direct employment in carbon dioxide production areas, estimated to increase from 161 in 1981 to a peak of 717 in 1983-84, will trigger a need for $3.6 million in community investments.

The New Mexico Bureau of Mines and the New Mexico Tech Geoscience Department on the campus of the New Mexico Institute of Mining & Technology acquired $250,000 worth of automatic mineral-analysis equipment. A DEC PDP-11 computer will control operations of a Rikaku X-ray fluorescence spectrometer and of a Rikaku X-ray diffractometer to provide quantitative analysis of major components of a rock sample in about 10 minutes.

Legislation and Government Programs.—During the 35th legislative session, no tax pertained specifically to the nonfuel minerals sector; however, general corporate tax relief (Senate Floor Substitute for Senate Bill 488, Chapter 176) set rates at 4% on net income under $1 million, 5% between $1 million and $2 million, and 6% over $2 million. House Bill 85, Chapter 177, amended the Investment Tax Credit Act by repealing Section 7-9A-10 NMSA 1978, under which the act would have terminated on January 1, 1982.

The Federal Bureau of Land Management (BLM) transferred $128 million to New Mexico in fiscal year 1981. BLM made payments biannually—$56 million at midyear and $72 million at yearend. These payments represented New Mexico's share of Federal revenues collected for mineral leases on public lands in the State during the year. The State receives 50% of bonuses, rentals, and royalties collected from mineral leasing on Federal lands; the funds are for any public purpose the State may prefer, with priority to areas adversely affected by mineral output on Federal lands. Higher payments to New Mexico in 1981 reflect the increased prices of crude oil and natural gas. New Mexico topped the 23 States that received mineral lease revenues in 1981.

The U.S. Bureau of Mines and U.S. Geological Survey continued investigating mineral resources in the following proposed wilderness areas: Columbine-Hondo, Hell Hole, Lower San Francisco, Manzano, Ryan Hill, Sacramento Mountains, and Sandia.

REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Copper.—Although copper output in New Mexico rose 3.2% in 1981, total value fell more than 14% as the average unit price decreased from $1.02 in 1980 to $0.85 in 1981. Copper demand eased markedly in the second half of the year. Producer stocks of the refined metal rose as demand from major construction and automobile markets dropped and showed no near-term sign of recovery toward yearend.

Surpassing the combined value of all other metal output, copper retained its leading position in the State. However, owing to the weakening markets by midyear, producers increasingly curtailed production through extended vacations, summer shutdowns, and layoffs. Sharon Steel Corp. began a series of layoffs in early March. The company reported a loss in 1981 from its copper operation. Phelps Dodge Corp. extended its normal 2-week summer shutdown to 3 weeks and imposed a 9-day furlough over the Christmas holidays. At the Kennecott Minerals Co. Chino operation, the firm announced at yearend that a cutback in production and layoffs were planned for early 1982.

A Kennecott-Mitsubishi Corp. partner-

ship (Chino Mines Co.) was formed in March. For its one-third interest, the Japanese firm invested an initial $116 million and will contribute one-third to the planned modernization of the Chino operation. Mitsubishi will receive one-third of Chino's production in return. A planned $350 million program will include a new concentrator near Santa Rita, a new slurry pipeline to move concentrates to the smelter, and certain smelter modifications. Bechtel Corp. was awarded the contract for designing and constructing the concentrator. The new facilities should allow Chino to increase copper production by 60% to 70% (to 110,000 short tons per year) and to lower costs by 20 to 30 cents per pound. Soon after the Kennecott-Mitsubishi agreement, Standard Oil Co. of Ohio bought Kennecott; stockholders quickly approved the $1.77 billion takeover, which became final in June.

Phelps Dodge planned to let a contract late in 1981 for constructing a new extraction plant at Tyrone; however, because of the depressed copper market, the project was postponed. The company also planned to expand its El Paso, Tex., refinery to recover all precious metals contained in Tyrone and other concentrates. Precious metal-bearing slimes from copper refining were shipped to another firm in New Jersey for processing. At midyear, Phelps Dodge completed the cleanup of a tailings spill along Mangus Creek that occurred in October 1980. About 1-1/2 feet of topsoil, mulch, and fertilizer, favored by heavier than normal rainfall, led to an excellent stand of grass by yearend.

Quintana Minerals Corp. of Tucson, Ariz., neared completion of its Copper Flat project at Gold Dust, 4 miles northeast of Hillsboro, Sierra County; M. M. Sundt of Tucson is the general contractor. Quintana is in partnership with Phibro Mineral Enterprises, Inc., of New York, a Philipps Bros. Div. of Englehard Minerals & Chemicals Corp. Copper and molybdenum concentrates will be produced from an open pit mine and adjacent concentrator. Copper Flat will be the easternmost porphyry-copper operation in the Nation. Quintana will operate the property, and Philipps Bros. will sell the concentrates. Annual output is expected to be 40 million pounds of copper, 1 million pounds of molybdenum, and small amounts of byproduct gold and silver. The 15,000-ton-per-day operation has reserves for 12 to 15 years.

In early 1981, Exxon Minerals Co. announced it was leaving the Pinos Altos property north of Silver City where the company had invested $11 million in exploration and development since 1971. The property has proven reserves of 7 million metric tons containing 2% copper and 3% zinc, plus minor amounts of gold and silver. The irregular deposit is 400 to 1,500 feet deep, about 2,500 feet long, and 1,000 feet wide. Geologic evidence suggests additional reserves beyond the limits of Exxon's property; however, the ore body apparently is not large enough to fit in with Exxon Mineral Co.'s objectives. At yearend, other firms had examined the property, and an operational arrangement with Exxon retaining a royalty interest was expected.

Conoco, Inc., was merged into E. I. du Pont de Nemours & Co., Inc., in August. The minerals division of Conoco has base metal and uranium holdings in New Mexico. Conoco has been conducting a drilling program at the Jones Hill prospect near Terrero in northwest San Miguel County; although work continued through yearend, there was no announcement of progress or results at the property.

The Anaconda Company was actively exploring in the Picuris district of Taos County. Santa Fe Industries, Inc., made initial investigations for a possible exploration program on Federal Resources Corp.'s Lordsburg properties.

Gold.—New Mexico was ranked fifth among the 13 gold-producing States in 1981; output was up more than fourfold. Although the price of gold was in a downtrend most of the year, total value of gold produced in the State more than tripled. The large increase in gold output was attributed to the initial production of the metal from Gold Fields Mining Corp.'s Ortiz Mine in the Ortiz Mountains, Santa Fe County. Gold Fields is a subsidiary of Consolidated Gold Fields, Ltd., of London. The mine is in the Old Placers (Ortiz-Dolores) mining district, site of New Mexico's first discovery of gold in 1828. Gold Fields annual report listed 27,035 ounces of gold from the Ortiz Mine, making it the largest producer in 1981 with 41% of the State's total gold. Other leading producers of lode gold included the Center, Continental, Summit, and Tyrone Mines in Grant County. Placer gold was recovered in Sierra County. A substantial quantity of gold was recovered as a byproduct from copper production.

Table 4.—New Mexico: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Mines producing		Material sold or treated (metric tons)	Gold		Silver	
	Lode	Placer		Troy ounces	Value	Troy ounces	Value
1979, total	9	1	24,640,160	r14,966	r$4,602,047	W	W
1980, total	r7	1	r22,239,228	r15,847	r9,707,239	W	W
1981:							
Grant	7	--	22,648,821	23,307	10,712,830	1,560,357	$16,412,412
Undistributed[1]	5	--	727,042	42,442	19,508,041	71,989	757,206
Total	12	--	[2]23,375,862	65,749	30,220,871	1,632,346	17,169,618

	Copper		Lead		Zinc		Total value
	Metric tons	Value	Metric tons	Value	Metric tons	Value	
1979, total	164,281	$336,934,074	43	$48,998	W	W	r$354,622,985
1980, total	149,394	337,328,102	--	--	W	W	r373,011,033
1981:							
Grant	154,077	289,134,593	W	W	W	W	316,467,112
Undistributed[1]	37	69,127	W	W	W	W	20,348,231
Total	154,114	289,203,720	W	W	W	W	336,815,343

rRevised. W Withheld to avoid disclosing company proprietary data.
[1]Includes Hidalgo, Luna, Santa Fe, and Socorro Counties, combined to avoid disclosing company proprietary data.
[2]Data do not add to total shown because of independent rounding.

Table 5.—New Mexico: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1981, by class of ore or other source material

Source	Number of mines[1]	Material sold or treated (metric tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode ore:							
Gold and silver[2]	8	738,046	[3]65,749	W	W	W	W
Copper	3	22,614,952	W	[4]1,632,346	133,425	W	W
Lead	1	7	--	W	--	W	--
Total	12	23,353,005	65,749	1,632,346	[5]133,425	W	W
Other lode material:							
Copper precipitates	1	22,857	--	--	[6]20,689	--	--
Grand total	12	23,375,862	65,749	1,632,346	154,114	W	W

W Withheld to avoid disclosing company proprietary data.
[1]Detail will not add to totals shown because some mines produce more than one class of material.
[2]Combined to avoid disclosing company proprietary data.
[3]Includes gold recovered from copper ore.
[4]Includes silver recovered from gold, silver, and lead ores.
[5]Does not include copper recovered from gold and silver ores.
[6]Includes copper recovered from gold and silver ores.

Table 6.—New Mexico: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1981, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode:					
Cyanidation and smelting of concentrates[1]	64,316	1,541,077	[2]137,419	W	W
Direct smelting of ore and precipitates[1]	1,433	91,269	16,695	W	W
Total	65,749	1,632,346	154,114	W	W

W Withheld to avoid disclosing company proprietary data.
[1]Combined to avoid disclosing company proprietary data.
[2]Includes copper recovered from precipitates from leached ore.

New Cinch Uranium Corp. continued exploration at its Orogrande prospect. The company has reported widespread mineralization of 0.04 to 0.05 ounce of gold per ton at the property that might be amenable to cyanide heap-leaching techniques. Other precious-metal exploration programs were conducted in the following districts: Cerrillos, Georgetown, Gold Hill, Hermosa, Hillsboro, Hopewell, Pinos Altos, and Winston-Chloride.

Iron Ore.—Sharon Steel Corp. did not recover byproduct iron concentrates from its Continental Mine in Grant County in 1981. Sharon shipped a small quantity of byproduct iron ore from carryover stocks.

Lead.—A small quantity of lead was produced in Grant County in 1981, following no output in 1980 and a small quantity in 1979. Lead price was off sharply in early 1981, rose steadily through the second and third quarters, and declined again at yearend. Average price for the year was $803 per metric ton. New Mexico ranked 10th among 14 States that recorded lead output in 1981.

Manganese.—Luck Mining Co. continued to mine manganiferous ore from its Boston Hill Mine outside Silver City, Grant County. Ores were processed and shipped to the CF&I Steel Corp. at Pueblo, Colo. Because of the depressed production rate of CF&I, demand for manganese was poor, and shipments in 1981 were one-third the quantity of those in 1980; price, however, was firm. New Mexico ranked third among three States that produced manganiferous ores in 1981.

Molybdenum.—Shipments of molybdenum concentrates plunged about 50% in 1981. Total value of molybdenum produced fell more than 50%, as the average unit price eased about 10% below that of 1980. The steel industry usually takes 75% or more of the domestically consumed molybdenum, and with both the automobile and construction industries depressed, these markets were exceptionally weak in 1981. Following the strike-induced low output in 1980, U.S. copper production rose 30% in 1981, and much of domestic molybdenum production is recovered as a byproduct of copper mining. Because of the firm supply of byproduct molybdenum, the primary molybdenum producer, Molycorp, Inc., in New Mexico, was forced to curtail its operations sharply. Average price per pound of molybdenum was down to $8.08 in 1981, from $8.69 in 1980.

Molycorp's development of its underground mine near Questa remained on schedule. The mill that serves the existing open pit mine was renovated and improved during a planned mining shutdown in August. Overburden stripping began in February to develop about 3 million tons of ore that will feed the mill before the underground mine comes onstream early in 1983. A tailings spill occurred at the Molycorp operation on March 9. Because the operation has had other spills, the company was constructing a new tailings line on the north side of Highway 38, opposite the Red River; the new location is to prevent tailings from entering the river.

The U.S. Geological Survey disclosed the occurrence of widespread, low-grade molybdenum mineralization in the South Fork Peak area, about 10 miles south-southeast of Questa.

Silver.—Production of silver increased about one-third in 1981; however, owing to a declining price throughout the year, total value was off one-third. Byproduct silver from Phelps Dodge Corp.'s Tyrone copper mine comprised most of the State's silver output. New Mexico was ranked eighth in silver recovery among 18 States that reported production in 1981.

The Goldfield Corp. of Florida pushed development of its St. Cloud property in the Black Range district near Chloride. The underground mine will utilize trackless diesel equipment. The firm reported the development of 377,000 tons of ore reserves grading 11.4 ounces of silver; 0.03 ounce of gold; and a combined 4.6% copper, lead, and zinc. Ore will be shipped to the company's San Pedro mill near Golden in Santa Fe County. Initial production is planned for 1982. The St. Cloud operation is expected to be the State's second largest producer of silver.

Vanadium.—Recovery and total value of vanadium from uranium-vanadium ores mined in San Juan County were about one-third those of 1980. Owing to cost problems and safety concerns in the nuclear power industry and continued sluggishness in the demand for electric energy, sharply reduced demand for uranium resulted in widespread cutbacks in high-cost uranium mining operations and subsequent byproduct-vanadium recovery. The average U.S. price of vanadium was $3.52 per pound V_2O_5 in 1981. New Mexico was ranked fifth among the six States that produced vanadium in 1981.

Zinc.—Although record prices for zinc prevailed for much of the year, zinc production was off by about one-fifth. Total value of zinc output declined only slightly because the average price for the year rose almost 20%, to $983 per metric ton. New Mexico was ranked 11th among the 16 zinc-producing States in 1981, down from 10th among 13 States in 1980.

NONMETALS

Carbon Dioxide.—Amerigas Corp., a subsidiary of UGI Corp., Valley Forge, Pa., continued producing natural carbon dioxide from wells in Harding County. New Mexico output declined about one-quarter as industrial demand—particularly in the oil industry—fell sharply toward yearend.

Cement.—The cement division of Ideal Basic Industries, Inc., manufactured cement at its Tijeras plant in Bernalillo County. Production of both portland and masonry cement rose from depressed levels in 1980; prices for both cement types also were up moderately. However, owing to the effect of high interest rates on the construction industry throughout 1981, the market for cement remained weak; although industrial and commercial sectors of the construction industry were resilient, single-family housing and highway construction continued to be depressed. Cement inventories, down in 1980, rose again in 1981.

Total fuel and energy required per ton of cement produced were down notably—natural gas in particular—as energy-saving capital investments completed in 1980 markedly affected 1981's production records. As in 1980, ready-mix concrete companies took more than one-half of the cement in 1981. Other markets also paralleled sales in 1980. Miscellaneous contractors and building-material dealers bought about one-third of the output; and concrete-product manufacturers, highway contractors, and miscellaneous customers took the remainder.

Clay and Shale.—Common clay and shale output increased about 7%, and value per ton eased slightly as construction industry demands for clay products remained slack. Largely used to fulfill refractory needs in smelters, fire clay production increased in quantity, and price rose sharply. Three different operators mined common clay in Bernalillo, Dona Ana, and San Juan Counties. Phelps Dodge in Hidalgo County and Mathis & Mathis Mining & Exploration Co. in Luna County mined fire clay. Most of the clay mined in the State was used for manufacturing common brick; a small quantity was used to manufacture roof tile.

Gypsum.—For the third consecutive year, gypsum output declined, off 8.8% in 1981, compared with 28% in 1980 and 4.6% in 1979. Price per ton firmed, however, at $13.59, up from $9.27 in 1980, to reverse a downtrend begun in 1979. White Mesa Gypsum Co. and Ernest Teeter mined gypsum at operations in Sandoval County, and Western Gypsum Co. produced gypsum at its quarry in Santa Fe County. Western Gypsum calcined its gypsum, and American Gypsum Co. calcined the White Mesa output. Western Gypsum closed its Rosario Mine and plant in May. Gypsum from Ernest Teeter's San Felipe operation was trucked to the Ideal Basic cement plant at Tijeras for use as a set-retarder in portland cement.

Lime.—Kennecott's Chino Mines Div. continued to quarry limestone for conversion to lime at its Hurley plant in Grant County. Output returned to normal in 1981 following the sharp downturn in 1980 because of the copper strike. Kennecott used the lime in its copper concentrator. Owing to the loss of the lime contract with Kennecott, Mathis Mining & Exploration Co. substantially reduced quarry production of limestone near Hanover, Grant County. Average price per ton of lime in 1981 was essentially unchanged from that of 1980.

Mica.—Mineral Industrial Commodities of America mined scrap and flake mica ore near Taos, Taos County, and processed the ore in its plant at Pojoaque, Santa Fe County. Both output and price rose moderately in 1981. The mica was sold mostly to cement and paint manufacturers.

Perlite.—New Mexico again led the Nation in output of processed perlite ore in 1981 with 83% of total production, off slightly from 85% in 1980. Price per ton was up from $26.72 in 1980 to $30.64 in 1981. As demands from most sectors of the construction industry weakened, State production declined 9.3% in 1981. All New Mexico perlite is shipped to out-of-State markets for exfoliation and manufacture in or near large metropolitan areas, usually to meet specific construction-industry needs.

Potash.—Demand for potassium salts from important agricultural consumers declined the second half of 1981 as another banner agricultural year compounded the grain carryover problem and resulted in weakened prices for major crops. New Mexi-

co output of potash in 1981 declined 3.9%, and sales fell 14%. New Mexico yielded most of the Nation's potassium salts—83% in 1981, about the same as in 1980. Average price per ton of potassium salts rose moderately, 5.5% in the State, considerably below the inflation rate in 1981.

International Minerals & Chemical Corp., AMAX Chemical Corp., Potash Co. of America, and Kerr-McGee Corp. were the top four producers, in that order. Duval Corp. and Mississippi Chemical Corp. were fifth and sixth, respectively, a reversal of their rank in 1980. National Potash Co. was seventh. National produced potash in Lea County; all the others recovered potash in Eddy County. Owing to the slack demand in the second half of 1981 and because of low-cost imports from Government-owned companies in several foreign nations, all seven potash producers increased their stocks. Total yearend stocks rose about 82%, from approximately 480,000 tons in 1980 to 875,000 tons in 1981.

AMAX recorded its 30th year of mining potash in the Carlsbad area in 1981. Its mine, since startup in 1952, had produced more than 75 million tons of ore and now has 73 million tons of reserves. A record 4.13 million tons was mined in 1981; however, because of a small decline in the grade of ore, a mill fire in September, and some metallurgical problems, potash recovery was off 2% from 1980. Mine-hoisting capacity was expanded to handle increasing underground output as continuous-miner units were added to the mine. Underground mining conversion is scheduled for completion in 1983.

Table 7.—Production and sales of potash in New Mexico

(Thousand metric tons and thousand dollars)

Period	Crude salts[1] mine production		Marketable potassium salts				
			Production		Sold or used		
	Gross weight	K_2O equivalent	Gross weight	K_2O equivalent	Gross weight	K_2O equivalent	Value[2]
1980:							
January-June	8,985	1,232	1,872	945	1,889	952	143,600
July-December	9,046	1,222	1,788	926	1,756	916	145,400
Total	18,031	2,454	3,660	1,871	3,645	[3]1,869	289,000
1981:							
January-June	9,129	1,186	1,786	904	1,732	881	147,559
July-December	9,361	1,234	1,726	894	1,386	720	113,675
Total	18,490	2,420	[3]3,513	1,798	3,118	1,601	261,234

[1]Sylvinite and langbeinite.
[2]F.o.b. mine.
[3]Data do not add to total shown because of independent rounding.

Potash Co. of America reported a 15% decline in production because of the lower grade ore mined and because of problems associated with its old mine. Kerr-McGee also noted a decline in demand for potash, particularly in exports to its Latin American markets. National Potash Co., a subsidiary of Freeport-McMoran Inc., reduced output by one-third and employment by one-fourth in the summer, and at yearend planned to suspend production in January 1982.

Pumice.—Four companies produced pumice in three New Mexico counties in 1981, unchanged from those in 1980. Although output increased by about one-tenth, price per ton rose only 2%. The demand for pumice in concrete aggregate was firm, up 21%; abrasive needs fell 13%; and landscaping, roofing, and other light construction and housing demands were off more than 30%.

Salt.—Output of salt rose sharply in 1981, up about one-fourth; however, average price per ton increased only 1.3%. United Salt Corp. continued to produce salt by solar evaporation in Eddy County. SPN Dismantling, Inc., and Williams Brine Service mined bulk rock salt in Eddy County. Pioneer Water Co., Lea County, and Potash Co. of America, Eddy County, produced brine.

Sand and Gravel.—To reduce reporting burdens and costs, the Bureau of Mines implemented new canvassing procedures

for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Sand and gravel was ranked first on the 1981 list of construction minerals produced in New Mexico. Estimated total output was 3.5% over that of 1980 and higher than that of any year since 1977. Average price at $2.47 per ton was essentially unchanged from that of the past 2 years. Commercial and industrial construction was firm in several metropolitan areas in the State; moreover, energy- and defense-related construction generally was strong. However, total demand for sand and gravel was sluggish during 1980-81 owing to exceptionally high interest rates that crimped highway and residential construction.

Table 8.—New Mexico: Construction sand and gravel sold or used by producers

	1980			1981[p]		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Sand	1,927	$5,137	$2.67	NA	NA	NA
Gravel	5,123	12,539	2.45	NA	NA	NA
Total or average	7,050	17,676	2.51	7,300	$18,000	$2.47

[p]Preliminary. NA Not available.

Stone.—Production of stone rose sharply to a record level in 1981: crushed stone almost doubled, dimension stone was up by one-half, and total stone increased 61%. Although the average price of crushed stone fell 8.3%, the average price of dimension stone rose 29%.

In 1981, 26 companies worked 38 quarries in New Mexico. One quarry yielded more than 1 million tons, 6 turned out 100,000 to 1 million tons, and 31 produced less than 100,000 tons each. Crushed granite comprised more than 40% of the State's stone output, crushed and dimension limestone more than 40% also, and the remaining stone in decreasing order of tonnage was volcanic cinder, traprock, scoria, sandstone, and marble. Crushed stone was produced in 16 counties; dimension stone in 3. In decreasing order of quantity produced, the leading five counties were Torrance, Bernalillo, McKinley, Union, and Eddy; in value, the leaders were Bernalillo, Torrance, Union, McKinley, and Lea.

All the crushed granite was used as railroad ballast. Major uses for crushed limestone in decreasing order of quantity were cement manufacture, unspecified aggregate, bituminous aggregate, concrete aggregate, and roadbeds. Much of the limestone was manufactured into lime. Crushed sandstone was used as a flux stone and for roadbeds. Traprock was consumed in roadbeds and bituminous aggregate. More than 80% of the crushed stone was transported by truck, and the remainder was shipped by railroad.

Table 9.—New Mexico: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Concrete aggregate	r420	r1,248	279	814
Bituminous aggregate	196	661	228	757
Dense-graded road base stone	252	540	494	1,360
Surface-treatment aggregate	129	553	66	162
Other construction aggregate and road stone	600	1,736	333	789
Riprap and jetty stone	6	10	67	279
Railroad ballast	r127	r349	W	W
Lime manufacture	84	W	W	W
Terrazzo and exposed aggregate	115	1,349	105	1,653
Filter stone	W	W	9	30
Other[2]	r654	r3,028	r2,581	6,641
Total[3]	r2,581	r9,473	4,162	12,485

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Other."

[1]Includes limestone, granite, sandstone, traprock, and volcanic cinders and scoria.

[2]Includes stone used for macadam aggregate (1980), railroad ballast, cement manufacture, flux stone, roofing granules, and other uses not specified.

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

Sulfur.—Eight companies recovered sulfur from natural gas and crude oil at 11 operations in 4 counties—Eddy, Lea, Roosevelt, and San Juan. Production rose more than 10% in 1981, and the small stocks carried over from 1980 declined slightly.

[1]State Liaison Officer, Bureau of Mines, Denver, Colo.

[2]Mining engineer, New Mexico Bureau of Mines and Mineral Resources, Socorro, N. Mex.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
Barite:			
Ranger Industries, Inc	Box 602 Socorro, NM 87801	Open pit mine and processing plant.	Socorro.
Carbon dioxide (natural):			
Amerigas Corp., a subsidiary of UGI Corp.	4455 LBJ Freeway Suite 1100 Dallas, TX 75234	Wells and liquefaction and solidification extraction plant.	Harding.
Cement:			
Ideal Basic Industries, Inc., Ideal Cement Co.[1]	950 17th St. Denver, CO 80201	Dry process, 2 rotary-kiln plants.	Bernalillo.
Clays:			
El Paso Brick Co	Box 12336 El Paso, TX 79912	Open pit mine	Dona Ana.
Kinney Brick Co., Inc	100 Prosperity Ave. Box 1804 Albuquerque, NM 87102	do	Bernalillo.
Copper:			
Kennecott Minerals Co., a subsidiary of Kennecott Corp., Chino Mines Div.[2]	Hurley, NM 88043	Open pit mine, flotation mill, precipitation plant, smelter.	Grant.
Phelps Dodge Corp., Tyrone Branch[3]	Drawer B Tyrone, NM 88065	Open pit mine and mill	Do.
Sharon Steel Corp.[4]	Box 406 Hanover, NM 88041	Underground mine, open pit mine, 2 flotation mills.	Do.
Gypsum:			
American Gypsum Co	Box 6345 Albuquerque, NM 87197	Processing and wallboard plant.	Bernalillo.
Western Gypsum Co., a subsidiary of Drywall Supply, Inc.	Box 2636 Sante Fe, NM 87501	Open pit and plant	Sante Fe.
White Mesa Gypsum Co	129 Jackson, NE Albuquerque, NM 87108	Open pit	Sandoval.
Lime:			
Mathis Mining & Exploration Co	1101 Santa Rita Box 2577 Silver City, NM 88061	Quarry and open pit mine.	Grant.
Manganese:			
Luck Mining Co	Box 29 Silver City, NM 88061	Open pit mine and plant.	Do.

See footnotes at end of table.

Table 10.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Mica:			
Mineral Industrial Commodities of America, Inc.	Box 2403 Santa Fe, NM 87501	Open pit mine	Taos.
Molybdenum:			
Molycorp, Inc., a division of Union Oil Co. of California.	Box 760 Los Angeles, CA 90051	Open pit mine and flotation mill.	Do.
Perlite:			
Grefco, Inc., a subsidiary of General Refractories Co.	Box 308 Antonito, CO 81120	Open pit mine; crushing, screening, air separation.	Socorro and Taos.
Manville Sales Corp., a division of Manville Corp.	Box 338 Antonito, CO 81120	do	Taos.
Silbrico Corp	Box 367 Antonito, CO 81120	Open pit	Do.
United States Gypsum Co	Box 216 Grants, NM 87020	Open pit mine, crushing plant.	Valencia.
Potash:			
AMAX Chemical Corp	Box 279 Carlsbad, NM 88220	Underground mine and plant.	Eddy.
Duval Corp., a subsidiary of Pennzoil Co.[5]	Box 511 Carlsbad, NM 88220	do	Do.
International Minerals & Chemical Corp.	Box 71 Carlsbad, NM 88220	do	Do.
Kerr-McGee Chemical Corp., a subsidiary of Kerr-McGee Corp.	Kerr-McGee Bldg. Oklahoma City, OK 73102	do	Do.
Mississippi Chemical Corp	Box 101 Carlsbad, NM 88220	do	Do.
National Potash Co., a subsidiary of Freeport Minerals Co.	Box 731 Carlsbad, NM 88220	do	Lea.
Potash Co. of America, a subsidiary of Ideal Basic Industries, Inc.[5]	Box 31 Carlsbad, NM 88220	do	Eddy.
Pumice:			
American Pumice Co., a division of Beatrice Foods Co.	Box 4305 Santa Fe, NM 87502	Processing plant	Santa Fe.
Copar Pumice Co	Box 38 Espanola, NM 87532	Open pit	Do.
General Pumice Corp	Box 449 Santa Fe, NM 87501	Open pit mine and crushing and screening plant.	Rio Arriba.
Salt:			
United Salt Corp	Box SS Carlsbad, NM 88220	Salt lake	Lea.
Sand and gravel:			
Albuquerque Gravel Products	Box 829 Albuquerque, NM 87103	Dredge and plant	Bernalillo.
Springer Building Materials Corp.	Drawer S Albuquerque, NM 87103	Pit and stationary crushing and screening plant.	Do.
Stone:			
Concrete Sales and Equipment Rentals.	Box 2547 Milan, NM 87021	Open pit mine and crusher.	McKinley.

[1]Also clays and stone.
[2]Also silver and lime.
[3]Also silver, gold, sandstone.
[4]Also gold, silver, zinc, iron.
[5]Also salt.

The Mineral Industry of New York

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the New York Geological Survey for collecting information on all nonfuel minerals.

By William Kebblish[1] and Robert J. Tuchman[2]

The value of nonfuel mineral production in New York was $492 million in 1981, a decrease of about $3.8 million from that of 1980. Nationally, New York ranked 17th in value of total nonfuel mineral output and led in production of synthetic graphite and synthetic calcium chloride. The State ranked third in the production of primary aluminum, salt, and zinc; fourth in calcined gypsum and talc; and fifth in peat. It was the only State in which emery was produced. Stone, cement, salt, sand and gravel, and zinc contributed the greatest value to the State's nonfuel mineral production.

Trends and Developments.—The transportation industry in New York continued to play an important function in the State's mineral economy during 1981. The U.S. Army Corps of Engineers studied the possibility of dredging the Ogdensburg port on the St. Lawrence River to accommodate additional vessels. Farther downstream at

Table 1.—Nonfuel mineral production in New York[1]

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
Clays[2] thousand short tons	596	$2,479	597	$2,310
Emery short tons	rW	rW	W	W
Gem stones	NA	20	NA	30
Lead (recoverable content of ores, etc.) metric tons	876	820	968	780
Peat thousand short tons	43	917	39	811
Salt do.	5,509	99,395	5,597	103,668
Sand and gravel do.	[3]21,918	[3]53,276	pW21,255	p [3]56,300
Silver (recoverable content of ores, etc.) thousand troy ounces	21	427	29	303
Stone:				
Crushed thousand short tons	34,483	120,764	30,681	117,689
Dimension do.	25	2,414	21	2,291
Zinc (recoverable content of ores, etc.) metric tons	33,629	27,750	36,889	36,235
Combined value of cement, clays (ball clay), garnet (abrasive), gypsum, iron ore, lime, sand and gravel (industrial), talc, titanium concentrate (ilmenite), wollastonite, and values indicated by symbol W	XX	r187,526	XX	171,554
Total	XX	r495,788	XX	491,971

pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes ball clay; value included with "Combined value" figure.

[3]Excludes industrial sand; value included with "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Albany	W	W	Cement, stone, clays, sand and gravel.
Allegany	$1,277	$1,263	Sand and gravel.
Broome	W	W	Sand and gravel, peat.
Cattaraugus	4,896	5,251	Sand and gravel.
Cayuga	226	W	Do.
Chautauqua	877	919	Do.
Chemung	1,559	W	Do.
Chenango	695	723	Do.
Clinton	W	W	Stone, sand and gravel.
Columbia	W	W	Do.
Cortland	1,046	720	Sand and gravel.
Delaware	1,965	W	Stone, sand and gravel.
Dutchess	W	W	Stone, sand and gravel, peat.
Erie	W	W	Stone, lime, sand and gravel.
Essex	r15,697	16,894	Wollastonite, iron ore, ilmenite, sand and gravel, stone, garnet.
Franklin	W	154	Stone, sand and gravel.
Fulton	438	478	Sand and gravel.
Genesee	W	W	Gypsum, stone, sand and gravel.
Greene	W	W	Cement, stone, sand and gravel.
Herkimer	W	W	Stone, sand and gravel.
Jefferson	3,174	2,902	Do.
Lewis	W	W	Wollastonite, stone, sand and gravel.
Livingston	W	W	Salt, stone, sand and gravel.
Madison	1,398	1,740	Stone, sand and gravel.
Monroe	W	W	Do.
Montgomery	W	W	Do.
Nassau	W	W	Sand and gravel, clays.
Niagara	W	4,729	Stone.
Oneida	W	4,304	Stone, sand and gravel.
Onondaga	58,728	59,026	Lime, stone, salt, cement, sand and gravel, clays.
Ontario	W	W	Stone, sand and gravel.
Orange	W	W	Stone, sand and gravel, clays.
Orleans	W	W	Stone, sand and gravel.
Oswego	1,487	1,501	Sand and gravel.
Otsego	285	231	Do.
Putnam	W	W	Stone.
Rensselaer	W	W	Sand and gravel, stone.
Rockland	W	W	Stone, sand and gravel.
St. Lawrence	15,537	34,596	Zinc, stone, talc, lead, sand and gravel, silver.
Saratoga	W	2,545	Stone, sand and gravel.
Schenectady	W	W	Sand and gravel.
Schoharie	W	W	Cement, stone, sand and gravel.
Schuyler	W	W	Salt, sand and gravel.
Seneca	W	W	Stone, peat, sand and gravel.
Steuben	W	W	Sand and gravel, stone.
Suffolk	4,977	3,904	Sand and gravel.
Sullivan	W	W	Stone, sand and gravel.
Tioga	1,561	1,156	Sand and gravel.
Tompkins	W	W	Salt, stone, sand and gravel.
Ulster	W	W	Cement, stone, clays, sand and gravel.
Warren	r15,019	13,722	Cement, garnet, stone, sand and gravel.
Washington	W	W	Stone, sand and gravel.
Wayne	W	W	Do.
Westchester	390	185	Emery, stone, peat, sand and gravel.
Wyoming	W	W	Salt, sand and gravel.
Yates	146	162	Sand and gravel.
Undistributed[2]	323,738	338,680	
Total	r455,116	[3]495,788	

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]Bronx, Hamilton, Kings, New York, Queens, and Richmond Counties are not listed because no nonfuel mineral production was reported.

[2]Includes gem stones and values indicated by symbol W.

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

Waddington, private parties proposed restoration of the port for scrap metal shipments. At Albany, Cibro Petroleum, Inc., and New Amsterdam Coal Co. considered improvements to the port for coal exportation, while local officials investigated similar possibilities for the New York City area.

In a rail-related action, Delaware & Hudson Railway Co. (D&H) of Albany was conditionally sold to a company in Guilford, Conn. D&H has rail lines stretching from central Pennsylvania through New York to Canada.

Table 3.—Indicators of New York business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	7,940.0	7,877.8	-0.8
Unemployment	do	556.0	606.1	+9.0
Employment (nonagricultural):				
Mining[1]	do	6.1	6.3	+3.3
Manufacturing	do	1,445.1	1,432.0	-.9
Contract construction	do	209.3	211.4	+1.0
Transportation and public utilities	do	431.4	429.3	-.5
Wholesale and retail trade	do	1,465.2	1,463.7	-.1
Finance, insurance, real estate	do	626.2	654.5	+4.5
Services	do	1,710.0	1,784.3	+4.3
Government	do	1,313.9	1,300.1	-1.1
Total nonagricultural employment[1]	do	7,207.2	[2]7,281.4	+1.0
Personal income:				
Total	millions	$180,497	$201,361	+11.6
Per capita		$10,252	$11,440	+11.6
Construction activity:				
Number of private and public residential units authorized		26,645	25,929	-2.7
Value of nonresidential construction	millions	$1,244.5	$1,344.2	+8.0
Value of State road contract awards	do	$482.0	$550.0	+14.1
Shipments of portland and masonry cement to and within the State	thousand short tons	2,455	2,506	+2.1
Nonfuel mineral production value:				
Total crude mineral value	millions	$495.8	$492.0	-.8
Value per capita, resident population		$28	$28	--
Value per square mile		$10,043	$9,924	-1.2

[p]Preliminary.
[1]Includes oil and gas extraction.
[2]Data do not add to total shown because of independent rounding.

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

Federal, State, and industry officials continued to examine high acidity levels in New York's streams and lakes. To neutralize the acidic water, lime produced within the State was added to several streams and lakes. Although this procedure is temporary, research was conducted to determine causes of the high acidity levels and further corrective measures to ameliorate water quality.

Site testing and environmental impact statements were underway during 1981 for a 2,800-acre site at Sterling, Cayuga County, proposed by the New York Department of Environmental Conservation for disposal of hazardous waste. The agency estimated that more than 1.3 million tons of hazardous nonnuclear wastes is generated each year by New York industries. Contributing to this waste production are the chemical and allied product industries, fabricated metal producers, and, to a lesser extent, the stone, clay, and glass industries.

Officials of Westchester County signed a contract with a private firm for construction of a resource recovery plant near the Hudson River, to be operational by 1985. Ferrous and nonferrous metal will be recovered from the approximately 365,000 tons of refuse to be processed annually at the plant.

In another development, marine scientists at the State University of New York (SUNY) at Stony Brook suggested dumping dredged material into abandoned sand and gravel sites in lower New York Harbor. The proposal is being studied by the Corps of Engineers.

Late in the year, the Adirondack Park Agency began a revaluation of the 8-year-old land use policy plan for the 6-million-acre park. Approximately 38% of the preserve is owned by the State, and the remainder, by private interests.

The New York Department of Environmental Conservation was considering leasing of State properties for extraction of wollastonite by a mining company. Royalties collected by the State would be used to purchase additional land for State park expansion.

Legislation and Government Programs.—Legislation signed into law by the Governor during 1981 included a subsidence insurance bill providing an insurance plan to landowners affected by abandoned underground gypsum mines east of Buffalo. On a local level, city officials in Warwick, Orange County, passed ordinances preventing prospecting or mining of uranium and temporarily restricted drilling and mining in areas zoned as mountain residential.

The New York Geological Survey was involved in 15 major projects during the year—8 related to environmental geology and 7 to regional geologic studies. Individual project topics included waste burial, geology of southeastern New York aquifers, geochemistry of glacial soils, historical seismicity of southeastern New York, the Taconic Mountains from Poughkeepsie to Whitehall, and stratigraphy of the Devonian in central New York. Projects in the Adirondack Mountains pertained to Precambrian stratigraphy and Cambrian-Ordovician biostratigraphy. Partial funding for the geological projects was obtained from the U.S. Geological Survey and the U.S. Nuclear Regulatory Commission.

Petty-Ray Geophysical, Inc., geologists began bedrock mapping using seismic methods in St. Lawrence and Essex Counties. Data obtained will be used by a five-university consortium to better understand regional stratigraphy. Funds for the study were made available by the National Science Foundation.

During fiscal year 1981, the U.S. Bureau of Mines funded research projects in New York totaling nearly $800,000. The largest contract was awarded to Dayton T. Brown, Inc., and involved instrumentation to locate trapped miners. Other projects pertained to health and safety equipment, improved communications systems, and borehole television components.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Abrasives, Manufactured.—Artificial abrasives were manufactured by three companies in New York in 1981. Abrasive-grade, high-purity fused aluminum oxide was produced in Niagara County by General Abrasives Div. of Dresser Industries, Inc., and by The Carborundum Co.; the latter also produced silicon carbide. In Erie County, Pellets, Inc., produced steel shot and grit for abrasive purposes.

Calcium Chloride.—New York ranked first of three States in the production of synthetic calcium chloride in 1981. Allied Chemical Corp. recovered synthetic calcium chloride as a byproduct of soda ash production at its plant in Solvay, Onondaga County. Both output and value declined slightly compared with 1980 levels. Calcium chloride was used for ice and snow removal and as a dust suppressant.

Cement.—Nationally, New York ranked 7th in portland cement shipments and 17th in masonry cement shipments. From 1980 to 1981, portland cement shipments decreased 6% in quantity and 4% in value; masonry cement shipments decreased only slightly in quantity but increased 13% in value. Five companies produced portland cement at six plants in five counties. Three plants used the wet process, two used the dry process, and one operated as a grinding facility.

In 1981, ready-mix concrete companies used more than 75% of the portland cement produced; the remainder was used by building material dealers, concrete product manufacturers, highway contractors, government agencies, and other customers. Approximately 85% of the cement was moved to market by truck; the rest, by rail, barge, and other means.

Early in the year, Alpha Portland Industries, Inc., parent of Alpha Portland Cement Co., closed its Jamesville plant. One company plant remains at Cementon, Greene County, where a demonstration project was underway to use waste solvents produced by New York's chemical industries as fuel. State permits allow burning of solvents at the rate of 15 gallons per minute, yielding 25% of the plant's fuel needs.

Lehigh Portland Cement Co., at Alsen, Greene County, owned by Heidelberger Zement AG of the Federal Republic of Germany, planned to increase capacity of portland cement by 50% to 750,000 tons annually by 1984.

A new cement distribution terminal was opened during the year at Oswego, on Lake Ontario, by Independent Cement Corp. Company terminals are also found in other northeastern U.S. cities.

Clays.—Clay and shale produced in 1981, excluding ball clay, amounted to 597,000 tons valued at $2.3 million, reflecting a slight increase in quantity but a slight decrease in value compared with 1980 levels. Common clay and shale was produced by nine companies in six counties. Leading producers were Atlantic Cement Co., Inc., Norlite Corp., and Northeast Solite Corp. Other producers were Binghamton Brick Co., Boston Valley Pottery Co., General Dynamics Corp., Grosso Excavating Co., Inc., Sawyer Excavating Co., and Syracuse Pottery, Inc. Producing counties, in de-

scending order of output, were Albany, Ulster, Broome, Onondaga, Orange, and Erie.

The average unit value of clay and shale was $3.87 per ton, down $0.29 from 1980 levels. Clay and shale was used mainly in the manufacture of portland cement, lightweight aggregate, common brick, and pottery.

A small amount of slip clay (statistically tallied as ball clay) was produced by Industrial Mineral Products, Inc., Albany County. The slip clay was used principally for ceramic glazes and bonding.

Emery.—The entire U.S. production of emery originated from open pit mines in Westchester County operated by De Luca Emery Mine, Inc., and John Leardi. Both production and value decreased from 1980 to 1981. The mined product was shipped to Emeri Crete, Inc., for processing. Emery was used mainly as a nonslip additive for floors, pavements, and stair treads.

Garnet.—Of the three States that produced garnet in 1981, New York ranked second in output and first in value. Garnet was produced by Barton Mines Corp., Warren County, from a surface mine on Gore Mountain near North Creek. Because reserves were depleted, another mine was being developed on nearby Ruby Mountain. NYCO, a division of Processed Minerals, Inc., Essex County, recovered garnet as a byproduct of wollastonite mining and processing. Garnet was used in coated and bonded abrasives, glass grinding and polishing, metal lapping, and sandblasting.

Gem Stones.—Value of gem stones and mineral specimens collected by mineral dealers and amateur collectors in New York was estimated at $30,000 in 1981. Favorite gem-collecting areas were Gore Mountain, near North Creek, Warren County; magnetite refuse areas of NL Industries, Inc., near Tahawus, Essex County; and Herkimer County, where clear quartz crystals are found.

Graphite, Manufactured.—New York ranked first of 15 States in production and value of synthetic graphite in 1981. Output amounted to more than 113,000 tons valued at nearly $220 million, representing a slight decrease in quantity but a slight increase in value compared with those of 1980. All synthetic graphite in the State was produced in Niagara Falls by Airco Carbon, a division of BOC International Group Co. based in England; The Carborundum Co.; Great Lakes Carbon Corp.; and Union Carbide Corp. The latter was the world's leading supplier of graphite electrodes, used in the electric-arc method of steelmaking.[3] Synthetic graphite was produced mainly from petroleum coke, coal tar, petroleum pitch binders, and impregnating agents. Graphite was sold principally for electrodes; other end uses included anodes, electric motor brushes, crucibles and vessels, powders, and lubricants.

Gypsum.—United States Gypsum Co. produced crude gypsum from its underground mine in Oakfield, Genesee County. From 1980 to 1981, production increased more than 21%, but value declined about 34%. Nationally, New York ranked fourth in production of calcined gypsum in 1981. Crude gypsum was calcined by three companies at plants in Erie, Genesee, Rensselaer, Rockland, and Westchester Counties for ultimate use in wallboard and various plasters.

Iodine.—Crude iodine was imported into the State by Sterling Organics, Rensselaer County, for use in the manufacture of pharmaceuticals, catalysts, and sanitation products. During 1981, H. Kohnstamm & Co., Kings County, and RSA Corp., Westchester County, sold iodine products from stock.

Iron and Steel Slag.—New York ranked eighth nationally in the production of iron and steel slag in 1981. Output increased 55% compared with 1980 figures, a reflection of the increase in pig iron production. Buffalo Slag Co., in Buffalo near steelmaking centers, processed slag for use in road base, asphaltic concrete aggregate, fill, cement, and concrete products.

Lime.—Bethlehem Steel Corp., Erie County, and Allied Chemical, Onondaga County, produced quicklime for use in alkalies and steelmaking. Production and value decreased approximately 31% and 29%, respectively, from 1980 to 1981, mainly owing to a drop in steel output in the Buffalo area.

Mullite.—The Carborundum Co., Niagara Falls, produced synthetic mullite by high-temperature processing of aluminum silicate materials. Mullite is a heat-resistant material used in furnace linings and refractories.

Peat.—New York ranked fifth of 20 States in peat production in 1981. Output totaled nearly 39,000 tons valued at more than $811,000, reflecting a decrease of 9% in quantity and 12% in value compared with 1980 levels. The largest producer was Anderson Peat Co., Inc., Westchester County. Other producers were Finger Lakes Peat Moss Co.; Good Earth Organics Corp.; Malcuria Bros., Inc.; Bob Murphy, Inc.; and

Stone Age Humus Corp. Peat was used for soil improvement and potting soil.

Perlite (Expanded).—Crude perlite imported from other States was expanded by Buffalo Perlite Div. of Pine Hill Concrete Mix Corp., National Gypsum Co., Scolite International Corp., and United States Gypsum Co. Production totaled 5,600 tons valued at $1 million, representing slight decreases in quantity and value from 1980 to 1981. Expanded perlite was used mainly in lightweight acoustical building plaster; other uses included loosefill insulation, soil conditioning, and filtration.

Quartz Crystal.—Bulova Watch Co., Queens County, and Frequency Electronics, Inc., Nassau County, consumed cultured quartz crystal during 1981. Major use was in the manufacture of electronic products.

Salt.—New York ranked third, behind Louisiana and Texas, in salt production in 1981. Output totaled nearly 5.6 million tons valued at more than $103 million, representing slight increases in quantity and value compared with 1980 levels. Cargill, Inc., operated an underground rock salt mine in Tompkins County, and International Salt Co. operated the Retsof underground mine in Livingston County. These two mines accounted for more than 50% of the State's total salt output. Other salt producers were Allied Chemical, Hooker Chemical Corp., and Morton Salt Co. Rock salt was used mainly for snow and ice removal; salt in brine was used for the manufacture of soda ash, chlorine, and other chemicals.

Sand and Gravel.—In late 1980, the U.S. Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but complete data on industrial sand and gravel. Estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Estimated production of construction sand and gravel in 1981 totaled 21.2 million tons valued at $56.3 million, a decrease in quantity but an increase in value owing to a higher unit price. In 1980, construction sand and gravel was produced by more than 300 companies throughout New York; principal producers were Valente Gravel, Inc., and Buffalo Slag. Leading producing counties were Cattaraugus, Dutchess, Rensselaer, and Suffolk. Construction sand and gravel was used mainly for road base, concrete aggregate, and fill.

Whitehead Bros. Co. was the only producer of industrial sand in New York in 1981. Production from the company's two mines increased slightly compared with that of 1980. Major sales were for moldings and foundry use.

Table 4.—New York: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	9,733	$23,666	$2.43	NA	NA	NA
Gravel	12,185	29,609	2.43	NA	NA	NA
Total or average	21,918	[1]53,276	2.43	[p]21,200	[p]$56,300	[p]$2.66
Industrial sand	W	W	10.92	55	W	W
Grand total or average	W	W	2.45	[p]21,255	W	[p]2.67

[p]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Data do not add to total shown because of independent rounding.

Stone.—In 1981, stone was extracted by 68 companies at 100 quarries in 37 of New York's 62 counties. Crushed stone was produced from 81 quarries and dimension stone from 22 quarries; 3 quarries produced both types of stone. Principal producers were Allied Chemical; Atlantic Cement; Fitzgerald Bros. Construction Co.; The General Crushed Stone Co., a subsidiary of Koppers Co., Inc.; Lone Star Industries, Inc.; and Tilcon, Inc. These six companies operated a total of 19 quarries and accounted for 50% of the

State's total stone output.

Limestone was the leading type of crushed stone mined; other types were sandstone, traprock, and slate. Main uses included bituminous aggregate, road base, and cement manufacture. Types of dimension stone quarried were granite, sandstone, and slate. Sales were for cut stone and flagging.

Slate was produced only in Washington County from 12 quarries; output increased more than 10% from 1977 to 1981. During this period, a report was prepared by Arthur D. Little, Inc., for the U.S. Bureau of Mines regarding the slate industry in New York and Vermont. The report identifies mining and marketing constraints and includes recommendations for industry growth.

In northern New York, Ogdensburg Stone & Asphalt Co. planned to develop a $1.1 million quarry in St. Lawrence County, providing employment for approximately 30 persons.

Table 5.—New York: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	346	2,165	255	1,697
Concrete aggregate	2,762	11,707	3,085	15,480
Bituminous aggregate	7,320	29,615	6,639	30,058
Macadam aggregate	731	2,784	704	2,773
Dense-graded road base stone	6,629	24,583	4,805	18,677
Surface-treatment aggregate	1,548	5,710	1,369	5,550
Other construction aggregate and road stone	6,101	20,080	5,306	18,859
Riprap and jetty stone	661	3,049	517	2,554
Railroad ballast	412	1,501	229	628
Filter stone	70	168	47	119
Manufactured fine aggregate (stone sand)	1,157	4,034	1,175	4,640
Cement manufacture	5,222	9,758	5,187	10,798
Lightweight aggregate (expanded slate)	11	85	11	91
Other[2]	1,512	5,525	1,352	5,767
Total[3]	34,483	120,764	30,681	117,689

[1]Includes limestone, sandstone, traprock, and slate.
[2]Includes stone used for agricultural marl and other soil conditioners, terrazzo and exposed aggregate, lime manufacture, flux stone, chemical stone for alkali works, abrasives, other fillers or extenders, drain fields, fill, roofing granules, and other uses not specified.
[3]Data may not add to totals shown because of independent rounding.

Table 6.—New York: Dimension stone[1] sold or used by producers, by use

Use	1980			1981		
	Short tons	Cubic feet (thousands)	Value (thousands)	Short tons	Cubic feet (thousands)	Value (thousands)
Rough stone:						
Irregular-shaped stone	298	4	$18	255	3	$13
Rubble	1,573	19	34	1,228	14	34
Flagging	11,652	138	1,194	11,446	136	1,255
Dressed stone:						
Cut stone	2,442	29	375	1,824	22	356
House stone veneer	725	9	29	485	6	19
Construction	W	W	W	W	W	8
Flagging	6,227	71	431	4,587	52	290
Roofing slate, standard	–	–	–	150	2	63
Structural and sanitary	195	2	24	190	2	25
Flooring slate	568	6	171	644	7	183
Other[2]	1,342	16	137	648	8	44
Total[3]	25,022	294	2,414	21,457	251	2,291

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes granite, sandstone, and slate.
[2]Includes stone used for rough blocks, curbing, other uses not specified, and items indicated by symbol W.
[3]Data may not add to totals shown because of independent rounding.

Sulfur (Recovered).—Elemental sulfur was recovered as a byproduct from oil refinery operations at Ashland Oil, Inc., Buffalo, for use in chemicals and various synthetic products. From 1980 to 1981, shipments decreased nearly 25% in quantity but increased more than 32% in value. During the year, Allied Corp. sold its sulfuric acid plant at Buffalo.

Talc.—New York ranked fourth of 10 States in talc production in 1981. All production originated from two mines operated by Gouverneur Talc Co., Inc., near Fowler, St. Lawrence County. Production increased 7% in quantity and nearly 22% in value compared with those of 1980. The ore was ground and processed at the company-owned mill and used mainly in ceramics and as a mineral filler in paints. Lesser amounts were used in filler as floor tile, rubber, paper, and various other products.

Clark Minerals, Inc., formed in October 1980 as a subsidiary of Whittaker, Clark, and Daniels, Inc., purchased the idle Carbola Chemical Co. in Natural Bridge, Jefferson County. The mill is being refurbished to grind talc and barium sulfate.

Vermiculite (Exfoliated).—W. R. Grace & Co. exfoliated vermiculite imported from out of State at its plant in Weedsport, Cayuga County. Both output and value declined from 1980 to 1981. The product was used for loose fill insulation, soil conditioning, ultralightweight concrete aggregate, and building plaster aggregate.

Wollastonite.—New York was one of two States in 1981 that produced wollastonite, a natural calcium metasilicate. Shipments increased 11% in quantity and 6% in value compared with those of 1980. NYCO, a division of Processed Minerals, Inc., operated an underground mine at Willsboro and a surface mine at Lewis, both in Essex County; R. T. Vanderbilt Co., Inc., operated the underground Valentine Mine in Lewis County. Wollastonite was used as a filler in ceramics, paints, plastics, and other products.

During the year, a $21,000 grant to investigate the feasibility of using wollastonite in the production of whitewares was awarded to Alfred University by the New York State Science and Technology Foundation. The project will try to determine whether wollastonite can be used in place of quartz to improve the properties of whitewares.[4]

METALS

Aluminum.—In 1981, New York was estimated to rank third, behind Washington and Kentucky, in primary aluminum production. Both output and value increased compared with those of 1980. Aluminum Co. of America (Alcoa) and Reynolds Metals Co. operated plants at Massena, on the St. Lawrence River, where hydroelectric power is comparatively less expensive. In June, the New York State Power Authority approved long-term electric rates for the two aluminum producers. Under the new contract, rates would increase to 16 mills per kilowatt-hour by 1987 for Reynolds Metals, while Alcoa would reach that rate in 1986. Also included in the contract were rate discounts if new jobs are created at the plants and aluminum produced is fabricated within the State.

In another action, Alcoa contracted with Pullman Swindell Co. in February for design and installation of a furnace for aluminum extrusion ingots.

Ferroalloys.—New York was one of 16 States that produced ferroalloys in 1981. Shipments decreased nearly 7% in quantity and more than 15% in value compared with those of 1980. SKW Alloys, Inc., and Union Carbide, Metals Div., both in Niagara Falls, produced various ferroalloys for ultimate use in the manufacture of cast iron and tubular and carbon steel products.

Iron Ore.—NL Industries produced magnetite concentrate from the MacIntyre Mine in Essex County. Concentrates were transported to market by rail. The company is the last remaining producer of iron ore in New York since Jones & Laughlin Steel Corp. turned over control of its abandoned Benson iron ore mine, together with surface facilities, to St. Lawrence County authorities in 1980.

Iron and Steel.—Pig iron shipments in New York in 1981 totaled 2.5 million tons valued at more than $546 million, an increase of about 17% in quantity and 24% in value compared with 1980 levels. During the year, unemployment in the Buffalo area, where the steel industry is concentrated, reached slightly more than 10% owing to the faltering automotive industry, a principal market for steel output. Bethlehem Steel, the Nation's second largest steelmaker, employed approximately 7,000 workers at its Lackawanna plant compared with 20,000 in 1971.

Nevertheless, steel companies continued acquisition and modernization plans. At midyear, the new Bethlehem Steel 13-inch bar mill at Lackawanna was opened, replacing the older 12-inch mill. The new mill is one of the most automated plants in the

Nation. In another development, St. Mary Manufacturing Corp., North Tonawanda, finalized plans to purchase a plant from Oehler Industries, Inc., to expand its welding, fabrication, and production machinery assembly areas.

Lead and Silver.—Lead was recovered as a byproduct from zinc ore processed from two mines in St. Lawrence County. Production of lead in 1981 increased to 968 metric tons, but value decreased to $780,000. Silver, in turn, was recovered during lead processing; output increased to 28,829 troy ounces, but value decreased to $303,000.

Titanium Concentrate (Ilmenite).—Ilmenite concentrate was produced by NL Industries, Essex County, as the major product from the MacIntyre titanium-iron ore mine operations. In 1981, the company was the leading supplier of titanium dioxide in Europe and one of the top three suppliers in the United States.[5] Ilmenite was used mainly in the manufacture of titanium dioxide pigments for use in paint, paper, plastics, rubber, and ceramics.

Zinc.—New York ranked third of 16 States in zinc production in 1981. Output totaled 36,889 metric tons valued at $36.2 million, an increase of nearly 10% in quantity and more than 30% in value compared with those of 1980. Early in the year, St. Joe Minerals Corp. closed its Edwards zinc mine in St. Lawrence County. The mine opened in 1926, yielding a total of 6.6 million tons of ore before reserves were depleted.

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[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]Liaison program assistant, Bureau of Mines, Pittsburgh, Pa.
[3]Union Carbide Corp. 1981 Annual Report. P. 11.
[4]American Ceramic Society Bulletin. Alfred To Study Wollastonite. V. 60, No. 12, December 1981, p. 1320.
[5]NL Industries, Inc. 1981 Annual Report. P. 19.

Table 7.—New York: Mine production (recoverable) of silver, lead, and zinc

		1980	1981
Mines producing: Lode		3	2
Material sold or treated: Zinc ore	thousand metric tons	395	510
Production:			
Quantity:			
Silver	troy ounces	20,702	28,829
Lead	metric tons	876	968
Zinc	do.	33,629	36,889
Value:			
Silver	thousands	$427	$303
Lead	do.	$820	$780
Zinc	do.	$27,750	$36,235
Total	do.	$28,997	$37,318

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasives:			
The Carborundum Co.[1]	Box 423 Niagara Falls, NY 14302	Plant	Niagara.
General Abrasives Div. of Dresser Industries, Inc.	2000 College Ave. Niagara Falls, NY 14305	do	Do.
Pellets, Inc	531 South Niagara St. Tonawanda, NY 14150	do	Erie.
Aluminum smelters:			
Aluminum Co. of America	1210 Alcoa Bldg. Pittsburgh, PA 15222	do	St. Lawrence.
Reynolds Metals Co	Box 27003-2A Richmond, VA 23215	do	Do.
Cement:			
Alpha Portland Cement Co.[2]	15 South 3d St. Easton, PA 18042	Quarry and plant.	Greene.
Atlantic Cement Co., Inc., a subsidiary of Newmont Mining Corp.	Box 30 Stamford, CT 06904	do	Albany.
The Glens Falls Portland Cement Co., Inc., a subsidiary of Moore McCormack Resources, Inc.[3]	Box 440 Glens Falls, NY 12801	do	Warren.
Lehigh Portland Cement Co.[3]	718 Hamilton Mall Allentown, PA 18105	do	Greene.
The Marquette Co., a subsidiary of Gulf + Western Industries, Inc.[2 3]	1 Commerce Place Nashville, TN 37239	do	Do.
Clays:			
Norlite Corp	628 South Saratoga St. Cohoes, NY 12047	Pits	Albany.

See footnotes at end of table.

Table 8.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Clays —Continued			
Northeast Solite Corp., a subsidiary of Solite Corp.	Box 27211 Richmond, VA 23261	Pit	Ulster.
Emery:			
De Luca Emery Mine, Inc	929 Constant Ave. Peekskill, NY 10566	Pit	Westchester.
Garnet:			
Barton Mines Corp	North Creek, NY 12853	Pit	Warren.
Gypsum, calcined:			
Georgia-Pacific Corp	Box 311 Portland, OR 97207	Plant	Erie and Westchester.
National Gypsum Co.[4]	4100 1st International Bldg. Dallas, TX 75270	do	Bronx.
United States Gypsum Co.[4]	101 South Wacker Dr. Chicago, IL 60606	Underground mine and plant.	Genesee, Richmond, Rockland.
Iron ore:			
NL Industries, Inc.[5]	Tahawus, NY 12879	Pit	Essex.
Lime:			
Allied Chemical Corp.[2 6]	Box 70 Morristown, NJ 07960	Quarry and plant.	Onondaga.
Bethlehem Steel Corp	701 East 3d St. Bethlehem, PA 18016	do	Erie.
Peat:			
Anderson Peat Co., Inc	Pleasant Hill Rd. Wingdale, NY 12594	Bog	Dutchess.
Good Earth Organics Corp	5960 Broadway Lancaster, NY 14086	Bog	Cattaraugus.
Perlite, expanded:			
Buffalo Perlite Div. of Pine Hill Concrete Mix Corp.	100 Sugg Rd. Cheektowaga, NY 14225	Plant	Erie.
Salt:			
Cargill, Inc	Box 9300 Minneapolis, MN 55402	Underground mine.	Tompkins.
International Salt Co	Clarks Summit, PA 18411	do	Livingston.
Morton Salt Co	110 North Wacker Dr. Chicago, IL 60606	Well	Wyoming.
Sand and gravel:			
Colonial Sand & Stone Co., Inc.[2 3 7]	1740 Broadway New York, NY 10019	Pits	Dutchess.
Roanoke Marbro Sand & Gravel Corp	Box 172 Riverhead, NY 11901	Pit	Suffolk.
Valente Gravel, Inc	Box 56, R.D. 5 Troy, NY 12180	Pits	Albany and Rensselaer.
Slag:			
Buffalo Slag Co., a subsidiary of Koppers Co., Inc.[2 8]	111 Great Arrow Ave. Buffalo, NY 14216	Plants	Allegany, Cattaraugus, Steuben.
Stone:			
The General Crushed Stone Co., a subsidiary of Koppers Co., Inc.	712 Drake Bldg. Easton, PA 18042	Quarry	Herkimer, Jefferson, Livingston, Onondaga, Ontario, Wayne.
Johnston & Rhodes Bluestone Co	East Branch, NY 13756	do	Delaware.
New York Trap Rock Corp., a subsidiary of Lone Star Industries, Inc.	162 Old Mill Rd. West Nyack, NY 10994	do	Rockland.
Sulfur, elemental:			
Ashland Oil, Inc.[2]	Tonawanda, NY 14150	Refinery	Erie.
Talc:			
Gouverneur Talc Co., Inc., a subsidiary of R. T. Vanderbilt Co., Inc.	Gouverneur, NY 13642	Underground mine.	St. Lawrence.
Wollastonite:			
NYCO, a division of Processed Minerals, Inc.[9]	Box 368 Willsboro, NY 12996	Underground and surface mines.	Essex.
R. T. Vanderbilt Co., Inc	30 Winfield St. Norwalk, CT 06855	Surface	Lewis.
Zinc:			
St. Joe Minerals Corp.[10]	250 Park Ave. New York, NY 10017	Mine	St. Lawrence.

[1] Also synthetic mullite and synthetic graphite.
[2] Also stone.
[3] Also clays.
[4] Also expanded perlite.
[5] Also ilmenite.
[6] Also salt.
[7] Also cement.
[8] Also sand and gravel.
[9] Also garnet.
[10] Also lead and silver.

The Mineral Industry of North Carolina

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

By Doss H. White, Jr.[1] and P. Albert Carpenter III[2]

The value of mineral production in North Carolina's nonfuel mineral sector in 1981 was $376.5 million, $3.8 million less than the record set in 1980. Although production decreased for many mineral commodities, the State continued to lead the world in the production of lithium minerals and was first in the United States in the output of feldspar, mica, olivine, and pyrophyllite. North Carolina ranked second in production of common clay and crushed granite and ranked third in phosphate rock output.

The State's mineral producers and manufacturers played a key role in the Nation's space program. The National Aeronautic & Space Administration's reusable spacecraft, *Columbia*, was launched from Cape Canaveral during the year. Ceramic tiles on the craft's exterior for heat protection during launch and reentry were fabricated from silica recovered from feldspar ore beneficiation by International Minerals & Chemical Corp., Spruce Pine. A number of specialty mica shapes used in the spacecraft's electronic systems were fabricated by the Spruce Pine Mica Co.

Table 1.—Nonfuel mineral production in North Carolina[1]

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2]	thousand short tons	2,852	$7,308	2,110	$6,838
Feldspar	short tons	499,600	15,062	462,864	13,517
Gem stones		NA	40	NA	50
Mica, scrap	thousand short tons	r77	r4,647	92	6,398
Sand and gravel	do.	9,309	28,735	p8,936	p32,640
Stone:					
Crushed	do.	34,764	125,019	28,833	117,092
Dimension	do.	55	4,536	30	2,773
Pyrophyllite	do.	W	W	[3]104	[3]825
Combined value of cement, clays (kaolin), lithium compounds, olivine, phosphate rock, talc (1981), and value indicated by symbol W		XX	194,986	XX	196,397
Total		XX	r380,333	XX	376,530

pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes kaolin; value included with "Combined value" figure.

[3]Excludes talc; value included with "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Alamance	W	W	Stone, clays.
Anson	W	$8,126	Sand and gravel, stone.
Ashe	$831	W	Stone.
Avery	W	1,852	Mica, clays, stone, olivine, sand and gravel.
Beaufort	W	W	Phosphate rock, sand and gravel.
Bertie	W	21	Sand and gravel.
Bladen	75	71	Do.
Brunswick	42	25	Do.
Buncombe	W	W	Stone, sand and gravel, clays.
Burke	W	W	Sand and gravel.
Cabarrus	W	W	Stone, sand and gravel, clays.
Caldwell	W	W	Stone, sand and gravel.
Camden	W	4	Sand and gravel.
Caswell	W	W	Stone.
Catawba	W	W	Stone, sand and gravel.
Chatham	W	2,157	Clays.
Cherokee	W	W	Stone, talc.
Chowan	W	4	Sand and gravel.
Cleveland	18,880	16,129	Lithium, stone, feldspar, mica, sand and gravel, clays.
Craven	W	W	Stone, sand and gravel.
Cumberland	711	660	Sand and gravel.
Currituck	W	W	Do.
Dare	W	W	Sand and gravel, clays.
Davidson	W	W	Stone, clays.
Davie	W	W	Stone, sand and gravel.
Duplin	W	W	Do.
Durham	W	W	Stone, clays.
Edgecombe	W	W	Stone, sand and gravel.
Forsyth	W	W	Stone.
Franklin	W	W	Sand and gravel.
Gaston	14,247	14,719	Lithium, feldspar, stone, sand and gravel, mica.
Granville	W	W	Stone.
Greene	W	49	Sand and gravel.
Guilford	W	W	Stone, clays, sand and gravel.
Halifax	W	W	Clays.
Harnett	W	W	Sand and gravel, stone, clays.
Haywood	W	2,216	Sand and gravel, stone.
Henderson	W	W	Stone, clays, sand and gravel.
Hertford	336	318	Sand and gravel.
Hyde	4	4	Do.
Iredell	W	W	Stone, sand and gravel, clays.
Jackson	W	3,919	Olivine, stone, sand and gravel, mica.
Johnston	W	W	Stone, sand and gravel.
Jones	41	71	Stone.
Lee	W	W	Stone, clays, sand and gravel.
Lenoir	W	W	Sand and gravel.
McDowell	783	880	Do.
Macon	W	1,386	Stone, sand and gravel.
Martin	13	12	Sand and gravel.
Mecklenburg	W	W	Stone.
Mitchell	W	14,819	Feldspar, mica, sand and gravel, stone, olivine.
Montgomery	W	W	Sand and gravel, clays, stone.
Moore	W	W	Talc, sand and gravel, clays.
New Hanover	32,945	29,527	Cement, stone, clays, sand and gravel.
Northampton	417	332	Sand and gravel.
Onslow	W	W	Stone.
Orange	1,450	W	Talc, stone, sand and gravel.
Pasquotank	W	W	Sand and gravel.
Pender	W	W	Stone, sand and gravel.
Person	W	W	Stone.
Pitt	W	W	Stone, sand and gravel.
Polk	418	W	Stone.
Randolph	W	W	Do.
Richmond	3,301	3,206	Sand and gravel, stone.
Rockingham	W	W	Stone, clays, sand and gravel.
Rowan	W	W	Do.
Rutherford	723	W	Stone.
Sampson	W	132	Clays.
Scotland	6	W	Sand and gravel.
Stanly	1,529	506	Clays.
Stokes	W	235	Clays, sand and gravel, stone.
Surry	W	W	Stone, sand and gravel.
Swain	W	W	Stone.
Transylvania	W	W	Stone, sand and gravel.

See footnotes at end of table.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Tyrrell	$7	$7	Sand and gravel.
Union	W	W	Stone, clays.
Vance	W	W	Stone.
Wake	W	W	Stone, clays.
Washington	W	W	Sand and gravel.
Watauga	W	W	Stone.
Wayne	188	152	Sand and gravel.
Wilkes	W	W	Stone, sand and gravel.
Wilson	W	W	Do.
Yadkin	W	W	Sand and gravel.
Yancey	W	2,632	Olivine, sand and gravel, mica.
Undistributed[2]	265,295	276,163	
Total[3]	342,241	380,333	

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: Alexander, Alleghany, Carteret, Clay, Columbus, Gates, Graham, Hoke, Lincoln, Madison, Nash, Pamlico, Perquimans, Robeson, and Warren.

[2]Includes gem stones, some sand and gravel (1979) 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 North Carolina business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	2,732.6	2,793.2	+2.2
Unemployment	do	176.0	189.7	+7.8
Employment (nonagricultural):				
Mining	do	5.2	4.9	-5.8
Manufacturing	do	820.0	817.3	-.3
Contract construction	do	118.7	114.9	-3.2
Transportation and public utilities	do	116.5	116.7	+.2
Wholesale and retail trade	do	472.9	473.5	+.1
Finance, insurance, real estate	do	95.5	98.0	+2.6
Services	do	341.3	352.4	+3.3
Government	do	409.9	408.7	-.3
Total nonagricultural employment	do	2,380.0	2,386.4	+.3
Personal income:				
Total	millions	$46,118	$51,670	+12.0
Per capita		$7,832	$8,679	+10.8
Construction activity:				
Number of private and public residential units authorized		37,007	31,014	-16.2
Value of nonresidential construction	millions	$606.6	$615.5	+1.5
Value of State road contract awards	do	$170.0	$136.0	-20.0
Shipments of portland and masonry cement to and within the State	thousand short tons	1,647	1,628	-1.2
Nonfuel mineral production value:				
Total crude mineral value	millions	$380.3	$376.5	-1.0
Value per capita, resident population		$65	$64	-1.5
Value per square mile		$7,214	$7,160	-.8

[p]Preliminary.

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

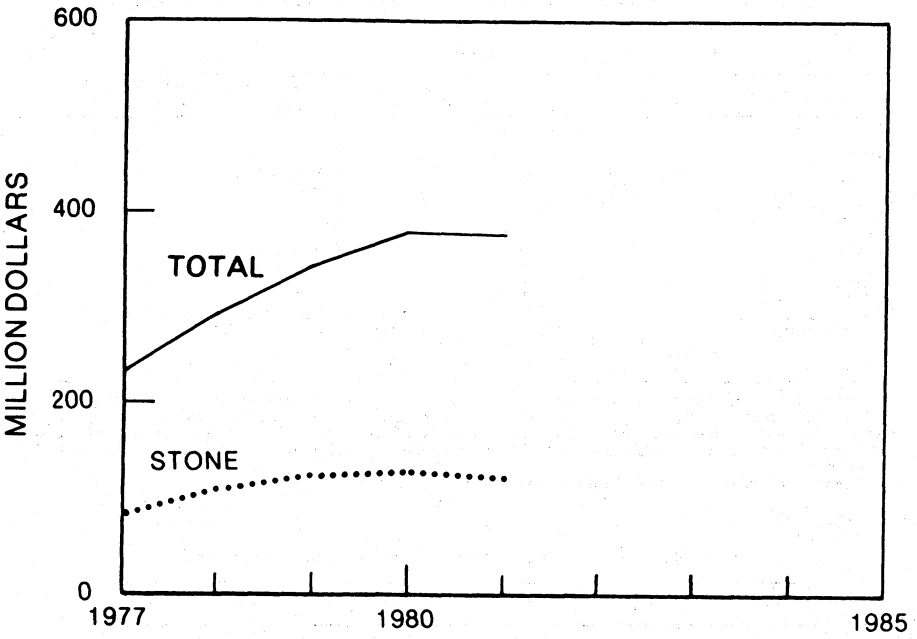

Figure 1.—Value of stone and total value of nonfuel mineral production in North Carolina.

Trends and Developments.—During the past decade, approximately 50% of the mineral output in North Carolina was used by the construction industry. The remainder was used in a myriad of applications, including glassmaking, electrical components, by the steel industry, in fertilizer manufacture, as insecticide carriers, wallboard filler, for lithium chemicals, and in the fabric industry. The depressed economy, a carryover from the previous year, which deepened into a recession during mid-1981, had a negative effect on most segments of the State's mineral industry.

Double-digit interest rates, inflated construction costs, and a shortage of mortgage money resulted in the continued drop in the output of mineral commodities used by the residential and commercial construction industries. Although the number of commercial construction permits issued increased slightly over that of 1980, the number of residential housing permits issued was 6,000 fewer than in 1980.

The largest market for crushed stone—highway construction and maintenance—was hard hit by the cutbacks in Federal funding for State highway projects. Production of mineral commodities used in construction were affected by slumping sales for the second year. Output of crushed stone, sand and gravel, and clay decreased 7 million tons from the previous year, and sales were $4.5 million less than in 1980.

Output of other North Carolina mineral commodities—cement, feldspar, phosphate, pyrophyllite, and talc—declined as economic conditions forced traditional customers to curtail purchases.

The State's metal producers were also affected by the economic downturn. A drop in aluminum demand and the need to control inventory forced the Aluminum Company of America (Alcoa) to reduce output at the Badin primary smelter by 62,500 tons per year.

Despite the economic downturn, a number of mineral producers and processors continued to expand, open, or update mines and plants.

Lithium Corp. of America, Gastonia, completed the final stage of a 3-year, $18 million expansion at the Gastonia Mine, mill, and chemical plant. At midyear, North Carolina Phosphate Co. began work on the erection of a 70-cubic-yard dragline to be used in

overburden and ore removal at the company's new mine in Beaufort County. Contracts were let for four bucket wheel excavators to aid in overburden removal and materials handling.

The Wake Stone Co. received a permit to open a stone quarry next to William B. Umstead State Park, west of Raleigh. A mining permit was denied by the State Department of Natural Resources and Community Development, but the ruling was overturned by the North Carolina Mining Commission.

At yearend, W. R. Grace & Co. was completing plans for the construction in Wilmington of the first commercial calcium nitrate plant in North America.

Universal Mining Corp. at Alverarle announced tentative plans to construct a $5 million gold processing plant and mine in Stanly County. The new facility would use a microgrinder to pulverize gold ore to submicron size prior to chemical treatment.

A number of companies were active in gold and other base metal exploration. Among these were Newmont Mining Co., which drilled the Portis gold property in Franklin County, and Gulf Mineral Resources, a division of Gulf Oil Co., which obtained mineral rights to acreage in Lee and Harnett Counties. Cominco, Ltd., a Vancouver, British Columbia, company, was active in base metal exploration in the southwestern portion of Burke County.

Legislation and Government Programs.—A bill to establish a mineral severance tax was introduced on the last day of the summer session of the 1981 budgetary biennium session of the North Carolina General Assembly. Also introduced was a bill to abolish the State mineral depletion allowance. The session adjourned without action on either bill.

The North Carolina Geological Survey continued work on a number of projects, including the publication of several 7 1/2-minute geologic quadrangle maps in the western part of the State and multicounty planning region maps in the Piedmont. The State contributed more than $300,000 in matching funds to continue the preparation of standard 7 1/2-minute quadrangle maps in cooperation with the U.S. Geological Survey (USGS). The program was expected to be completed in 1985.

During the year, work began on planning for a new State geologic map scheduled for 1985. Planning also began on a project to map Randolph County in detail.

The North Carolina State University Minerals Research Laboratory in Asheville continued work on the evaluation and beneficiation of ores from North Carolina, other States, and foreign sources. The laboratory, founded in 1946, has a worldwide reputation for excellence in its field and is one of the top-ranked University-affiliated minerals testing laboratories in the country. The laboratory is equipped with the latest mineral processing equipment and analytical support facilities for batch and continuous pilot plant research. Workable flowsheets and bulk samples for company evaluation are two of the principal objectives of the laboratory. Among the projects completed in 1981 were (1) beneficiation of Beaufort County and Onslow Bay (North Carolina) phosphate, (2) recovery of feldspar and quartz from pegmatite river sand, (3) magnetic separation to upgrade refractory materials, (4) pebble milling of sericite mica ore, and (5) pilot-scale beneficiation of foundry sand and beneficiation of oil well frac sands.

The Mineral Land Assessment Section at the U.S. Bureau of Mines Eastern Field Operations Center, Pittsburgh, Pa., was involved in a number of investigations to determine the mineral potential of several North Carolina RARE II and Wilderness Areas. During the year, the results of these assessments were placed on open file for Ellicott Rock Expansion (RARE II), Persimmon Mountain (RARE II), and Ellicott Rock Wilderness (MLA 29-81). Also published were the results of investigations on the mineral potential of Harper Creek and Lost Cove RARE II Areas (MLA 1-82). At yearend, work was completed on Overflow (MLA 31-82) and Snowbird (MLA 42-82) manuscripts. The completed report on the mineral potential of the Shining Rock Wilderness Area (MLA 13-81) was in revision to integrate work on the area by geologists with the USGS.

Bureau personnel also completed reconnaissance sampling of stream sediments and pan concentrates on the Cherokee Reservation in southwestern North Carolina. In addition, a geochemical survey grid was established for several areas of known mineral potential near the reservation.

The Bureau's Tuscaloosa Research Center, Tuscaloosa, Ala., tested the firing properties of several North Carolina clay samples under a Memorandum of Understanding to test and evaluate a number of the State's mineral commodities.

The USGS continued work on several projects of potential interest to the mineral

industry and geologic community. Investigations were completed on mineral occurrences in the Charlotte 2° Quadrangle, and a public meeting to discuss the results of the investigation was scheduled for 1982.

The USGS also continued detailed studies of known hydrothermal systems in the Carolina volcanic slate belt, and studies of the structural setting of the Great Gossen lead sulfide deposit continued. Investigations were ongoing to produce a series of mineral deposit maps of the Appalachian Orogen. Deposits investigated were those containing significant amounts of gold, pyrophyllite, kyanite, topaz, tourmaline, and/or hydrothermal clays.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Production and sales of most nonmetallic commodities declined as the recession slackened demand and traditional customers cut back on orders. Production of 7 of the 11 nonmetallic mineral commodities in North Carolina fell, and total value was off almost $4 million. The only mineral commodities with higher output and sales were cement, lithium, mica, and olivine.

Boron.—Boric acid manufactured in California and colemanite, a calcium borate mined in Turkey and processed in South Carolina, were used by PPG Industries, Inc., in fiberglass manufacture at the company's Shelby and Lexington plants. Work continued on the $20 million expansion of the Shelby facility scheduled for completion in 1982.

Cement.—Ideal Basic Industries, Inc., the State's sole cement producer, manufactured portland and masonry cement at its wet-process plant at Castle Hayne in New Hanover County. Although the nationwide recession depressed construction activity, the cement company reported an increase in portland cement shipments. Masonry cement production felt the effects of the slump in construction as output fell.

Clays.—The slump in construction activity reduced the demand for structural clay products; production of common clay dropped by almost 750,000 tons, and value was down almost $500,000. Kaolin output, used in specialty clay applications, was less affected as output and sales increased over those reported in 1980.

Table 4.—North Carolina: Common clay and shale sold or used by producers, by county

County	1980			1981		
	Number of mines	Quantity (short tons)	Value	Number of mines	Quantity (short tons)	Value
Alamance	1	53,601	$107,845	1	49,934	$110,454
Cabarrus and Durham	3	364,141	978,741	3	240,554	974,835
Chatham	4	527,862	2,157,499	3	225,180	869,082
Davidson	1	52,668	100,069	1	W	W
Iredell	1	29,321	r55,710	1	W	44,826
Lee	3	741,276	1,353,310	3	249,987	502,972
Montgomery and New Hanover	4	149,558	512,878	4	152,972	555,157
Rockingham	2	W	W	3	241,027	387,074
Rowan	2	W	W	3	150,715	912,407
Sampson	1	32,500	131,625	1	30,000	121,500
Stanly	2	W	W	3	288,300	1,330,168
Stokes	1	35,538	89,911	1	35,538	89,911
Undistributed[1]	r10	865,284	r1,820,015	10	446,173	940,034
Total	35	2,851,749	7,307,603	37	2,110,380	6,838,420

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Includes Buncombe, Dare (1980), Guilford, Halifax, Harnett, Henderson, Moore, Union, and Wake Counties and data indicated by symbol W.

In 1981, the industry consisted of 19 companies operating 54 pits to produce common clay for the manufacture of brick and other structural clay products. A cement company in New Hanover County on the Atlantic Coast mined clay for use in cement manufacture. Kaolin was recovered by Harris Mining Co. in Avery County and Kings Mountain Mica Co. in Cleveland County as a coproduct of mica mining.

Feldspar.—The State, as in past years, led the Nation in the output of feldspar, used primarily in the manufacture of glass and ceramics. Sales continued to decline, and output was 37,000 tons less than in 1980, owing primarily to the slump in the automotive and home construction industries, which weakened the market for glass. Also affecting sales was the use of plastic containers in place of glass containers.

Three producers in the Spruce Pine district recovered feldspar by flotation of

alaskite ore. Two companies in the Kings Mountain-Gastonia area recovered a feldspar concentrate in the beneficiation of spodumene, a lithium ore. A third company in the Kings Mountain area recovered a feldspar concentrate as a coproduct of mica, clay, and silica production.

Gem Stones.—North Carolina was the leading State in the East and one of the leaders in the Nation in the output of gem stones. Rubies, sapphires, garnets, hiddenite, and aquamarine are among the gems occurring in a number of counties in the southwestern part of the State. A number of large gem stones were found during the summer of 1981, and collectors from many parts of the country and several foreign countries visited the many gem mines in North Carolina.

During the year, gem mine owners in Cowee Valley near Franklin reached agreement with State authorities on monitoring water leaving the mine-sites. Several owners are required to collect and analyze water samples on a weekly basis to insure that silt from their operations does not create a problem downstream.

Graphite.—Great Lakes Carbon Corp. produced synthetic graphite at a facility in Morganton. Petroleum coke and pitch, a refinery byproduct, was the primary raw material used in the manufacturing process. Synthetic graphite was used to manufacture anodes, electrodes, crucibles, and vessels.

Gypsum.—National Gypsum Co., Wilmington, imported crude gypsum from Nova Scotia to calcine and manufacture wallboard. Ideal Basic Industries, Inc., also purchased Nova Scotia gypsum imported through Virginia for cement manufacture at the company's Castle Hayne facility. Byproduct gypsum was produced during phosphoric acid manufacture at Texasgulf's Lee Creek facility. A limited tonnage was sold locally for agricultural purposes.

Iodine.—Mallinkrodt, Inc., near Raleigh, imported crude iodine from Japan for the manufacture of X-ray contrast media.

Lithium.—The Kings Mountain-Gastonia area of North Carolina continued to lead the world in the production of spodumene, a lithium aluminum silicate used in the manufacture of lithium carbonate. According to company 10K reports, production increased almost 10% over that reported in 1980.

Foote Mineral Co., Inc., Kings Mountain, Cleveland County, and Lithium Corp. of America, Gaston County, mined spodumene-rich pegmatite by open pit methods. Following a series of beneficiation steps, lithium carbonate was produced, which is the feedstock for a variety of lithium-based products. Byproduct feldspar, mica, and silica were recovered during beneficiation.

Mica.—North Carolina again led the Nation in scrap and flake mica output; the State produced approximately 69% of the 133,000 tons produced in the United States during 1981. Mica output and sales in 1981 were 92,000 tons, valued at $6.4 million, an increase of 15,000 tons and $1.8 million over that reported for 1980. A strong demand for ground mica for oil well drilling mud buoyed mica sales throughout the year.

Olivine.—Three companies operated five open pit mines in Mitchell, Yancey, and Jackson Counties in western North Carolina. Principal sales were to the steel and foundry industries for a slag conditioner and foundry sand. Despite the effects of the recession on the steel and related industries, the companies reported a significant increase in production and sales.

Following a multiyear controversy, Appalachian Properties, Inc., was granted permission by the U.S. Forest Service to develop an olivine mine on Buck Creek in the Nantahala National Forest. Forest Service recommendations were to allow mining on a 150-acre tract. However, the company must establish a 103-acre botanical area, and set aside 93 acres for recreational mineral collecting. Mining is contingent upon lease issuance by the Department of the Interior Bureau of Land Management and market conditions.

Table 5.—North Carolina: Ground mica sold or used by producers, by use

Use	1980[r]		1981	
	Quantity (short tons)	Value	Quantity (short tons)	Value
Roofing	W	W	W	W
Paint	7,192	$1,384,527	7,843	$1,671,244
Rubber	2,659	645,609	W	W
Joint cement	29,566	3,969,125	26,927	4,106,481
Other[1]	37,027	5,368,409	42,133	6,884,441
Total	76,444	11,367,670	76,903	12,662,166

[r]Revised. W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes insulation (1981), plastics, textile coatings, wallpaper (1980), welding rods (1981), well drilling, other miscellaneous uses, and uses indicated by symbol W.

Table 6.—North Carolina: Mica industry in 1981

Company	Location	Grinding process	Comments
Producers (mica):			
Harris Mining Co	Spruce Pine	Wet	Primary mica.
Deneen Mica Co	do	Dry	Do.
The Feldspar Corp	do	XX	Byproduct mica; sold to United States Gypsum Co.
Foote Mineral Co	Kings Mountain	XX	Byproduct mica; sold to Asheville Mica Co.
International Minerals & Chemical Corp.	Spruce Pine	XX	Byproduct mica; sold to Harris Mining Co.
Kings Mountain Mica Co	Kings Mountain	Dry and wet	Primary mica.
Lawson-United Feldspar & Mineral Co.	Spruce Pine	XX	Byproduct mica; sold to Harris Mining Co.
Lithium Corp. of America	Kings Mountain	XX	Byproduct mica; sold to various firms.
Mitchell Mining & Manufacturing Co.	Spruce Pine	Wet	Processes mica schist and scrap from mica fabricators.
Producers (sericite):			
Piedmont Minerals Co	Hillsboro	XX	Sold to brick and ceramics industries.
Processors of purchased mica:			
Asheville Mica Co	Asheville	Dry.	
Diamond Mica Co	Spruce Pine	Dry.	
Franklin Mineral Co	Franklin	Wet	Mica received from Georgia.
United States Gypsum Co	Spruce Pine and Kings Mountain.	Dry.	
Fabricators:			
Spruce Pine Mica Co	Spruce Pine	XX	Mica obtained from foreign sources.
Tar Heel Mica Co	Plumb Tree	XX	Do.

XX Not applicable.

Perlite.—Carolina Perlite Co., Inc., Rowan County, operated an expanded perlite plant at Gold Hill. Raw material was obtained by rail from New Mexico. Output and sales dropped for the second year as the construction industry, the major user of the product, remained in a depressed state.

Phosphate Rock.—The State ranked third nationally behind Florida and Idaho in phosphate rock output. However, production was less than the 1980 level as farmers, feeling the effects of the recession, purchased less fertilizer than in previous years. Foreign sales were also depressed.

In 1981, Texasgulf added a third dredge to the company's fleet at Lee Creek. The 30-inch dredge, the Sir Walter Raleigh, will be used in the initial step of overburden removal. After mining, the ore is processed by flotation to produce a concentrate containing about 30.5% phosphorus pentoxide. The phosphate concentrate is reacted with sulfuric acid to produce phosphoric acid, which is sold in the liquid state and used by the company to manufacture granular fertilizer. Work continued on the fertilizer facility expansion, which will raise capacity to 1 million tons of phosphorus pentoxide when completed in 1982.

North Carolina Phosphate Co., a subsidiary of Agrico Chemical Co., continued work on the new mine at Lee Creek, adjacent to the Texasgulf operation. Erection began on the dragline used for overburden removal, and orders were placed for four bucket wheel excavators. Plans were underway to relocate a portion of the highway from Aurora to the Lee Creek area to improve resource recovery.

At yearend, Agrico and Anic, an affiliate of the Italian ENI group, formed a 50-50 partnership on North Carolina Phosphate Co.'s new mine. Under this agreement, the partnership acquired a 21.6% interest in the proposed 3.7-million-ton-per-year operation. Earlier in the year, Agrico formed a partnership with Cie. Francaise de L'Azote, acquiring 19% of the mine.

Geologists at North Carolina University and the University of Southern Florida continued work to evaluate offshore phosphate resources. The deposits, in water depths ranging from 50 to 130 feet, contain individual beds up to 26 feet thick.

Pyrophyllite.—The pyrophyllite industry in North Carolina is composed of three companies, Standard Minerals Co., Inc., and Glendon Pyrophyllite, Inc., in Moore Coun-

ty and Piedmont Minerals Co., Inc., in Orange County.

The Moore County operations produce a "textbook" pyrophyllite by open pit mining, which is marketed as an insecticide filler and carrier, for use in wallboard, latex foam filler, and ceramic products.

The Orange County operation produces an andalusite-rich pyrophyllite by open pit mining and heavy-media concentration. The material is trucked to Greensboro for refractory uses. Piedmont also recovers sericite and quartzite in the mining operation, which are sold as a material in brick manufacture and as a driveway aggregate.

Table 7.—North Carolina: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	5,640	$12,485	$2.21	NA	NA	NA
Gravel	2,197	8,425	3.84	NA	NA	NA
Total or average	7,837	20,910	2.67	p7,700	p$22,200	p$2.88
Industrial:						
Sand	862	3,526	4.09	637	5,593	8.78
Gravel	610	4,299	7.05	599	4,847	8.09
Total or average	1,472	7,825	5.32	1,236	10,440	8.44
Grand total or average	9,309	28,735	3.09	p8,936	p32,640	p3.65

pPreliminary. NA Not available.

Sand and Gravel.—The U.S. Bureau of Mines, to reduce reporting burdens and costs, implemented new sand and gravel canvassing procedures for the survey of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel operators will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but contains complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

In 1981, North Carolina's sand and gravel industry consisted of 115 companies operating 245 pits.[3] Preliminary data indicated that 8.9 million tons valued at $32.6 million was produced, a decrease of 373,000 tons.

Nationally, North Carolina ranked in the top 10 in industrial sand and gravel output. Six companies marketed industrial sand; output was centered in Anson, Richmond, and Harnett Counties, which accounted for approximately 95% of the production. Additional tonnages of industrial-grade silica were produced as a byproduct of feldspar and lithium beneficiation. Major sales were to the container and flat glass industries.

Stone.—Although stone continued to be the State's leading mineral commodity in terms of sales, the slump in construction depressed the market for the second year, and sales fell $5 million below that reported for 1980. Crushed stone output was down almost 6 million tons and dimension stone production dropped 25,000 tons lower than the amount quarried in 1980, a 46% drop.

Table 8.—North Carolina: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural marl and other soil conditioners	W	W	208	1,113
Poultry grit and mineral food	30	294	30	281
Concrete aggregate	5,027	20,528	5,050	23,512
Bituminous aggregate	3,883	15,042	3,302	14,360
Macadam aggregate	W	W	790	3,319
Dense-graded road base stone	11,020	35,720	7,676	27,691
Surface-treatment aggregate	1,043	3,820	733	2,937
Other construction aggregate and road stone	7,882	28,913	6,372	25,609
Riprap and jetty stone	512	2,139	441	2,478
Railroad ballast	2,544	8,228	2,373	8,788
Filter stone	551	2,026	52	242
Manufactured fine aggregate (stone sand)	901	2,834	916	3,094
Terrazzo and exposed aggregate	6	73	5	71
Asphalt filler	--	--	6	29
Roofing granules	W	W	26	209
Other[2]	1,366	5,402	852	3,358
Total[3]	34,764	125,019	28,833	117,092

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, granite, marl, sandstone (1981), traprock, and slate.
[2]Includes stone used in agricultural limestone, cement manufacture, and other uses not specified.
[3]Data may not add to totals shown because of independent rounding.

Table 9.—North Carolina: Dimension stone[1] sold or used by producers, by use

Use	1980			1981		
	Quantity			Quantity		
	Short tons	Cubic feet (thousands)	Value (thousands)	Short tons	Cubic feet (thousands)	Value (thousands)
Rough stone:						
Rough blocks	6,800	81	$323	3,480	40	$236
Irregular-shaped stone	6,090	75	274	5,389	67	175
Rubble	1,145	14	20	722	9	12
Monumental	3,947	48	229	3,634	44	257
Dressed stone:						
Cut stone	4,200	53	851	4,505	56	912
Monumental	W	W	W	671	8	237
Construction stone	4,800	60	646	--	--	--
Curbing	25,200	315	1,407	7,718	96	431
Structural and sanitary	W	W	W	1,228	14	356
Other[2]	3,183	37	786	2,559	31	157
Total	55,365	[3]682	4,536	29,906	365	2,773

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes granite, marble, sandstone, and slate.
[2]Includes flagging, house stone veneer, and dressed flagging.
[3]Data do not add to total shown because of independent rounding.

In spite of the depressed aggregate market, Wake Stone Co. completed plans for opening a new quarry in the Raleigh area. The proposed operation, next to a State park, was opposed by citizens groups and some State officials. Plans by Martin Marietta Corp. to develop a quarry in Forsyth County also met opposition. Quarry opponents cited noise, air pollution, and traffic problems that could be associated with the proposed operation.

Talc.—The Warner Corp., Murphy, produced talc for cosmetics and talc pencils from the State's only underground mine. Production fell as the recession softened the cosmetic market and foreign imports adversely affected talc pencil sales.

METALS

Aluminum.—Alcoa produced aluminum at a 125,000-ton-per-year primary smelter at Badin in Stanly County. Feed for the smelter was shipped from the company's bauxite-to-alumina plant in Mobile, Ala.

Poor market conditions forced Alcoa to cut production at a number of smelters, including the Badin facility. Output was cut 62,500 tons per year.

Cobalt.—Carolmet, Inc., produced extra-fine cobalt powder at a plant in Laurinburg

in southern North Carolina. Cobalt was sold as a cementing material for use in the manufacture of carbide cutting tools. Raw material, cobalt "slugs," was obtained from the Zairian cobalt producer, Gécamines.

Copper.—SCM Co., Glidden Metal Div., completed construction on a powdered metal facility at Durham. Copper powder is produced from scrap for the bearing and friction products industries.

Lithium Metal.—Foote Mineral Co. and Lithium Corp. of America produced lithium metal using molten salt electrolysis. Output consisted of ingots, rod, wire, shot, and dispersions.

Magnetite.—Cranberry Magnetite Corp. imported ground magnetite from New York. The material was dried, bagged, and marketed in West Virginia, Virginia, Tennessee, and Alabama for use in coal preparation.

Manganese.—Manganiferous schists mined in northwestern South Carolina were imported for use as a coloring agent by brick companies.

Steel.—North Carolina's only steel mill is located in Charlotte in the south-central part of the State. The Florida Steel Co. facility operates 32- and 36-ton electric furnaces and two 2-strand continuous billet casters.

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[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]Geologist, North Carolina Geological Survey Section, Raleigh, N.C.
[3]McDaniel, R. D., and P. A. Carpenter, III. Directory of North Carolina Mineral Producers—1981. North Carolina Department of Natural Resources & Community Development, Division of Land Resources, Geological Survey Section, 1982, 56 pp.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum, smelter:			
Aluminum Co. of America	1501 Alcoa Bldg. Pittsburgh, PA 15219	Plant	Stanly.
Cement:			
Ideal Basic Industries, Inc.[1 2]	950 17th St. Denver, CO 80201	do	New Hanover.
Clays:			
Boren Clay Products Co	Box 368 Pleasant Garden, NC 27313	Open pit mines and plant.	Chatham, Guilford, Sampson.
Sanford Brick Corp	Drawer 458 Sanford, NC 27330	do	Chatham, Lee, Stanly.
Solite Corp	Box 27211 Richmond, VA 23261	do	Rockingham and Stanly.
Feldspar:			
The Feldspar Corp.[1 2 3]	Box 99 Spruce Pine, NC 28777	Open pit mines and plants.	Mitchell.
International Minerals & Chemical Corp.[3]	666 Garland Place Des Plaines, IL 60016	do	Do.
Lawson-United Feldspar & Minerals Co.[3]	Box 309 Spruce Pine, NC 28777	do	Do.
Lithium minerals:			
Foote Mineral Co.[1]	Box 792 Kings Mountain, NC 28086	Open pit mine and plant.	Cleveland.
Lithium Corp. of America	449 North Cox Rd. Gastonia, NC 28052	do	Gaston.
Mica:			
Deneen Mica Co.[4]	Box 28 Micaville, NC 28755	Open pit mines	Mitchell.
Harris Mining Co.[1 2]	Box 628 Spruce Pine, NC 28777	do	Avery.
Kings Mountain Mica Co.[4]	Box 709 Kings Mountain, NC 28086	do	Cleveland.
Olivine:			
International Minerals & Chemical Corp.	Box 672 Spruce Pine, NC 28777	do	Jackson and Yancey.
Perlite, expanded:			
Carolina Perlite Co., Inc	Box 741 Hillside, NJ 07205	Plant	Rowan.
Phosphate rock:			
Texasgulf, Inc.[5]	Box 48 Aurora, NC 27806	Open pit mine and plant.	Beaufort.
Pyrophyllite:			
Glendon Pyrophyllite, Inc	Box 306 Carthage, NC 28327	Open pit mines and plant.	Alamance and Moore.
Piedmont Minerals Co., Inc.[3]	Box 566 Hillsborough, NC 27278	Open pit mine and plant.	Orange.
Standard Minerals Co., Inc	Box 278 Robbins, NC 27325	do	Moore.

See footnotes at end of table.

Table 10.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel:			
Becker Sand & Gravel Co	Box 848 Cheraw, SC 29520	Pits	Anson and Harnett.
W. R. Bonsal Co	Box 38 Lilesville, NC 28091	do	Anson.
B. V. Hedrick Gravel and Sand Co.[1]	Box 8 Lilesville, NC 28091	do	Do.
Stone:			
Martin Marietta Corp	Box 30013 Raleigh, NC 27612	do	Various.
Nello L. Teer Co	Box 1131 Durham, NC 27702	do	Do.
Vulcan Materials Co., Mideast Div.	Box 7506, Reynolds Station Winston-Salem, NC 27109	do	Do.
Talc:			
Warner Corp	Box 459 Murphy, NC 28906	Underground mine	Cherokee.
Vermiculite, exfoliated:			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plant	Guilford.

[1]Also stone.
[2]Also clays.
[3]Also mica.
[4]Also feldspar.
[5]Also gypsum.

The Mineral Industry of North Dakota

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the North Dakota Geological Survey for collecting information on all nonfuel minerals.

By James H. Aase[1]

Nonfuel mineral production in North Dakota during 1981 was valued at $22.4 million, a slight increase over that of 1980. Sand and gravel was the State's leading nonfuel mineral commodity in value, constituting an estimated 63% of the total output value in 1981. Other nonfuel mineral commodities produced in the State during the year, in descending order of production value, included salt, lime, clays, peat, and gem stones, none of which gained in output over that of the previous year.

North Dakota, in 1981, was positioned 48th among all the States for nonfuel mineral production values.

The State Legislature has designated the North Dakota State Soil Conservation Committee (NDSSCC) to administer North Dakota's Surface Mining Reports Law; the law requires any party conducting surface mining operations for minerals other than coal to provide information on land disturbed by surface mining and on reclamation activities. NDSSCC reported that during 1981, surface mining operations for minerals other than coal affected 791.7 acres of land from which 7,791,665 cubic yards of minerals was mined and 948,422 cubic yards of overburden was disturbed. The NDSSCC indicated that 155 pits were operated, ranging from 0.2 to 50 acres; clay, gravel, sand, and scoria were mined from these pits.

Employment in the State's nonfuel mining industry during 1981, the North Dakota Job Service reported, averaged 288 workers, ranging from 150 in January to 370 workers in July and August.

The U.S. Department of the Interior, Bureau of Land Management, paid North Dakota approximately $4.1 million as the State's share of Federal revenue collected for mineral leasing on public lands during Federal fiscal year 1981. The State receives 50% of the bonuses, rentals, and royalties collected from mineral-leasing activities on federally owned public lands in the State.

Table 1.—Nonfuel mineral production in North Dakota[1]

Mineral	1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Gem stones	NA	$2	NA	$2
Peat thousand short tons	W	31	W	36
Sand and gravel do	5,173	14,457	[p]4,900	[p]14,100
Combined value of clays, lime, and salt	XX	7,886	XX	8,307
Total	XX	22,376	XX	22,445

[p]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Barnes	$241	$71	Sand and gravel.
Benson	--	W	Do.
Bottineau	72	W	Sand and gravel, peat.
Bowman	W	W	Sand and gravel.
Burke	W	555	Do.
Burleigh	3,694	3,148	Do.
Cass	W	W	Do.
Dickey	79	--	
Divide	81	79	Sand and gravel.
Dunn	4	--	
Eddy	914	777	Sand and gravel.
Emmons	--	111	Do.
Foster	W	W	Do.
Grand Forks	W	W	Do.
Kidder	W	94	Do.
McHenry	W	W	Do.
McKenzie	166	W	Sand and gravel, salt.
McLean	930	622	Sand and gravel.
Mercer	--	205	Do.
Morton	W	W	Sand and gravel, clays.
Mountrail	1,358	W	Sand and gravel.
Pembina	W	949	Lime, sand and gravel.
Pierce	W	W	Sand and gravel.
Ramsey	--	61	Do.
Ransom	W	W	Do.
Renville	W	W	Do.
Richland	W	W	Lime, sand and gravel.
Rolette	57	63	Sand and gravel.
Stark	W	1,585	Do.
Stutsman	758	909	Do.
Towner	W	W	Do.
Traill	414	155	Do.
Walsh	478	220	Do.
Ward	1,647	2,120	Do.
Williams	4,070	6,290	Salt, sand and gravel.
Undistributed[2]	6,268	4,363	
Total[3]	21,234	22,376	

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: Adams, Billings, Cavalier, Golden Valley, Grant, Griggs, Hettinger, La Moure, Logan, McIntosh, Nelson, Oliver, Sargent, Sheridan, Sioux, Slope, Steele, and Wells.

[2]Includes gem stones and values indicated by symbol W.

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

The 1981 North Dakota Legislature passed a number of bills relating to mining; these measures effected minor changes in the comprehensive set of mining and reclamation laws written by the legislative assemblies of the 1970's. Included among the enactments were the following:

HB 1385—Defines a mineral developer, pertaining to coal, as the owner of 75% of the mineral rights to the area to be mined. The bill would allow companies to start strip mining even if they do not completely own the mineral rights to the property. The courts had held that a developer must own 100% of the mineral rights before he had legal standing as the mineral owner.

SB 2329—Expands definition of surface and mineral owner to "their successors, assignees, or predecessors" for coal. The bill protects the interest of the company or individual leasing mineral rights by binding new or future surface owners to the terms of the coal leases former landowners signed for surface damage and crop destruction.

The North Dakota Geological Survey underwent a number of operational changes during the year. The most significant event affecting the agency was the passage of HB 1536 by the State's 47th Legislative Assembly. The legislation amends sections of Chapter 38-08 of the North Dakota Century Code relating to the powers and duties of the Industrial Commission and the State geologist. Basically, the legislation reorganizes the State's natural resource agencies, transferring the Survey's role in oil and gas regulation directly to the State Industrial Commission. Consequently, all Survey personnel who had been involved in oil and gas regulation were transferred to a newly created Industrial Commission Oil & Gas Div. The changes involve about 25 Survey employees. The Survey no longer maintains offices in either Bismarck or Williston.

Table 3.—Indicators of North Dakota business activity

		1980	1981[P]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	291.0	301.6	+3.6
Unemployment	do.	15.3	15.7	+2.6
Employment (nonagricultural):				
Mining[1]	do.	7.8	10.9	+39.7
Manufacturing	do.	15.6	15.3	-1.9
Contract construction	do.	16.5	14.8	-10.3
Transportation and public utilities	do.	16.8	17.1	+1.8
Wholesale and retail trade	do.	66.8	66.3	-.8
Finance, insurance, real estate	do.	11.4	11.8	+3.5
Services	do.	49.4	51.9	+5.1
Government	do.	60.9	60.5	-.7
Total nonagricultural employment[1]	do.	245.2	248.6	+1.4
Personal income:				
Total	millions	$5,643	$6,930	+22.8
Per capita		$8,626	$10,525	+22.0
Construction activity:				
Number of private and public residential units authorized		3,141	1,910	-39.2
Value of nonresidential construction	millions	$89.0	$104.9	+17.9
Value of State road contract awards	do.	$64.0	$88.8	+38.8
Shipments of portland and masonry cement to and within the State	thousand short tons	277	324	+17.0
Nonfuel mineral production value:				
Total crude mineral value	millions	$22.4	$22.4	--
Value per capita, resident population		$34	$34	--
Value per square mile		$317	$318	+.3

[P]Preliminary.
[1]Includes coal and oil and gas extraction.

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

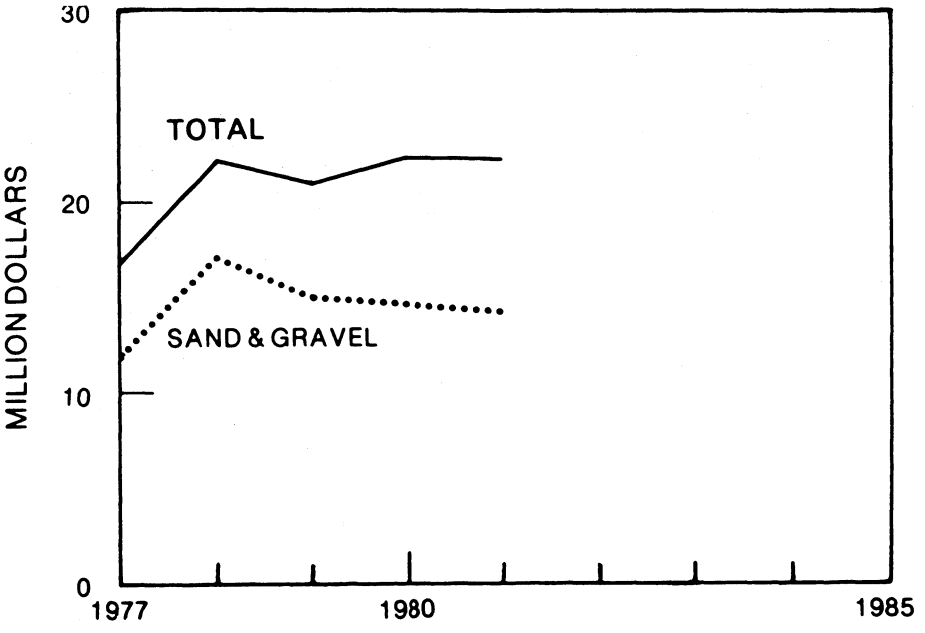

Figure 1.—Value of sand and gravel and total value of nonfuel mineral production in North Dakota.

During the year, the Survey released more than a dozen new publications dealing with the State's mineral and water resources and geology. Included among the publications were a bibliography of North Dakota geology (1960-1979) and a lexicon of stratigraphic names; a correlation chart of Williston Basin stratigraphic names in use in North Dakota, South Dakota, Montana, and Saskatchewan and Manitoba (Canada); the geology of Sheridan County; ground water recharge in western North Dakota, the ground water resources of Billings, Golden Valley, McHenry, McIntosh, Sheridan, and Slope Counties; North Dakota's hydrothermal resources with map; and a supplement to the drill-stem test catalog.

Exploring for and developing North Dakota coal continued to be a major research area for the Survey during the year. Studies in coal stratigraphy and an estimation of total strippable coal in western North Dakota were in progress. Also underway was a regional study of the Cenozoic rocks in the Williston and Powder River Basins, dealing with coal-mining potential, uranium occurrences, and related ground water problems. Other areas of research included an evaluation of geologic, geochemical, and geotechnical aspects of surface mine reclamation; geothermal-gradient and heatflow studies for evaluating the potential use of geothermal resources in the State; and the impact reclamation of abandoned surface mines has on ground water. Future research will focus on the mineralogy and geochemistry of North Dakota potash deposits.

REVIEW BY NONFUEL MINERAL COMMODITIES

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Clays.—The 1981 production of clays decreased in quantity and value from the levels attained the previous year.

The State's entire clay output during the year was from two firms. Production at the Hebron Brick Co.'s operation in Morton County was restarted in May, following a 4-month shutdown because of a large inventory and sagging brick sales. Near Mandan, also in Morton County, U.S. Noonlite, Ltd., mined clay for its own use in manufacturing lightweight aggregate. The bulk of the material was used in concrete block and structural concrete products.

Gem Stones.—Agate, chalcedony, and petrified wood are the most common gem stones collected in the State.

No commercial gem stone operations were reported in North Dakota during 1981. The value of material collected by mineral collectors and other hobbyists is estimated at not more than $2,000.

Lime.—American Crystal Sugar Co. in Pembina County and Minn-Dak Farmers Co-op. in Richland County were the sole producers of lime in the State during 1981. Limestone used in manufacturing quicklime was all obtained from out-of-State sources. All of the quicklime the two companies produced was used onsite at their respective sugar-refining facilities.

Lime consumed in the State during 1981, obtained from all U.S. sources, was approximately 93,000 tons.

Peat.—The quantity of peat produced in 1981 reflected little change from that of the previous year. All peat production, consisting of the reed-sedge variety, was by Peat Products Co. from the Turtle Mountain area in Bottineau County. The material was marketed in bulk form for general soil improvement and packing plants.

Salt.—Production of salt decreased slightly in quantity and value compared with levels of the previous year.

The Hardy Salt Co., near Williston in Williams County, used solution mining in obtaining its output. The company's finished products included evaporated salt for a variety of uses and brine salt for use as a component in drilling muds. Williams Exploration Co., in McKenzie County, acquired a well formerly operated by Rainbow Resources, Inc., and produced salt brine for use in oil and gas drilling. These companies accounted for the State's entire salt production.

Sand and Gravel.—To reduce reporting burdens and costs, the Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for 1981 production of construction sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and made final the following year.

Table 4.—North Dakota: Construction sand and gravel sold or used by producers

	1980			1981[p]		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Sand	1,481	$4,049	$2.73	NA	NA	NA
Gravel	3,692	10,408	2.82	NA	NA	NA
Total or average	5,173	14,457	2.79	4,900	$14,100	$2.88

[p]Preliminary. NA Not available.

Sulfur.—Elemental sulfur was recovered as a byproduct at the natural gas processing plants of Aminoil USA, Inc., at Tioga in Williams County, and Warren Petroleum Corp. at Little Knife in Billings County.

Vermiculite.—Vermiculite mined out of State was exfoliated at the plant of Robinson Insulation Co. at Minot in Ward County. The exfoliated material was used as aggregate in concrete, block insulation, and loose-fill insulation.

[1]State Liaison Officer, Bureau of Mines, Minneapolis, Minn.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Clays:			
Hebron Brick Co	Hebron, ND 58638	Pit and plant	Morton.
U.S. Noonlite, Ltd	Box 117 Mandan, ND 58554	do	Do.
Lime:			
American Crystal Sugar Co	101 North 3d St. Moorhead, MN 56560	Shaft kiln at beet sugar refinery.	Pembina.
Minn-Dak Farmers Co-op	Wahpeton, ND 58075	do	Richland.
Peat:			
Peat Products Co	821 4th St. Bismarck, ND 58501	Bog	Bottineau.
Salt:			
Hardy Salt Co	Drawer 449 St. Louis, MO 63166	Brine well and plant	Williams.
Williams Exploration Co	1300 Maine, Suite 1530 Houston, TX 77002	do	McKenzie.
Sand and gravel (1980):			
Ames Sand & Gravel, Inc	Box 2702 Fargo, ND 58102	Pit and plant	Burke.
Anderson Sand & Gravel, Inc	Route 1 New Rockford, ND 58356	Pits and plants	Eddy and Foster.
Border States Paving, Inc	Box 3162 Fargo, ND 58108	do	Burke and Rolette.
Cactus Concrete Products, Inc	Box 1483 Williston, ND 58801	do	Williams.
Fisher Sand & Gravel Co	Box 1034 Dickinson, ND 58601	do	Bowman, McLean, Mercer, Morton, Stark.
Minot Sand & Gravel	Box 116 Minot, ND 58701	do	Ward.
Missouri River Sand & Gravel, Inc	Box 2024 Bismarck, ND 58501	Pit and plant	Burleigh.
Northern Improvement Co	Box 1254 Bismarck, ND 58501	Pits and plants	Do.
Schriock Construction Co	Route 3, Radio City Minot, ND 58701	Pit and plant	Ward.
Sheyenne Sand & Gravel, Inc	Box 178 Sheyenne, ND 58374	do	Eddy.
Sulfur, recovered elemental:			
Aminoil USA, Inc	Box 94193 Houston, TX 77018	Plant	Williams.
Warren Petroleum Corp., a division of Gulf Oil Corp.	Box 1589 Tulsa, OK 74101	do	Billings.
Vermiculite, exfoliated:			
Robinson Insulation Co	Box 1782 Minot, ND 58702	do	Ward.

The Mineral Industry of Ohio

By Donald K. Harrison[1]

The value of Ohio's nonfuel mineral production in 1981 was $554.2 million, an $8.2 million decrease from that of 1980. Major mineral commodities produced included stone, sand and gravel, lime, cement, clays, and salt. Gypsum, peat, and natural and artificial abrasives were also produced. Mineral commodities imported into the State for further processing included alumina, beryllium, iron ore, perlite, titanium, vermiculite, zinc, and zircon.

Nationally, Ohio ranked 15th in value of nonfuel mineral production. The State ranked first in the Nation in the production of ferroalloys (shipments), lime, and steel slag; second in blast furnace slag and fire clay; third in pig iron shipments; and fourth in natural abrasives, salt, and construction sand and gravel.

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

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:					
Masonry	thousand short tons	126	$8,549	105	$7,129
Portland	do.	1,625	77,696	1,461	69,517
Clays	do.	2,718	11,516	2,217	10,411
Gypsum	do.	136	1,346	148	1,566
Lime	do.	2,786	122,817	2,767	127,751
Peat	do.	10	166	10	191
Salt	do.	3,228	87,371	3,608	90,254
Sand and gravel	do.	36,972	114,291	p36,087	p118,493
Stone:					
Crushed	do.	42,441	136,929	36,950	125,588
Dimension	do.	35	1,558	W	W
Combined value of abrasives, gem stones, and value indicated by symbol W		XX	101	XX	3,290
Total		XX	562,340	XX	554,190

pPreliminary. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Adams	W	W	Stone.
Allen	$3,044	$2,531	Do.
Ashland	W	W	Sand and gravel, clays.
Ashtabula	W	W	Lime, sand and gravel.
Athens	W	W	Stone, sand and gravel.

See footnotes at end of table.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Auglaize	$1,501	W	Stone, sand and gravel, clays.
Belmont	W	W	Sand and gravel, stone.
Brown	235	$233	Stone, sand and gravel.
Butler	7,743	7,495	Sand and gravel.
Carroll	W	W	Stone, sand and gravel.
Champaign	531	631	Sand and gravel.
Clark	W	W	Sand and gravel, stone.
Clermont	309	283	Sand and gravel.
Clinton	W	W	Stone.
Columbiana	910	W	Sand and gravel, clays, stone.
Coshocton	W	W	Sand and gravel, stone, clays.
Crawford	W	W	Stone.
Cuyahoga	28,840	23,314	Salt, lime, clays, peat.
Darke	913	2,456	Sand and gravel.
Delaware	W	3,695	Stone, clays.
Erie	W	W	Lime, stone, sand and gravel.
Fairfield	W	W	Sand and gravel.
Fayette	W	W	Stone, sand and gravel.
Franklin	W	W	Sand and gravel, stone, clays.
Gallia	W	W	Sand and gravel.
Geauga	W	W	Sand and gravel, stone.
Greene	35,984	32,760	Cement, sand and gravel, stone, clays.
Guernsey	W	--	
Hamilton	10,546	11,072	Sand and gravel.
Hancock	1,767	1,766	Stone.
Hardin	W	W	Do.
Harrison	W	W	Stone, clays.
Henry	W	W	Sand and gravel, clays.
Highland	W	W	Stone, sand and gravel.
Hocking	W	W	Sand and gravel, clays.
Holmes	W	W	Stone, clays, sand and gravel.
Huron	W	W	Sand and gravel, stone.
Jackson	W	W	Clays, stone, sand and gravel.
Jefferson	W	W	Clays.
Knox	W	W	Sand and gravel, stone.
Lake	W	W	Salt, lime, sand and gravel.
Lawrence	W	W	Cement, clays, sand and gravel.
Licking	W	W	Sand and gravel, clays.
Logan	1,517	1,753	Stone, sand and gravel, peat.
Lorain	17,116	19,047	Lime, stone, sand and gravel, abrasives.
Lucas	W	W	Stone, sand and gravel, cement.
Mahoning	W	W	Stone, clays, peat.
Marion	W	2,710	Stone, sand and gravel, clays.
Medina	W	W	Sand and gravel, stone, clays.
Meigs	4,067	2,402	Sand and gravel.
Mercer	W	W	Stone.
Miami	5,994	6,842	Stone, sand and gravel.
Monroe	W	W	Stone.
Montgomery	W	W	Sand and gravel, stone.
Morgan	W	W	Do.
Morrow	242	241	Sand and gravel.
Muskingum	W	W	Cement, stone, sand and gravel, clays.
Noble	1,000	1,274	Stone.
Ottawa	W	W	Stone, lime, gypsum.
Paulding	25,837	21,660	Cement, stone, clays.
Perry	W	W	Sand and gravel, stone, clays.
Pickaway	W	W	Sand and gravel, stone.
Pike	W	W	Do.
Portage	9,747	7,771	Sand and gravel.
Preble	822	1,010	Sand and gravel, stone.
Putnam	W	W	Stone, clays.
Richland	W	W	Sand and gravel, clays.
Ross	W	2,033	Sand and gravel.
Sandusky	W	W	Lime, stone.
Scioto	1,566	W	Clays, stone, sand and gravel.
Seneca	W	W	Lime, stone, clays.
Shelby	1,595	1,417	Stone, sand and gravel.
Stark	W	11,310	Cement, sand and gravel, stone, clays.
Summit	W	W	Salt, sand and gravel, stone.
Trumbull	W	W	Sand and gravel, stone.
Tuscarawas	W	W	Sand and gravel, clays, stone.
Union	W	W	Stone.
Van Wert	1,203	1,045	Do.
Vinton	W	W	Clays.
Warren	W	W	Sand and gravel, stone.
Washington	1,433	1,180	Do.
Wayne	W	W	Salt, sand and gravel, stone, clays.
Williams	W	W	Sand and gravel, peat.
Wood	3,599	4,322	Stone.
Wyandot	W	W	Stone, lime, sand and gravel, peat, clays.
Undistributed[2]	439,256	390,082	
Total[3]	607,320	562,340	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]Defiance, Fulton, and Madison Counties are not listed because no nonfuel mineral production was reported.

[2]Includes gem stones and values indicated by symbol W.

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

Table 3.—Indicators of Ohio business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	5,004.0	5,104.9	+2.0
Unemployment	do.	430.0	601.2	+39.8
Employment (nonagricultural):				
Mining[1]	do.	30.7	30.3	-1.3
Manufacturing	do.	1,264.5	1,232.5	-2.5
Contract construction	do.	167.4	154.2	-7.9
Transportation and public utilities	do.	223.1	218.4	-2.1
Wholesale and retail trade	do.	957.0	946.0	-1.2
Finance, insurance, real estate	do.	203.8	205.2	+.7
Services	do.	830.9	856.2	+3.0
Government	do.	689.9	680.2	-1.4
Total nonagricultural employment[1 2]	do.	4,367.4	4,323.1	-1.0
Personal income:				
Total	millions	$102,387	$111,805	+9.2
Per capita		$9,460	$10,371	+9.6
Construction activity:				
Number of private and public residential units authorized		32,085	23,897	-25.5
Value of nonresidential construction	millions	$1,445.7	$1,537.7	+6.4
Value of State road contract awards	do.	$177.0	$327.0	+84.8
Shipments of portland and masonry cement to and within the State	thousand short tons	2,810	2,458	-12.5
Nonfuel mineral production value:				
Total crude mineral value	millions	$562.3	$554.2	-1.4
Value per capita, resident population		$52	$51	-1.9
Value per square mile		$13,642	$13,444	-1.5

[p]Preliminary.
[1]Includes bituminous coal and gas extraction.
[2]Data may not add to totals shown because of independent rounding.

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

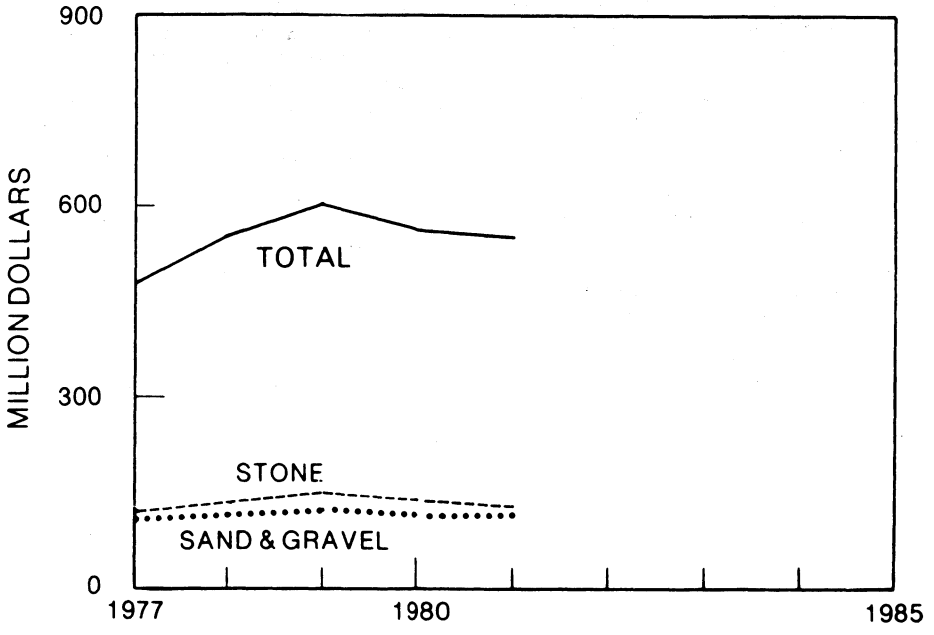

Figure 1.—Value of sand and gravel and stone, and total value of nonfuel mineral production in Ohio.

Trends and Developments.—Output of most construction mineral commodities declined during the year primarily because of high interest rates and a slowdown in residential construction in the State. Output decreased for cement (-11%), clays (-18%), sand and gravel (-2%), and crushed stone (-13%).

Like the construction industry, the State's steel industry also suffered by the downturn in the economy. Numerous layoffs, closings, and temporary shutdowns occurred throughout the State's steel industry; the Youngstown and Cleveland districts were particularly affected. The slowdown in steel production also diminished expectations of the Great Lakes shipping firms transporting iron ore and other raw materials. Although shipments on the lakes through October were slightly higher than the same period in 1980, they were still far behind 1979 shipments. Many shipping firms were awaiting better economic conditions before going ahead with new investments.

On the positive side, Timken Co. announced that it would build a $500 million specialty steel mill in Canton. The plant is to have an ingot capacity of 550,000 tons of alloy steel per year and is expected to be completed in 1985. The Canton site was chosen after contract concessions were made by members of the United Steel Workers.

At Battelle Memorial Institute's Columbus laboratories, a method for greater recovery of minerals in tailings dumps was being examined. The method, known as selective flocculation, shows promise of handling and separating extremely fine particles from tailings.[2]

Legislation and Government Programs.—House bill 385, signed into law in December, established a geological mapping program in the Ohio Division of Geological Survey (DGS), Department of Natural Resources. Part of the State's mineral severance tax revenues will be used to map and publish reports on the geology and mineral resources of each county. House bill 385 also carries provisions for DGS to compile mineral production statistics for Ohio, a function previously handled by the Ohio Department of Industrial Relations, Division of Mines. In addition, a portion of the severance tax monies provided to DGS is to be used to increase personnel and upgrade facilities in the Subsurface Geology Section. The law will be effective for a period of 10 years beginning March 17, 1982.

Amended House bill 518 increases from 25% to 50% that portion of the net value of sales of timber, forest products, minerals, and mineral right royalties from State forest lands that must be paid to the county in which the lands are located. The law also requires that one-half of the revenues a county receives from those sources be paid to the township in which the lands are located. Effective date of the bill is June 16, 1982.

During 1981, DGS began publication of "Ohio Geology," a quarterly newsletter that details the DGS's activities and programs as well as news items from other sources concerning the geology and mineral resources of Ohio. Also established was a Mineral Resources and Geology Advisory Council, composed of mineral industry leaders, whose purpose is to advise DGS in matters relating to geologic needs of the mineral industries.

Major ongoing programs of DGS during 1981 were an investigation of washability and petrographic characterization of Ohio coals, preparation of an atlas of Ohio's principal coal seams, mapping of a number of mineral resources including sand in Lake Erie, and preparation of geologic guides along several interstate highways.

In the fall of 1981, Ohio State University reestablished its master of science degree in mining engineering. The program will include specialty areas in explosives, surface mine equipment use, coal and mineral preparation, mining management, and strata control. Ohio State, the State's only federally funded Mining and Mineral Resource Research Institute, is the only school in Ohio to offer both undergraduate and graduate degrees in mining engineering.

The U.S. Forest Service began developing a land management plan for Wayne National Forest for the 1980's. The plan for the 176,000-acre forest will specify how resources and activities like minerals, timber, and recreation will be managed in the forest. In 1981, local government units received $146,749 from the Federal Government for its share of funds generated by activities (mineral leases, timber sales, special use permits, etc.) in Wayne National Forest. These monies represent 25% of the revenues collected by the Forest Service in Ohio.

During fiscal year 1981, the U.S. Bureau of Mines had 26 active contracts or grants in Ohio valued at nearly $1.2 million. These were awarded to State and local agencies,

universities, research institutes, and private industry, and pertained to various aspects of the mineral industry.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Abrasives.—One company produced natural abrasives, and three produced manufactured abrasives during the year. Cleveland Quarries Co., the only natural abrasive producer in the State, produced grindstone as a byproduct of sandstone quarrying operations at Amherst in Lorain County.

In Butler County, Steel Abrasives, Inc., manufactured both annealed and chilled iron shot and grit. Steel shot and grit were also produced by Globe Steel Abrasives in Richland County and by National Metal Abrasives Co. in Medina County. During the year, Cleveland Metal Abrasives Co. closed its Toledo plant, and Metal Blast, Inc., discontinued production of chilled iron shot and grit in Cleveland.

In late 1981, Carborundum Co., a major manufacturer of abrasive products, announced plans to move its headquarters from Niagara Falls, N.Y., to Cleveland. The move is part of a consolidation effort that followed the company's June 4 acquisition by the Standard Oil Co. (an Ohio corporation).

Cement.—Five companies operated six cement plants during 1981. Portland cement was produced at all six plants; four also produced masonry cement. Shipments of portland cement decreased about 10% (163,877 tons) compared with those of 1980; masonry cement shipments also decreased by almost 17% (21,089 tons) during this same period. The bulk of the portland cement shipped was Type I (general construction use) and Type II (moderately low heat and moderate degree of resistance to sulfate attack). Both the dry- and wet-grinding methods were used.

Table 4.—Ohio: Portland cement salient statistics

(Short tons)

	1980	1981
Number of active plants	5	6
Production	1,693,308	1,570,984
Shipments from mills:		
Quantity	1,624,836	1,460,959
Value	$77,695,559	$69,516,803
Stocks at mills, Dec. 31	130,208	160,979

Table 5.—Ohio: Masonry cement salient statistics

(Short tons)

	1980	1981
Number of active plants	4	4
Production	129,140	112,057
Shipments from mills:		
Quantity	126,315	105,226
Value	$8,549,420	$7,129,491
Stocks at mills, Dec. 31	21,422	27,402

General Portland Inc.'s Paulding plant received a Reclamation Achievement Award from the Ohio Aggregates Association for reclamation work at its Paulding quarry during 1981. The company has begun a systematic program of reclaiming approximately 250 acres of strip-mined land that was first disturbed in 1951. By yearend, about 20 of the 250 acres of land were completely reclaimed and restored to use as productive farmland. Reclamation will continue on the remaining 230 acres until completed.

Clays.—Ohio ranked fourth in the Nation in common clay and shale output and was second in fire clay output. Common clay and shale (approximately 84%) accounted for the majority of the State's clay production while fire clay (approximately 16%) accounted for the remainder. In 1981, 36 companies operated 51 pits to extract common clay and shale; 13 companies mined fire clay at 15 operations while 1 company produced a small amount of kaolin at 1 operation in Lawrence County. Major end uses for the common and fire clay were for drain tile, refractories, quarry tile, face brick, concrete block, and portland cement. The kaolin was used in the manufacture of adhesives.

Maryland Refractories Co. purchased the inactive Colonial plant of Swank Refractories Co. in Jefferson County. The plant's main product is calcined fire clay (grog) in granular form, made by crushing rejected fire clay brick. The material is ground, bagged, and shipped to the steel, foundry, ceramic, and petroleum industries principally in the market areas of Cleveland, Pittsburgh, Pa., and Gary, Ind. Grog is used principally to reduce the shrinkage of plastic clays and to give additional porosity. It

enables refactory goods to withstand sudden changes of temperature. The plant also makes one finished product, an air-setting, refractory-bonding mortar used in making stopper rod assemblies for use in teeming ladles in the steel industry. Approximately $200,000 will be invested in capital improvements at the plant.

The new multimillion dollar Belden brick plant in Sugar Creek was operating at 80% capacity in October. The new plant, under construction for the past several years, has a capacity to produce 40 million sand-molded face brick annually with just 40 employees.

DGS published an Educational Leaflet (EL12) that gives a brief description of the geologic origins of Ohio clay and shale resources, as well as the history of their production and use. The report contains a geologic map showing the location of clay and shale mines and a graph of the yearly production of clay and shale in Ohio since 1876.

Fluorspar.—Seaforth Mineral & Ore Co. continued to operate a fluorspar concentrate drying and processing plant in East Liverpool. The filter cake, used by the ceramic industry, is imported from Mexico and the Republic of South Africa.

Gem Stones.—Flint (State gem), calcite, celestite, and jasper were some of the mineral specimens collected by hobbyists in the State. Flint was the most sought after mineral collected. The flint area begins southeast of Newark and ends northwest of Zanesville, in Licking and Muskingum Counties.

There are a number of rock and mineral clubs in Ohio. The Midwest Federation of Mineralogical and Geological Societies (MWF) includes 38 Ohio clubs, with a total membership of more than 2,500. Many of these clubs are affiliated with museums, schools, nature centers, rock shops, and industries around Ohio. A listing of the clubs and a brief description of some of their activities can be found in DGS's publication, "Ohio Geology," spring 1982.

Graphite (Synthetic).—Union Carbide Corp. continued to manufacture high-modulus graphite fibers and cloth and fibers at its Fostoria plants.

Gypsum.—Gypsum, in economic concentrations, crops out along the Lake Erie shoreline in Erie and Ottawa Counties near Sandusky Bay. Celotex Div., a subsidiary of the Jim Walter Corp., was the only company that mined gypsum. It operated an open pit mine on Marblehead Peninsula in Ottawa County. Production increased 9%, offsetting the 10% decrease reported in 1980.

National Gypsum Co., United States Gypsum Co., and Celotex Div. calcined crude gypsum mined in Ohio and other States at plants in Ottawa and Lorain Counties. The calcined gypsum was used primarily to make wallboard. Production dropped again in 1981 because of the decline in housing construction activity.

Lime.—Ohio continued to lead the Nation in the production of lime, producing nearly 15% of the Nation's total output. In 1981, lime sold or used remained essentially the same as that of 1980. Although less lime was utilized in refractories, glassmaking, sewage treatment, and agriculture, an increase in use by the steel industry and miscellaneous users offset these decreases.

A total of 14 companies produced both quicklime and hydrated lime in 9 counties. Leading counties in order of output were Sandusky, Lake, Lorain, Erie, and Seneca. The lime was used principally in steelmaking, refractories, and glass.

Table 6.—Ohio: Lime sold or used by producers, by use

Use	1980		1981	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Steel, basic oxygen furnace	1,589,238	$67,346	1,534,288	$70,864
Steel, electric	87,685	3,693	211,171	10,232
Refractory dolomite	308,977	16,638	193,894	10,061
Glass	152,878	6,516	143,918	6,393
Steel, open-hearth	27,756	1,217	86,631	4,483
Water purification	30,840	1,396	W	W
Sewage treatment	12,077	496	10,563	461
Agriculture	9,303	565	6,997	363
Other[1]	r566,892	24,950	579,914	24,894
Total	2,785,646	122,817	2,767,376	127,751

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Other."

[1]Includes acid mine water, calcium carbide, fertilizer, 1980; finishing lime, magnesia from seawater or brine; mason's lime, other chemical and industrial uses, other construction lime, road stabilization, sugar refining, and uses indicated by symbol W.

Peat.—Six companies produced 10,000 tons of peat from bogs in five counties (Cuyahoga, Logan, Mahoning, Williams, and Wyandot). The peat was used as a soil conditioner and for other horticultural purposes.

Perlite.—Crude perlite, shipped from mines in the Western States, was expanded by National Gypsum Co. in Lorain County, Celotex Div. at Lockland in Hamilton County, and Cleveland Gypsum Co. at Cleveland in Cuyahoga County. Production decreased in 1981 compared with that of 1980. Principal uses of the expanded perlite were for cavity fill insulation and construction and horticultural aggregate.

Quartz Crystal (Synthetic).—Synthetic quartz crystal was manufactured by the Bliley Electric Co. at Cortland in Trumbull County and by Sawyer Research Products, Inc., a wholly owned subsidiary of Brush Wellman Inc., at Eastlake in Lake County. Sawyer produced cultured single-crystal quartz for frequency control and timing applications. Other uses were in microprocessors, telecommunications systems, timepieces, navigation systems, and optical equipment. Approximately 50% of the company's sales were to international markets.

Salt.—In 1981, Ohio ranked fourth nationally behind Louisiana, Texas, and New York in salt production. Four firms with five operations extracted rock salt and brine. Rock salt was recovered from two underground mines; International Salt Co. operated a mine at Whiskey Island in Cleveland and Morton Salt Co., a division of Morton-Norwich Products, Inc., mined rock salt at Fairport Harbor in Lake County. Average value per ton in 1981 was $13.52, down from $16.24 in 1980. The rock salt was used principally for snow and ice control.

Brine was pumped by PPG Industries, Inc., and Diamond Crystal Salt Co. in Summit County and by Morton Salt Co. in Wayne County. The brine was evaporated by both the open pan and vacuum process and used mainly by the chemical and food processing industries.

A team of scientists constructed a chamber inside the Morton Salt Co.'s mines along Lake Erie in an effort to learn more about proton decay. The chamber is a 60- by 65- by 80-foot "pool" that holds 2.5 million gallons of fresh, purified water. The salt mine was chosen because its depth underground helps to shield it from cosmic rays, which would interfere with the study.

Sand and Gravel.—The U.S. Bureau of Mines, to reduce reporting burdens and costs, implemented new sand and gravel canvassing procedures for the survey of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel operators will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production, but complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Based on these preliminary estimates, output of construction sand and gravel remained essentially the same in 1981. Principal uses of construction sand and gravel were for concrete aggregate, road base and paving, and fill.

Table 7.—Ohio: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	16,866	$42,807	$2.54	NA	NA	NA
Gravel	18,596	54,884	2.95	NA	NA	NA
Total or average	35,462	[1]97,690	2.75	[p]34,600	[p]$97,600	[p]$2.82
Industrial:						
Sand	1,424	15,856	11.14	1,421	20,395	14.35
Gravel	85	745	8.76	66	498	7.57
Total or average	[1]1,510	16,601	11.00	1,487	20,893	14.05
Grand total or average	36,972	114,291	3.10	[p]36,087	[p]118,493	[p]3.28

[p]Preliminary. NA Not available.
[1]Data may not add to totals shown because of independent rounding.

Industrial sand and gravel was produced by 10 companies from 12 operations in 9 counties. Principal producing counties were Geauga, Perry, Ross, and Knox. In 1981, production remained essentially the same but unit value increased by $3.05 to $14.05. Leading producers were Oglebay Norton Co., Perry and Knox Counties; Best Walter, Inc., Geauga County; and Southern Silica, Inc., Ross County. Industrial sand was used primarily for mold and core, containers, specialty glass, and fiberglass.

DGS continued mapping sand and gravel resources in several northeastern Ohio counties. Two county reports have been published: Report of Investigation 114, "Sand and Gravel Resources of Portage County," and Report of Investigation 119, "Sand and Gravel Resources of Medina County." Each report includes a map showing the location and extent of the sand and gravel deposits, as well as descriptions and analyses of the material.

Slag.—Ohio was the Nation's second leading producer of slag, after Pennsylvania. Both iron slag (blast furnace) and steel slag were produced. Iron slag sold or used decreased 1.1 million tons to 2.6 million tons in 1981. Shipments of steel slag amounted to nearly 1.7 million tons, essentially the same as those of 1980. Most of the slag was used in roadbuilding and as fill. It was also used as an aggregate in concrete and asphaltic concrete, and as railroad ballast.

Stone.—Ohio ranked sixth nationally in crushed stone production in 1981. Crushed and dimension limestone and sandstone were the two major types produced, with limestone accounting for most of the State's total output. Most of the limestone production was from the western part of the State; sandstone was primarily quarried in northeastern Ohio. Crushed stone output dropped nearly 5.5 million tons in 1981 compared with 1980 output.

In 1981, there were 116 crushed limestone quarries and 2 dimension limestone quarries in the State. The primary uses for crushed limestone were for construction and concrete aggregate, agricultural lime, cement manufacture, and as a fluxstone. Dimension limestone was used for rough block and rubble.

Nineteen crushed sandstone quarries and 21 dimension sandstone quarries operated during the year. Crushed sandstone was used primarily for aggregate, road base, and riprap. Leading counties in order of declining output were Sandusky, Fayette, Ottawa, Wyandot, and Geauga.

Table 8.—Ohio: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	1,838	7,103	1,612	6,938
Concrete aggregate	6,895	20,812	5,615	18,086
Bituminous aggregate	2,981	9,433	2,956	10,229
Macadam aggregate	3,795	11,470	2,981	9,625
Dense-graded road base stone	5,283	16,883	4,094	13,880
Surface-treatment aggregate	2,086	7,096	2,148	7,776
Other construction aggregate and road stone	8,084	24,875	6,367	20,521
Riprap and jetty stone	481	1,643	469	1,616
Railroad ballast	1,134	3,053	1,084	3,302
Filter stone	W	W	93	253
Manufactured fine aggregate (stone sand)	440	1,268	593	1,926
Cement manufacture	2,744	10,894	2,394	8,365
Lime manufacture	3,165	7,845	2,768	7,298
Dead-burned dolomite	667	1,630	1,046	2,446
Flux stone	1,924	5,535	1,911	5,784
Other fillers	99	1,165	75	1,017
Glass manufacture	407	3,464	404	3,686
Other[2]	419	2,762	340	2,841
Total[3]	42,441	136,929	36,950	125,588

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

[1]Includes limestone and sandstone.

[2]Includes stone used for agricultural marl and other soil conditioners, terrazzo and exposed aggregate, ferrosilicon, refractory stone, mine dusting, asphalt filler, whiting or whiting substitute, roofing granules, sulfur removal from stack gases, and other uses not specified.

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

In May, France Stone Co. opened a new $7 million aggregate plant in Flat Rock, Seneca County. The plant has a capacity in excess of 1 million tons annually of minus 1-inch aggregate. The new plant replaces the nearby Bellevue plant, operational since 1895.

Near yearend, Consolidated Rail Corp. (Conrail), announced rate reductions of 18% to 32% on shipments of fluxing stone transported between mining areas in northwestern Ohio and steel-producing centers in eastern Ohio, northern West Virginia, and western Pennsylvania. The new rates, to be in effect through March 24, 1982, are about 5% below those offered by motor carriers.[3]

Also at yearend, Cleveland Quarries in Amherst was still awaiting further word from Conrail on its proposal to abandon 2.4 miles of track that extend to the company's quarries. The 2.4-mile track segment is one of more than 200 miles of rail lines that Conrail originally planned to abandon.

Sulfur.—Elemental sulfur was recovered as a byproduct of petroleum refining by Standard Oil Co. of Ohio at its Lima refinery in Allen County and Toledo refinery in Lucas County; by Gulf Oil Co. and Sun Co., Inc., at their Toledo refineries in Lucas County; by Ashland Oil, Inc., at its Canton refinery in Stark County; and by Republic Steel Corp. at the Iron & Chemical Operations in Trumbull County. Shipments amounted to 31,339 metric tons valued at $2.2 million. This represents an increase of 46% in output and 57% in value over 1980 levels.

Vermiculite (Exfoliated).—Ohio continued to rank first in output among 31 States producing exfoliated vermiculite in 1981. Cleveland Gypsum Co., a division of Cleveland Builders Supply Co. in Cleveland, and O. M. Scott & Sons Co. in Marysville, exfoliated vermiculite shipped in from other States for use primarily as a fertilizer carrier and in loose-fill insulation, block insulation, horticulture, and soil conditioning. Output decreased nearly 12% in 1981 primarily because of a drop in use as a fertilizer carrier.

METALS

Aluminum.—Ormet Corp., which is 66% owned by Consolidated Aluminum and 34% by Revere Aluminum, continued to produce primary aluminum at its 260,000-ton-per-year Hannibal reduction plant. Output in 1981 was 3% lower than that of 1980. In November 1981, the company shut down two 45,000-ton-per-year potlines, reducing production by one-third.

During the year, Ormet completed installation of one of the world's largest bag filter systems at the Hannibal plant to remove contaminants from exhaust gases generated by the potlines. The replacement system, a dry absorption fume treatment system, replaced a wet scrubbing system that no longer met U.S. Environmental Protection Agency guidelines.

Beryllium.—Brush Wellman Inc. produced beryllium alloys, beryllia ceramic, and metallic beryllium at its Elmore plant from beryllium hydroxide concentrate produced at its extraction facilities near Delta, Utah. In 1981, the company completed the installation of a $5 million arc furnace at the Elmore plant as part of a $30 million expansion to increase capacity for producing beryllium copper alloys. The new furnace allows the company to manufacture a homogeneous master alloy of copper and beryllium that is subsequently used to produce beryllium copper products. The company also completed a $1 million expansion and modernization of the Cleveland beryllium research and development laboratories.

Also during the year, Brush Wellman asked the Federal Government for "assurances" that it will purchase a minimum volume of metallic beryllium during the next several years so that the company can proceed with manufacturing and environmental improvements at the Elmore plant. The United States consumes 90% of Brush Wellman's metallic beryllium output through the companies that receive Government contracts for production of nuclear warheads, military aircraft brakes, and aerospace flight instruments.

Ferroalloys.—Ohio continued to be a leading producer of ferroalloys, accounting for one-third of the Nation's total shipments. Ferroalloys of chromium, manganese, silicon, and vanadium were produced in the State in 1981. Shipments dropped from 483,000 tons in 1980 to 462,000 tons in 1981, because of weak demand and competition from imports.

Ohio Ferro Alloys Corp. discontinued high-carbon ferromanganese production at its Philo plant in late 1980 and at the end of 1981, the plant was operating only one of seven furnaces. The company's Powhatan ferrosilicon plant shut down in October and remained closed at yearend.

At midyear, Ohio Ferro Alloys signed a

letter of intent to sell its ferroalloy plants in Philo and Powhatan to Fesil & Co. A.S., a group of Norwegian ferroalloys producers. However, in November, Fesil decided not to complete the sales agreement and Ohio Ferro Alloys was considering possible legal action.

Union Carbide Corp. completed the sale of two ferroalloy plants in Ashtabula and Marietta to Elkem A.S. of Norway. The plants were two of five ferroalloy plants owned by Union Carbide in the United States and Norway that were sold to Elkem. They will be operated by Elkem Metals Co., headquartered in Pittsburgh, Pa.

Iron Oxide Pigments.—Synthetic iron oxide pigments were manufactured by the Ottawa Chemical Div., Ferro Corp., at its plant in Lucas County. Hilton Davis Chemical Div., Sterling Drug, Inc., produced natural and synthetic iron oxide pigments at its plant in Hamilton County.

Iron and Steel.—Consumption of pig iron increased nearly 9% in 1981 from 10.8 million tons in 1980 to 11.9 million tons in 1981. Value of shipments also increased from $2.2 billion in 1980 to $2.6 billion in 1981.

A combination of reduced demand, high interest rates, foreign competition, and cost of environmental regulations continued to plague the Nation's steel industry. At yearend, there were more than 61,000 unemployed in the Nation's steel industry. In the Cleveland district alone, nearly 7,000 steelworkers were on layoff. Additional 1- to 2-week furloughs were announced for the yearend holidays as companies curtailed or shut down operations.

Despite cutbacks, layoffs, and the uncertainty of future steel markets, several steel firms were planning to invest in processing and other equipment to revitalize their plants. LTV Corp. announced plans to spend $315 million to modernize its Youngstown steelmaking facility. The company is expected to install a continuous steel caster and rehabilitate coke operations. New investments, including continuous casters and other improvements, were also announced by Republic Steel Corp. for its Cleveland plant and by United States Steel Corp. for its Lorain plant. Hunt Energy Corp., Salem, plans to install two electric arc furnaces at the old Jones & Laughlin Steel Corp.'s Brier Hill works in Youngstown. The company intends to manufacture tubular products for use in oil production.

Following a union vote to grant the company contract concessions on wages and work rules, Timken Co. announced plans to build a $500 million specialty steel mill in Canton. The fully automated plant will initially produce 550,000 ingot tons annually of high-quality alloy steel. Expected completion date is early 1985.

Titanium.—TIMET, a division of Titanium Metals Corp. of America, the largest U.S. integrated titanium producer, manufactured titanium mill products at its plant in Toronto, using ingot made at its Henderson, Nev., plant.

RMI Co., the Nation's second largest integrated titanium producer, produced titanium sponge and mill products at its plants in Ashtabula and Niles, respectively. In late 1981, the company announced the planned construction of a $20 million melt shop that will feature two new vacuum arc melting furnaces. The new shop is part of a $50 million modernization program started by the company in 1979.

Titanium dioxide pigments were produced at facilities owned by Gulf + Western Industries, Inc., and SCM Corp., both in Ashtabula. The pigments are primarily used by the paint, varnish, lacquer, and paper industries.

Zinc.—ASARCO Incorporated produced zinc oxide at its refinery in Columbus from zinc concentrates shipped from out of State. Zinc oxide production (metal content) in 1981 was 11,800 tons, down from 19,000 tons in 1980. The reduced output was the result of a 3-1/2-month strike at the plant that was settled in October.[4] The zinc oxide was primarily used in the manufacture of rubber, paints, ceramics, and in various chemical applications.

Zirconium.—Six companies produced zirconia, zirconium alloys, refractory cores and molds, and zirconium ceramics. End uses included foundry and ceramic industry applications, castings of high-temperature alloys and zircon-based welding rod coatings.

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[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]Minerals Week. V. 3, No. 18, May 1, 1981, p. 140.
[3]Skillings' Mining Review. V. 71, No. 4, Jan. 23, 1982, p. 18.
[4]ASARCO Incorporated. 1981 Annual Report. P. 11.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Columbia Cement Corp	Box 1531 Zanesville, OH 43701	Plant	Muskingum.
General Portland Inc.[1 2]	Box 109 Paulding, OH 45879	do	Paulding.
Marquette Cement Co.[2]	Box 8 Pedro, OH 45659	do	Lawrence.
SME Cement, Inc	Box 1187 Uniontown, PA 15401	do	Stark and Lucas.
Southwestern Portland Cement Co.[1 2]	Box 191 Fairborn, OH 45324	do	Greene.
Clays:			
Belden Brick Co	Box 910 Canton, OH 44701	Pits	Tuscarawas.
Hydraulic Press Brick Co	Box 7786 Independence, OH 44131	Pit	Cuyahoga.
Swank Refractories Co	400 Rouser Rd. Coraopolis Hts., PA 15108	Pit	Jefferson.
Ferroalloys:			
Elkem Metals Co.[3]	Box 266 Pittsburg, PA 15230	Plants	Ashtabula and Washington.
Foote Mineral Co	Route 100 Exton, PA 19341	do	Guernsey.
Interlake, Inc	2015 Spring Rd. Oak Brook, IL 60521	do	Washington.
Graphite, synthetic:			
Union Carbide Corp	270 Park Ave. New York, NY 10017	do	Seneca.
Gypsum:			
Celotex Div.,[4] Jim Walter Corp	1500 North Dale Mabry Tampa, FL 33607	Pit and plant	Ottawa.
National Gypsum Co.[4]	4100 First International Bldg. Dallas, TX 75270	Plant	Lorain.
United States Gypsum Co.[1 3]	101 South Wacker Dr. Chicago, IL 60606	do	Ottawa.
Lime:			
Basic, Inc	Maple Grove Fostoria, OH 44830	do	Seneca.
Huron Lime Co	Box 428 Huron, OH 44839	do	Erie.
Martin Marietta Chemicals[1]	Executive Plaza II Hunt Valley, MD 21030	do	Sandusky.
Republic Steel Corp	Box 6778 Cleveland, OH 44101	do	Lake.
Steetley Resources, Inc.[1]	Box E Gibsonburg, OH 43431	do	Sandusky.
United States Steel Corp	600 Grant St. Pittsburgh, PA 15230	do	Lorain.
Peat:			
Buckeye Peat Moss	R.D. 1 Bellefontaine, OH 43311	Bog	Logan.
Perlite, expanded:			
Cleveland Builders Supply Co.[5]	2100 West 3d St. Cleveland, OH 44113	Plant	Cuyahoga.
Salt:			
Diamond Crystal Salt Co	916 South Riverside St. Clair, MI 48079	do	Summit.
International Salt Co	Clarks Summit, PA 18411	Underground mine.	Cuyahoga.
Morton-Norwich Products, Inc	110 North Wacker Dr. Chicago, IL 60606	do	Lake and Wayne.
PPG Industries, Inc	Box 31 Barberton, OH 44203	Plant	Summit.
Sand and gravel:			
American Aggregates Corp.[1]	Garst Ave. Greenville, OH 45331	Pits	Various.
Dravo Corp	5254 Wooster Rd. Cincinnati, OH 45226	do	Butler, Hamilton, Warren.
Hilltop Basic Resources, Inc	Lane Ave. Cincinnati, OH 45214	do	Greene and Montgomery.
Twin Lakes Sand Co	2307 State Route 303 Streetsboro, OH 44240	do	Portage.
Stone:			
Davon, Inc	2152 Tremont Center Columbus, OH 43221	Quarries	Adams and Highland.
France Stone Co	1800 Toledo Trust Bldg. Toledo, OH 43604	do	Lucas, Sandusky, Seneca.
National Lime & Stone Co.[3]	First National Bank Bldg. Findlay, OH 45840	do	Various.
Woodville Lime & Chemical Co	Box 218, 643 Lime Rd. Woodville, OH 43469	Quarry	Sandusky.

[1]Also stone.
[2]Also clays.
[3]Also lime.
[4]Also expanded perlite.
[5]Also exfoliated vermiculite.

The Mineral Industry of Oklahoma

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Oklahoma Geological Survey, for collecting information on all nonfuel minerals.

By Albert E. Ward[1]

Total value of nonfuel minerals in Oklahoma increased 5.6% in 1981, down from the 10.7% increase in 1980 and 9.6% in 1979. Basic construction materials again comprised the bulk of output value; topping the production list were cement, stone, and sand and gravel, in that order. Together, the value of these commodities exceeded 85% of the total nonfuel mineral value.

As reported by the Center for Economic and Management Research at the University of Oklahoma, the U.S. Department of Commerce, and the U.S. Department of Labor, economic indicators for Oklahoma generally were significantly more favorable than nationwide figures. Employment in Oklahoma was up in all business sectors except for a 0.2% decrease in agriculture and a 1.7% decrease in Government. Total employment was 1,339,300, up 6.2% from that of 1980, whereas U.S. employment was up 1.1%. Estimated unemployment was 4.8%; the national figure was 7.6%. Employment of 95,700 in the mineral industries, mostly in oil and gas activities, was 27.8% over that of 1980, the highest employment gain in all sectors of the State's economy. This increase continued a trend begun in 1973 when initial deregulation of the petroleum industry encouraged domestic energy-resources development. Employment in the mining industries, other than in oil and gas, was about 3,400. Approximately one-half of this number were employed in nonfuel mines; the other one-half were employed in coal mines.

Commercial construction up 89.4% and industrial construction, almost doubling with a 98.0% increase, accounted for the 23.8% increase in total construction. Other changes in construction activity were as follows: single family residential, off 1.8%; multifamily, up 6.0%; and nonbuilding, off 19.1%. Commercial and industrial construction commonly use substantial quantities of steel, sheet metal, and architectural aluminum and glass from out-of-State sources. In contrast, demands upon such in-State building materials as clays, stone, and sand and gravel were only nominal; therefore, the marked increase in total construction value in the State in 1981 was not reflected in needs for Oklahoma-produced construction minerals and for such manufactured items as prestressed concrete products, brick, and tile.

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

Mineral		1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
Clays	thousand short tons	972	$2,249	838	$2,064
Gem stones		--	--	NA	2
Gypsum	thousand short tons	1,326	11,230	1,177	9,870
Helium:					
High-purity	million cubic feet	349	8,027	49	1,274
Crude	do.	23	276	22	264
Pumice	thousand short tons	1	W	1	W
Sand and gravel	do.	11,881	37,162	p11,700	p38,117
Stone:					
Crushed	do.	28,173	76,267	29,930	83,407
Dimension	do.	16	678	18	738
Combined value of cement, feldspar, iodine, lime, salt, tripoli, and values indicated by symbol W		XX	88,244	XX	100,876
Total		XX	224,133	XX	236,612

pPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; included with "Combined value" figure. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Adair	W	W	Sand and gravel.
Alfalfa	W	W	Do.
Atoka	$1,871	$2,676	Stone, sand and gravel.
Beaver	W	W	Sand and gravel, pumice.
Blaine	W	W	Gypsum, sand and gravel.
Bryan	W	W	Stone, sand and gravel.
Caddo	W	W	Gypsum, stone.
Canadian	W	W	Sand and gravel, clays, gypsum.
Cherokee	W	W	Stone, sand and gravel.
Choctaw	3,693	4,642	Do.
Cimarron	9,505	8,303	Helium.
Cleveland	241	1,501	Sand and gravel.
Coal	W	W	Stone.
Comanche	W	W	Stone, gypsum.
Cotton	W	1,360	Sand and gravel.
Craig	W	673	Stone.
Creek	W	W	Stone, sand and gravel, clays.
Custer	W	W	Sand and gravel, clays.
Garfield	W	--	
Garvin	W	W	Sand and gravel.
Greer	W	W	Stone, clays, sand and gravel.
Harmon	W	W	Salt.
Haskell	W	W	Stone.
Hughes	W	W	Sand and gravel.
Jackson	W	W	Gypsum.
Johnston	W	W	Sand and gravel, stone.
Kay	W	W	Stone, sand and gravel.
Kingfisher	W	W	Sand and gravel.
Kiowa	4,491	W	Stone.
Le Flore	279	W	Sand and gravel, stone, clays.
Logan	W	419	Sand and gravel.
McClain	1,071	1,154	Sand and gravel.
McCurtain	W	W	Stone, sand and gravel.
McIntosh	W	W	Stone.
Major	W	W	Stone, sand and gravel.
Mayes	W	W	Cement, stone, clays.
Murray	W	W	Stone, sand and gravel.
Muskogee	W	W	Sand and gravel, feldspar.
Nowata	--	W	Stone.
Oklahoma	W	W	Sand and gravel, clays.
Okmulgee	34	W	Stone.
Osage	W	1,405	Do.
Ottawa	W	W	Stone, tripoli, sand and gravel.
Pawnee	W	1,157	Stone, sand and gravel.
Payne	W	W	Do.
Pittsburg	W	1,758	Do.
Pontotoc	W	W	Cement, stone, sand and gravel, clays.
Pottawatomie	W	W	Sand and gravel.
Pushmataha	223	W	Do.

See footnotes at end of table.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Rogers	W	W	Cement, stone, clays.
Seminole	W	W	Stone, sand and gravel, clays.
Sequoyah	W	W	Lime, stone, sand and gravel.
Stephens	--	W	Sand and gravel.
Texas	W	W	Do.
Tillman	--	W	Do.
Tulsa	W	$13,220	Stone, sand and gravel, clays.
Wagoner	$640	877	Sand and gravel.
Washington	1,127	W	Stone.
Woods	W	--	
Woodward	W	W	Iodine, sand and gravel.
Undistributed[2]	179,323	184,987	
Total[3]	202,521	224,133	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]Beckham, Carter, Delaware, Dewey, Ellis, Grady, Grant, Harper, Jefferson, Latimer, Lincoln, Love, Marshall, Noble, Okfuskee, Roger Mills, and Washita Counties are not listed because no nonfuel mineral production was reported.

[2]Includes some sand and gravel (1979) 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 Oklahoma business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	1,330.0	1,408.0	+5.9
Unemployment	do	57.7	54.7	-5.2
Employment (nonagricultural):				
Mining[1]	do	74.9	95.7	+27.8
Manufacturing	do	191.3	198.8	+3.9
Contract construction	do	57.3	53.8	-6.1
Transportation and public utilities	do	68.6	69.0	+.6
Wholesale and retail trade	do	266.3	278.3	+4.5
Finance, insurance, real estate	do	56.5	58.5	+3.5
Services	do	194.3	202.1	+4.0
Government	do	228.5	236.9	+3.7
Total nonagricultural employment[1]	do	1,137.7	1,193.1	+4.9
Personal income:				
Total	millions	$27,493	$31,656	+15.1
Per capita		$9,066	$10,210	+12.6
Construction activity:				
Number of private and public residential units authorized		18,101	14,905	-17.7
Value of nonresidential construction	millions	$596.0	$998.8	+67.6
Value of State road contract awards	do	$59.6	$109.1	+83.0
Shipments of portland and masonry cement to and within the State	thousand short tons	1,682	1,882	+11.9
Nonfuel mineral production value:				
Total crude mineral value	millions	$224.1	$236.6	+5.6
Value per capita, resident population		$74	$78	+5.4
Value per square mile		$3,206	$3,384	+5.6

[p]Preliminary.

[1]Includes bituminous coal and oil and gas extraction.

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

Legislation and Government Programs.—The Oklahoma Senate recreated the State Mining Board in Senate Bill 609, which will continue until July 1, 1986, in accordance with the provisions of the Oklahoma Sunset Law. The Board will continue to be composed of nine members—five shall be practical miners (including three strip miners and at least one from a noncoal mining operation), two shall be superintendents or owners of coal mines, one shall be a lay member, and the last member shall be the State's Chief Mine Inspector. The comprehensive bill also calls for the delineation

of mining districts by the Chief Mining Inspector, sets forth duties of the inspector and deputies, defines certificates of competency for mine foremen, and lists regulations for State mining operations. House Bill 1735 set forth rules and regulations for the establishment of a mining operation in the State, including application for a permit for each separate mine and a reclamation plan with a performance bond or security deposit.

The Oklahoma Geological Survey (OGS) completed an inventory of all active and inactive surface mines determined by use of aerial photos and an inventory of all active mines, pits, quarries, and prospects to be entered into the U.S. Bureau of Mines data base, the Mineral Industry Location System. In cooperation with the U.S. Geological Survey, the OGS continued its hydrologic studies. Ongoing OGS studies included basic research in stratigraphy, sedimentology, paleontology, petrology, and geologic mapping of five counties.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Cement.—High interest rates in 1981 restrained highway, housing, and other light construction for the second consecutive year in most of Oklahoma. Large-scale commercial construction and relatively strong housing developments in the Oklahoma City and Tulsa metropolitan areas, along with some scattered energy-related construction activity, were the exceptions to this sluggish activity. Portland cement production increased about 9% in 1981 over that of 1980, but masonry cement decreased 12%. Portland shipments were up only 2%, whereas masonry shipments fell 5%. Portland cement stocks increased 9%, and masonry cement stocks were slashed by one-third. Average value per short ton of portland and masonry cement increased about 11%—portland to $51 and masonry to $63.

Statewide, the cement industry increased its use of coal and electrical energy and decreased its use of natural gas. In terms of British thermal unit consumption, coal use was about 6.3 times that of natural gas, up from 5.4 in 1980. The industry continued to reduce energy needs per ton of cement output but at a decreasing rate, suggesting that most economies of energy use had been attained. Approximately 70% of the cement output was sold to ready-mix companies. Building-material dealers and concrete-product manufacturers bought 12.9%, and highway and other contractors took most of the remainder.

Oklahoma Cement completed its first full year of operations as a unit of Lone Star Industries, Inc. The original 190,000-ton-per-year facility in Pryor, Mayes County, was known as Oklahoma Cement Co. when founded in 1959 as an independent portland cement producer. Production began in 1960, and plant capacity was doubled to 380,000 tons in 1962. The company acquired oil, refinery, and real estate interests and became OKC Corp. Through interim plant improvements and modifications, the cement operation increased capacity to 450,000 tons in 1974, and in a major expansion, capacity was increased to 720,000 tons in 1980. Limestone and shale raw materials were quarried from surface deposits at the 1,400-acre plantsite. Both high lime, more than 88% carbonate, and low lime, about 60% carbonate, were quarried. Reserves are ample to support the current rate of output for 70 years. Small quantities of the cement additives iron ore and sand were purchased; coal, the fuel used for normal operation, was bought and trucked in from a number of small mines in northeast Oklahoma. In recent years, about one-third of Oklahoma Cement sales have been low-alkali cements for the oil and gas drilling industry. Until the latest expansion, one 300-horsepower Pettibone hammer mill had crushed all the stone at the plant throughout its 20-year history. In the last expansion, a 600-horsepower, single-rotor impactor was installed to serve as the primary crusher; the 20-year-old hammer mill is now used as a secondary crusher. The new primary crusher has the capacity to support future expansions.

Clays.—Oklahoma produced only common clay in 1981, the same as in 1980. Although output declined 13.8% in 1981, average price per ton moved up 6.5%, from $2.31 in 1980 to $2.46 in 1981. Clay production figures in 1980 and 1981 clearly indicate the lack of highway and single family home construction growth in most of Oklahoma because of persistently high interest rates. Ten companies recorded clay or shale output from 13 mines in 10 counties. Clays or shale were used mainly in manufacturing face and common brick, pipe, pottery, concrete block, structural, and as an ingredient in cement.

Feldspar.—Arkhola Sand and Gravel Co. continued to recover feldspathic sand dredged from the bed of the Arkansas River near Muskogee. Feldspar comprises about 25% of

the feldspar-silica sands in the river. Production in 1981 was about 13% over that of 1980; price per ton eased about 3%. Glass plants in Oklahoma took all the feldspathic sand output.

Gypsum.—For the second consecutive year, crude gypsum output declined in Oklahoma, down 11.2% in 1981, about the same as the 10.4% decline in 1980. Average value per short ton eased about 1%, from $8.47 to $8.39. Five companies mined gypsum in four counties in 1981. In 1980, six companies operated in five counties. Two companies calcined gypsum in 1981, the same as in 1980. Although calcined gypsum output was essentially unchanged, unit price reversed the decline of 1980, moving sharply toward the peak price of 1979.

Oklahoma State University agronomists were conducting studies to improve peanut production, including experiments in the time-controlled release of micronutrient and gypsum applications.

Helium.—High-purity helium production, valued at $26 per thousand cubic feet, up from $23 in 1980, declined about 60% in 1981. Recovery of crude helium, unchanged at $12 per thousand cubic feet, was off 4%.

Iodine.—Compared with 1980 output, iodine production rose about one-third, and price was maintained at the strong 1980 level. Woodward Iodine Operations, a joint project of PPG Industries, Inc., and Amoco Production Co., increased output and approached its rated annual capacity of 2 million pounds of iodine.

At Woodward, brine from the 7,000-foot-deep Morrowan (Pennsylvanian) strata is held briefly in a storage tank, fed to a stripping column where iodine-rich vapor is removed, and then sent to a second column where the vapor is absorbed into solution. The iodine from the solution is crystallized, filtered, and dried in the plant recovery system. Subjected to temperatures ranging from 250° to 280° F, the molten iodine is flaked in a cooling process and packed in 100-pound drums for shipment. Stripped brine is neutralized, moved to an effluent pond, filtered, and then pumped to injection wells where it is returned to the Morrowan strata to maintain pressure on the remaining iodine-bearing brine.

Beard Oil Co. of Oklahoma City and two Japanese firms—Godoe (U.S.A.), Inc., a subsidiary of United Resources Industry Co., a worldwide leader in iodine extraction and manufacturing technology, and Inorgchem Development, Inc., a subsidiary of the large trading firm, Mitsui & Co.—plan to construct Oklahoma's second commercial iodine facility. The joint venture will operate under the name North American Brine Resources. A pilot plant that proved the economic feasibility of the system has been in operation since 1980.

Iodine will be extracted from brines produced along with crude oil at Beard's wells northeast of Dover in Kingfisher County. Construction of a purifying plant began in November at a Beard disposal well where brine is reinjected, and Beard obtained permission to extract iodine from three other saltwater disposal wells in the area. These peripheral wells will have their individual iodine extraction miniplant, each capable of processing 5,000 barrels of brine per day.

Liquid iodine will be trucked to the Dover processing plant for conversion into purified crystalline iodine for marketing. The production target by mid-1982 is 120 to 160 metric tons annually. Highly automated, the operation will require 6 to 10 employees at the extraction facilities and main plant. National iodine consumption exceeds 3,000 tons per year; about two-thirds is imported, mostly from Japan.

Lime.—St. Clair Lime Co. in Sequoyah County continued to produce lime in 1981. Although output was essentially unchanged from that of 1980, unit price was up about 6% in 1981. The flat production figures of 1980 and 1981, off from the rising trend in the late 1970's, reflect statewide reduced light construction activity.

Pumice (Volcanic Ash).—Axtell Mining Corp. continued to produce volcanic ash from its lakebed deposit near Gate in Beaver County. Off slightly in 1980, output declined about 25% in 1981. Unit value per short ton remained firm.

Salt.—Recovery of salt increased sharply, 77% in 1981 compared with 1980 output. However, as nationwide domestic supplies increased and approximated demand in 1981, the average price of Oklahoma salt increased only 18% in 1981; this increase contrasted to the marked 43% price rise in 1980 precipitated by shortages in several parts of the Nation. Oklahoma's salt is recovered from natural springs and wells drilled into brine-filled solution cavities in the shallow salt beds within the Permian Flowerpot Shale in Harmon County.

Sand and Gravel.—To reduce the burdens and costs of reporting, the Bureau of Mines implemented new canvassing procedures for its 1981 surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel

producers will continue to be conducted annually. This chapter, therefore, contains only preliminary estimates for construction sand and gravel production but contains complete data on industrial sand and gravel. The preliminary estimates of construction sand and gravel production for odd-numbered years will be revised and completed the following year.

As in 1980, sand and gravel ranked second in quantity to stone among nonfuel minerals produced in Oklahoma in 1981; value remained in third place behind cement and stone. Based on the estimate of construction sand and gravel, total sand and gravel output was off about 1.5%, with industrial sand and gravel down 5.5% and construction off about 1%.

Three companies produced industrial sand and gravel at four operations in three counties—Johnston, Pontotoc, and Muskogee, in order of quantity—the same as in 1980. Although output declined modestly in response to weakened demand, average price per short ton rose 10%, from $8.68 in 1980 to $9.54 in 1981. The price range per ton for various markets was about $4 to $23 in 1981, compared with $4 to $20 in 1980. Although unit value was up for all 15 uses the Bureau of Mines lists, quantity used was up in only 5 categories.

Containers again consumed most of the industrial sand, about 39%, as in recent years. Flat and specialty glasses took about 30%, off from 33% in 1980. Most declines in sand and gravel use were housing related or otherwise sensitive to high interest rates. Demand for hydraulic fracture sands declined about 6% when oil drilling plateaued in late 1981 and when natural gas activity increasingly centered on areas of deep gas potential. Although oil and gas drilling remained active in Oklahoma in 1981, the uptrend in working rigs appeared to be over at yearend; therefore, the rising demand for fracturing sand and its strong price trend in recent years also may ease somewhat.

Table 4.—Oklahoma: Sand and gravel sold or used by producers, by use

Use	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	8,421	$18,950	$2.25	NA	NA	NA
Gravel	1,873	4,445	2.37	NA	NA	NA
Total or average	10,294	23,395	2.27	p10,200	p$23,800	p$2.33
Industrial sand	1,587	13,767	8.68	1,500	14,317	9.54
Grand total or average	11,881	37,162	3.13	p11,700	p38,117	p3.26

pPreliminary. NA Not available.

Stone.—In 1981, in terms of value, stone surrendered its long-held position of leading nonfuel mineral produced in Oklahoma. Value of total stone output—dolomite, granite, limestone, and sandstone—increased 9.4% in 1981; however, value of cement was up about 12%. Stone tonnage moved up 6.2%. Limestone continued to be the leading stone quarried; most stone output again came from quarries in Comanche, Kiowa, Murray, Rogers, and Tulsa Counties.

Crushed stone production moved up 6.2% in 1981 after declining 0.5% in 1980. Average price of crushed stone was firm in 1981 at $2.79 per ton, up from $2.71 in 1980. Crushed stone average price had risen 15% in 1980 over that of 1979. Dimension stone output increased 12.5% in 1981, recovering part of its sharp 58% decline in 1980. Average price of dimension stone eased 4.6% to $40.48 per ton in 1981, in contrast to its 16% gain in 1980 to $42.

In January, the St. Clair Lime Co. Marble City plant increased pulverized and fine-ground limestone capacity by 50%. Additional crushing, screening, drying, and air-classification equipment was added for processing the high-grade calcium limestone.

Table 5.—Oklahoma: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	457	995	602	1,300
Concrete aggregate	6,984	21,048	6,572	21,166
Bituminous aggregate	2,158	6,418	1,762	5,504
Dense-graded road base stone	8,428	18,276	10,744	23,436
Surface-treatment aggregate	2,642	9,427	1,990	7,918
Other construction aggregate and road stone	1,301	3,179	3,116	8,027
Riprap and jetty stone	1,202	3,507	758	2,141
Railroad ballast	1,897	5,783	1,216	5,040
Filter stone	97	382	65	184
Manufactured fine aggregate (stone sand)	W	W	113	244
Cement manufacture	2,352	4,248	2,514	4,759
Fill	132	W	--	--
Waste material	1	1	1	2
Other[2]	523	3,004	476	3,686
Total[3]	28,173	76,267	29,930	83,407

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

[1]Includes limestone, granite, sandstone, and miscellaneous stone.

[2]Includes stone used for agricultural marl and other soil conditioner (1981), poultry grit and mineral food, macadam aggregate, lime manufacture, asphalt filler, glass manufacture, and other uses not specified.

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

Tripoli.—Output increased about 15% in 1981, thereby recovering about one-half the level of production lost in 1980 from the recent peak in 1979. Price per short ton in 1980 was just about equal to the national average price of $5.58; however, in 1981 a divergence was recorded as the average price nationwide rose slightly and the price in Oklahoma fell more than 10%. As in past years, raw tripoli was shipped to Seneca, Mo., and processed into fine-grained abrasives.

Vermiculite.—W. R. Grace & Co. increased its production of exfoliated vermiculite by about 8% at the Oklahoma City plant. Output was used mostly for loose and block insulation and in aggregates; a small amount was used for agricultural purposes.

METALS

No metallic ore was mined in Oklahoma during 1981. A variety of metals were recovered from in-State smelters that used recycled materials from local and out-of-State sources and ore concentrates from out-of-State producers. National Zinc Co., a subsidiary of Engelhard Minerals & Chemical Corp., recorded its 74th year of operations at the Bartlesville electrolytic refinery and byproduct sulfuric acid plant. In Picher, 7,000 former miners and residents returned in August for an informal reunion in the former lead-zinc mining district.

OGS published a new geological map detailing the zinc resources in Murray County. Entitled "Geologic Map of Southwest Davis Zinc Field, Arbuckle Mountains, Oklahoma," the map comes with a 16-page illustrated booklet that discusses regional geology, mineralogy of the ores, chemical analyses of ore samples, and history of the area. Two other base-metal publications were a report on Triassic copper in the Oklahoma Panhandle and a compilation of three maps showing copper, lead, and zinc deposits in the Ouachita Mountains.

Water pollution in the Picher lead-zinc mining area continued to be investigated in 1981. Water from mine workings and artesian springs in the Tar Creek watershed, encompassing an estimated 435 abandoned zinc and lead mines in the Picher district, has caused orange and orange-brown stains and encrustations on the banks and bottoms of creeks in the district.

Tar Creek originates in Kansas, trends south into Oklahoma at the Kansas-Oklahoma State line 1.5 miles northwest of Picher, and apparently becomes highly polluted in section 29, about 1.5 miles southwest of Picher. Much of the eastern four-fifths of section 29 is a flat, topographic low, and is drained north to south by Tar Creek near its western end and northeast to southwest by Lytle Creek. Tar and tributary Lytle Creeks converge at the southern boundary of section 29. Aquatic life is evident in Tar Creek about one-third mile into section 29.

The western edge of section 29 is lined with three huge waste dumps, locally referred to as "chat piles." Smaller chat piles

and tailings are scattered in the eastern four-fifths of section 29, but mostly the eastern part of the section is marked by numerous small ponds formed by caved mine workings. Because of limited relief, much of the uncaved area is swampy or tree and brush covered.

Tar Creek in this area contains acidic zinc-, lead-, copper-, and cadmium-water and is bright orange to orange-brown. At its confluence with Tar Creek, Lytle Creek is orange-brown to brown. South of Picher, toward Commerce and Miami, other tributaries to Tar Creek drain agricultural lands to the east, and the water becomes brown. Besides section 29, about a dozen other sections in the Picher district have had intensive zinc and lead mining. The Roubidoux Formation, an aquifer tapped in many areas in the Tri-State district of Oklahoma, Kansas, and Missouri, underlies the mine workings in the Picher district. Contamination of the Roubidoux Formation remains a potential long-term problem.

[1]State Liaison Officer, Bureau of Mines, Denver, Colo.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Ideal Basic Industries, Inc., Ideal Cement Co.[1 2]	Box 8789 Denver, CO 80201	Quarry and plant	Pontotoc.
Lone Star Industries, Inc.[1 2]	Box 68 Pryor, OK 74361	____do_____	Mayes.
Martin Marietta Cement Western Div.[1 2]	5350 East 46th St. Tulsa, OK 74135	____do_____	Rogers.
Clays:			
Chandler Materials Co	5805 East 15th St. Tulsa, OK 74102	Mines and plants	Oklahoma and Rogers.
Commercial Brick Corp	Box 1382 Wewoka, OK 74884	Mine and plant	Seminole.
W. S. Dickey Clay Manufacturing Co	Box 6 Pittsburg, KS 66762	Mine	Le Flore.
Justin Industries Acme Brick Co	Box 425 Fort Worth, TX 76101	Mines and plants	Canadian, Custer, Oklahoma, Tulsa.
Mangum Brick Co	Box 296 Mangum, OK 73554	Mine and plant	Greer.
Oklahoma Brick Corp	Box 75368 Oklahoma City, OK 73147	____do_____	Canadian.
Feldspar:			
Ashland Oil Co.-Arkhola Sand and Gravel Co.[2 3]	Box 1627 Fort Smith, AR 72902	Dredge and plant	Muskogee.
Gypsum:			
Harrison Gypsum Co., Inc	Box 336 Lindsay, OK 73052	Quarry	Caddo.
Republic Gypsum Co	Box 750 Dallas, TX 75221	Quarry and plant	Jackson.
Temple Gypsum	Box 1270 West Memphis, AR 72301	Quarry	Comanche.
United States Gypsum Co	101 South Wacker Dr. Chicago, IL 60606	Quarry and plant	Blaine.
Iodine:			
PPG Industries, Inc., Woodward Iodine Operations.	Box 1245 Woodward, OK 73801	Brine field and plant.	Woodward.
Lime:			
St. Clair Lime Co	Box 569 Sallisaw, OK 74955	Plant and quarry	Sequoyah.
Pumice (volcanic ash):			
Axtell Mining Corp	Box 92 Gate, OK 73844	Open pit	Beaver.
Salt:			
Acme Salt Co	Box 420 Erick, OK 73645	Solar evaporation	Harmon.

See footnotes at end of table.

Table 6.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sand and gravel:			
The Dolese Co	Box 677 Oklahoma City, OK 73101	Pits and plants	Canadian, Garfield, Kingfisher, Logan, McClain.
E & A Materials	Box 365 Wichita Falls, TX 76307	Pit and plant	Cotton.
General Materials Co., Inc	Box 24044 Oklahoma City, OK 73124	do	Oklahoma.
McMichael Concrete Co.[2]	Box 9486 Tulsa, OK 74107	do	Tulsa.
Mohawk Rock and Sand Co	Box 640 Sand Springs, OK 74063	do	Do.
Pennsylvania Glass Sand Corp., Oklahoma Works.	Box 36 Mill Creek, OK 74856	do	Johnston.
Shoffner Sand of Oklahoma, Inc	Box 863 Edmond, OK 73034	do	Oklahoma.
Stone:			
Anchor Stone Co.[3]	Box 6130 Tulsa, OK 74106	Quarry	Tulsa.
Ashland Oil Co.-Standard Industries, Inc.	Box 15670, Admiral Station Tulsa, OK 74112	Quarries	Kay, Osage, Tulsa.
Delta Mining Corp	Box 85 Mill Creek, OK 74856	Quarry	Johnston.
Dolese Bros. Co	Box 677 Oklahoma City, OK 73101	Quarries	Atoka, Caddo, Carter, Coal, Comanche, Kiowa, Murray, Seminole.
Eagle-Picher Industries, Inc	Box 910 Miami, OK 74354	Rock waste recovery.	Ottawa.
Fairfax Granite, Inc	Box 482 Barre, VT 05641	Quarries	Comanche, Greer, Kiowa.
Hallett Construction Co	Box 13 Boone, IA 50036	Quarry	Murray.
Lattimore Industries, Inc	Box 1186 Denison, TX 75020	do	Bryan.
The Quapaw Co.[1]	Box 72 Drumright, OK 74030	do	Creek.
Willia-Pellow Bros. Monument Co	Box 188 Granite, OK 73547	Quarry and plant	Greer.
H. D. Youngman, Contractor	Box 647 Eufaula, OK 74432	Quarries and plants	Choctaw and McIntosh.
Tripoli:			
The Carborundum Co	Box 489 Seneca, MO 64865	Pits	Ottawa.

[1]Also clays.
[2]Also stone.
[3]Also sand and gravel.

The Mineral Industry of Oregon

By George T. Krempasky[1]

Oregon's nonfuel mineral production was valued at $147 million in 1981. Nonmetals—cement, clays, diatomite, gem stones, lime, pumice, sand and gravel, stone, and talc—accounted for 88% of production value. Metals accounted for the remainder. The 1981 value of nonfuel mineral production was 5% more than the average value of production for the 5-year period (1977-81).

Nonmetals, especially cement and other construction materials, continued to show the effects of an economic downturn.

New surface mining permits issued by the Oregon Department of Geology and Mineral Industries, Mined Land Reclamation Program, totaled 185 in 1981 compared with 126 in 1980. A total of 26 permits were terminated in 1980 compared with 65 in 1981. As of December 31, 1981, the State had 703 sites under permit, an increase of about 14% over the number under permit in 1980.

Trends and Developments.—Mineral exploration expenditures continued to increase in 1981. It was reported that companies expended $11.2 million in the search for new ore, compared with $5.62 million in 1980. Most of the activity centered in Baker and Grant Counties in the Blue Mountains of eastern Oregon. The principal target was gold. Precious metals were also being sought in Douglas, Josephine, Lane, Malheur, Marion, and Union Counties. To a lesser degree, there was some base metal exploration activity in Baker, Douglas, Josephine, Lane, and Marion Counties. Laterite deposits containing nickel, chromium, and cobalt were being evaluated in Josephine County, and a chromium occurrence was being investigated in Grant County.

Activities in the metal processing sector of the mineral industry included the Albany Titanium Inc. plan to produce titanium sponge at a rate of 35,000 pounds per month, the expansion of the Oregon Metallurgical Corp. titanium plant at Albany, the Bergsoe Metal Corp. 50,000-ton-per-year secondary lead smelter going onstream at Saint Helens, and various mills started processing precious metal ores. Some negative impacts were Union Carbide Corp.'s plans to close its ferroalloys plant at Portland, and the Reynolds Metals Co.'s shutdown of two 25,000-ton-per-year potlines at its Troutdale aluminum plant. Reynolds was considering closure of the Troutdale plant rather than attempting to meet new State antipollution rules.

Legislation and Government Programs.—The 61st Oregon Legislature Assembly completed its biennial session on August 2, 1981. Several bills related to the mineral industry were passed into law. The two bills of major concern were House Bills 2160 and 2220. House Bill 2160 (Oregon Revised Statute 517) underwent significant changes that increased the maximum amount of bonding, increased the ceiling for penalties and liens, and increased the minimum amount of material extracted related to the definition of surface mining. House Bill 2220 increased the operating permit fee for new surface mine operators and increased the annual renewal permit fee for existing sites.

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

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Clays	thousand short tons	172	$321	176	$300
Gem stones		NA	450	NA	600
Gold (recoverable content of ores, etc.)	troy ounces	rW	rW	2,830	1,301
Lead (recoverable content of ores, etc.)	metric tons	--	--	W	W
Nickel (content of ore and concentrate)	short tons	14,653	W	12,099	W
Pumice	thousand short tons	r219	r1,318	W	W
Sand and gravel	do	16,005	47,300	p14,400	p42,400
Silver (recoverable content of ores, etc.)	thousand troy ounces	1	17	7	79
Stone:					
Crushed	thousand short tons	r19,251	r49,606	16,482	46,055
Dimension	do	15	231	(2)	5
Combined value of cement, copper (1981), diatomite, lime, talc, and values indicated by symbol W		XX	r52,727	XX	56,107
Total		XX	r151,970	XX	146,847

pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; values included with "Combined value" figure. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Less than 1/2 unit.

Table 2.—Value of nonfuel mineral production in Oregon, by county

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Baker	$14,633	$18,275	Cement, stone, sand and gravel, clays, gold, silver, pumice.
Benton	W	W	Sand and gravel, stone, clays.
Clackamas	W	W	Cement, sand and gravel, stone, clays.
Clatsop	W	1,403	Stone, sand and gravel.
Columbia	W	W	Sand and gravel, stone.
Coos	W	W	Stone, sand and gravel.
Crook	W	W	Do.
Curry	385	W	Do.
Deschutes	W	W	Pumice, stone, sand and gravel.
Douglas	W	W	Nickel, stone, sand and gravel.
Gilliam	W	--	
Grant	W	W	Sand and gravel, stone.
Harney	1,263	W	Stone.
Hood River	260	W	Stone, sand and gravel.
Jackson	r3,376	W	Gold, sand and gravel, stone, talc.
Jefferson	361	W	Stone, pumice.
Josephine	W	W	Sand and gravel, stone.
Klamath	W	W	Stone, sand and gravel, clays.
Lake	W	W	Diatomite, stone, sand and gravel.
Lane	15,080	7,726	Sand and gravel, stone.
Lincoln	4,061	W	Stone, sand and gravel.
Linn	1,737	1,179	Do.
Malheur	W	W	Lime, sand and gravel, stone.
Marion	5,523	3,513	Sand and gravel, stone.
Morrow	W	W	Do.
Multnomah	W	W	Sand and gravel, lime, stone, clays.
Polk	W	873	Stone, sand and gravel.
Sherman	117	--	
Tillamook	393	782	Do.
Umatilla	2,218	1,612	Do.
Union	744	W	Sand and gravel, stone.
Wallowa	W	W	Do.
Wasco	147	479	Stone.
Washington	11,297	10,485	Stone, sand and gravel.
Wheeler	W	--	
Yamhill	2,618	2,021	Do.
Undistributed[1]	r101,109	103,623	
Total[2]	r165,321	151,970	

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Includes gem stones and stone that cannot be assigned to specific counties and values indicated by symbol W.
[2]Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Oregon business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	1,248.2	1,323.3	+6.0
Unemployment	do	107.9	154.5	+43.2
Employment (nonagricultural):				
Mining	do	2.3	2.2	-4.3
Manufacturing	do	215.1	203.3	-5.5
Contract construction	do	46.5	37.6	-19.1
Transportation and public utilities	do	60.5	59.7	-1.3
Wholesale and retail trade	do	255.6	253.7	-.7
Finance, insurance, real estate	do	70.0	68.4	-2.3
Services	do	191.4	192.2	+.4
Government	do	203.2	202.2	-.5
Total nonagricultural employment	do	1,044.6	1,019.3	-2.4
Personal income:				
Total	millions	$24,533	$26,483	+8.0
Per capita		$9,296	$9,991	+7.5
Construction activity:				
Number of private and public residential units authorized		19,480	13,574	-30.3
Value of nonresidential construction	millions	$476.6	$404.3	-15.2
Value of State road contract awards	do	$148.4	$175.4	+18.2
Shipments of portland and masonry cement to and within the State	thousand short tons	832	627	-24.6
Nonfuel mineral production value:				
Total crude mineral value	millions	$152.0	$146.8	-3.4
Value per capita, resident population		$57	$56	-1.8
Value per square mile		$1,544	$1,514	-2.0

[p]Preliminary.

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

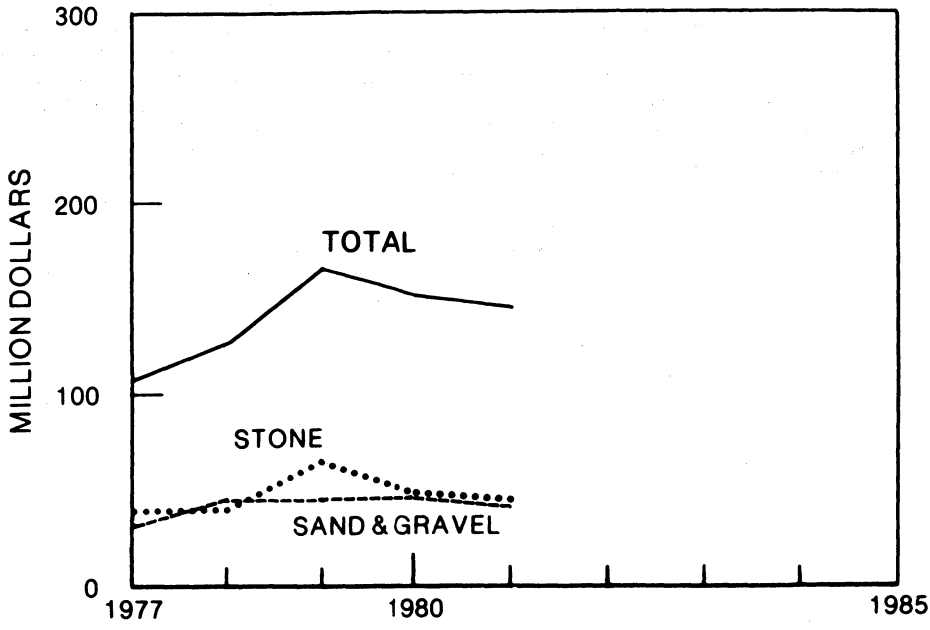

Figure 1.—Value of sand and gravel and stone, and total value of nonfuel mineral production in Oregon.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

The economic downturn continued to have adverse effects on the nonmetals industry, especially construction materials. In 1981, the value of nonmetals produced in Oregon was approximately 88% of that in 1980. Oregon's Economic Development Commission approved $1.9 million in industrial development bonds for North Santiam Sand & Gravel Inc. to expand its concrete plant in Marion County and to construct an asphalt plant in Linn County. Ross Island Sand & Gravel Co. was issued a 35-year conditional use permit by the Portland City Council for gravel mining on Ross Island.

Cement.—Oregon Portland Cement Co., the State's only cement producer, produced cement at its Durkee and Oswego plants. Cement production in 1981 was somewhat less than the average for the 5-year period (1977-81). Value of production was slightly more than the 5-year average.

Clays.—Common clay and shale was mined by four companies from five pits in four counties. Clay production in 1981 was 18% more than the average for the 5-year period (1977-81), with the value of the product increasing 12% over the average value for the 5-year period.

Diatomite.—Oil Dri Production Co. continued to mine and process diatomaceous earth for pet litter and floor-sweeping absorbent from its Christmas Valley site in Lake County. Production in 1981 was 56% more than the average for the 5-year period (1977-81). The value of production was 71% more than the average value for the 5-year period.

Pumice.—Pumice was produced by two companies from two pits in 1981, compared with three producers from three pits in 1980. The material was used for concrete aggregate, landscaping, road construction, and roofing material.

Sand and Gravel.—To reduce reporting burden and costs, the Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary statistics for construction sand and gravel production. The preliminary statistics for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Preliminary statistics indicated that the construction sand and gravel sold or used in 1981 was down 10% in quantity and value from that of 1980. The decline may be attributed to the general economic downturn. As was the case in previous years, more than one-half of the sand and gravel used was transported by truck.

Table 4.—Oregon: Construction sand and gravel sold or used by producers

	1980			1981[p]		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Sand	4,203	$11,907	$2.83	NA	NA	NA
Gravel	11,802	35,392	3.00	NA	NA	NA
Total or average	16,005	[1]47,300	2.96	14,400	$42,400	$2.94

[p]Preliminary. NA Not available.
[1]Data do not add to total shown because of independent rounding.

Stone.—Crushed and/or dimension stone, including scoria and volcanic cinders, was produced from 334 quarries in 28 counties. The U.S. Forest Service, which mined stone in various counties, was the leading producer. Excluding Forest Service production, Washington County was the leading source with about 2.2 million short tons of crushed stone.

The larger stone quarries, yielding more

than 200,000 short tons per year, and Forest Service production accounted for 70% of the State total, two-thirds of which was produced by the Forest Service.

Crushed stone sold or used by producers, by use, is shown in table 5. More than 96% of the product was transported to users by truck. Principal producers, each with annual production of more than 300,000 short tons, are listed in table 6.

Table 5.—Oregon: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Concrete aggregate	120	$345	62	$209
Bituminous aggregate	1,263	3,443	2,291	7,330
Macadam aggregate	885	2,510	242	711
Dense-graded road base stone	r4,454	r10,558	4,123	10,379
Surface treatment aggregate	1,639	4,293	506	1,480
Other construction aggregate and road stone	r9,311	r23,458	7,893	21,233
Riprap and jetty stone	523	963	347	773
Railroad ballast	238	931	213	827
Filter stone	17	78	20	89
Manufactured fine aggregate (stone sand)	3	17	67	209
Terrazzo and exposed aggregate	1	4	(2)	1
Ferrosilicon	20	W	16	W
Fill	W	W	1	2
Drain fields	1	2	--	--
Other[3]	776	3,004	701	2,813
Total	r19,251	r49,606	16,482	[4]46,055

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Other."

[1]Includes limestone, granite, sandstone, traprock, miscellaneous stone, and volcanic cinder and scoria.

[2]Less than 1/2 unit.

[3]Includes stone used for agricultural limestone, poultry grit and mineral food, cement manufacture, fill, and sugar refining.

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

Talc.—Steatite of Oregon Inc. continued to mine and process talc in Jackson County. The product has been used for art carving and other specialty uses.

METALS

Aluminum.—Martin Marietta Aluminum Inc., at The Dalles, and Reynolds Metals Co., at Troutdale, continued to operate at various capacities. Curtailed production was attributed to a slow market.

Copper, Gold, and Silver.—Gold production figures for 1979 and 1980 have been revised upward to include placer production. In 1981, available production figures disclose that gold was recovered from the ores of three mines in two counties; however, there was no placer production reported for 1981.

Silver and copper were recovered from the ores of three mines in two counties.

Nickel.—The Hanna Mining Co., the only domestic producer of primary nickel, continued its Nickel Mountain operation. Output of contained nickel from its smelter complex declined in 1981. The 1981 production was 13% less than the average for the 5-year period (1977-81).

Titanium.—During the year, numerous changes took place at Oregon Metallurgical Corp. in Albany. The long-term outlook was strong, prompting additional capacity, a broadening of product lines, and investments in facilities and processes that will reduce costs. In 1981, sponge capacity was increased from 6 to 9 million pounds per year with an ability to add another 3-million-pound capacity with short notice. The new mill products facility was completed. Major investments are planned for 1982 and 1983; they include refurbishment of the titanium tetrachloride facility and augmenting the magnesium recovery unit.

Zirconium.—Four plants worldwide produced zirconium metal in 1981. The major domestic supplier continued to be Teledyne Wah Chang Albany Corp. in Albany. Nuclear power depression in the United States has resulted in lower zirconium usage. Production and shipments of zirconium mill products declined for the fourth consecutive year.

[1]Formerly State Liaison Officer, currently deputy chief, Western Field Operations Center, Bureau of Mines, Spokane, Wash.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum:			
Martin Marietta Aluminum Inc	6801 Rock Ledge Dr. Bethesda, MD 20034	Smelter	Wasco.
Reynolds Metals Co	Troutdale, OR 97060	Plant	Multnomah.
Cement:			
Oregon Portland Cement Co.[1]	111 SE. Madison St. Portland, OR 97214	Plants and quarries.	Baker and Clackamas.
Diatomite:			
Oil Dri Production Co	Box 191 Christmas Valley, OR 97638	Mine and plant	Lake.
Lime:			
Amalgamated Sugar Co	Nyssa, OR 97914	Plant	Malheur.
Ash Grove Cement Co	8900 Indian Creek Pkwy. Suite 600 Overland Park, KS 66225	do	Multnomah.
Nickel:			
The Hanna Mining Co	Riddle, OR 97469	Mine and plant	Douglas.
Pumice:			
Central Oregon Pumice Co	5 Greenwood Ave. Bend, OR 97701	do	Deschutes.
Graystone Corp (Cascade Pumice Co.)	Box 1087 Bend, OR 97701	do	Do.
Stone:			
L. H. Cobb	21305 SW. Koehler Rd. Beaverton, OR 97005	Quarry	Washington.
Rogers Construction Co	11760 NE. Glissan Portland, OR 97220	do	Do.
U.S. Forest Service, Region VI	319 SW. Pine St. Portland, OR 97208	Quarries	Various.
Titanium:			
Oregon Metallurgical Corp	Box 580 Albany, OR 97321	Plant	Linn.
Zirconium:			
Teledyne Wah Chang Albany Corp	Box 460 Albany, OR 97321	do	Do.

[1]Also clays and stone.

The Mineral Industry of Pennsylvania

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Pennsylvania Bureau of Topographic and Geologic Survey, Department of Environmental Resources, for collecting information on all nonfuel minerals.

By William Kebblish[1] and Robert J. Tuchman[2]

The value of Pennsylvania's nonfuel mineral production was $633.1 million in 1981, a 5% decrease from that of 1980. The decrease was related to economic conditions curtailing activities in nearly all mineral-related industries. Pennsylvania led the Nation in production of masonry cement and iron slag. The State was second in the production of pig iron; third in portland cement, lime, and stone; and fifth in expanded perlite and zinc. Nationally, Pennsylvania ranked 13th in value of total nonfuel mineral output.

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

Mineral		1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
Cement:					
Masonry	thousand short tons	324	$20,298	293	$14,799
Portland	do	5,570	237,684	5,150	215,883
Clays[2]	do	1,650	12,112	1,246	7,497
Gem stones		--	--	NA	5
Lime	thousand short tons	1,768	84,291	1,690	85,418
Mica (scrap)	do	3	W	3	134
Peat	do	26	552	25	647
Sand and gravel	do	15,603	68,257	p [3]14,300	p [3]55,400
Stone:					
Crushed	do	61,143	218,231	53,258	207,821
Dimension	do	65	6,397	51	7,193
Tripoli	short tons	W	W	1,263	W
Zinc (recoverable content of ores, etc.)	metric tons	22,556	18,613	24,732	24,293
Combined value of clays (kaolin), sand and gravel (industrial 1981), and values indicated by symbol W		XX	1,171	XX	13,966
Total		XX	667,606	XX	633,056

pPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes kaolin; value included in "Combined value" figure.

[3]Excludes industrial sand; value included in "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Adams	W	$20,603	Stone, lime, clays, mica.
Allegheny	W	W	Cement, clays, stone, sand and gravel.
Armstrong	W	W	Sand and gravel, stone, clays.
Beaver	$12,419	W	Sand and gravel, clays.
Bedford	2,737	W	Stone.
Berks	W	W	Cement, stone, clays.
Blair	W	W	Stone, sand and gravel.
Bradford	W	889	Sand and gravel.
Bucks	W	W	Stone, sand and gravel, clays.
Butler	r36,658	29,295	Lime, cement, stone, sand and gravel, clays.
Cambria	W	--	
Cameron	W	W	Sand and gravel.
Carbon	W	W	Sand and gravel, stone.
Centre	35,491	35,609	Lime, stone.
Chester	W	W	Stone, lime, clays.
Clarion	W	W	Stone, sand and gravel.
Clearfield	W	W	Clays, sand and gravel.
Clinton	W	W	Stone, clays.
Columbia	W	W	Stone, sand and gravel.
Crawford	917	667	Sand and gravel.
Cumberland	5,523	W	Stone, sand and gravel, clays.
Dauphin	W	W	Stone, sand and gravel.
Delaware	W	W	Stone.
Elk	W	66	Do.
Erie	4,643	4,484	Sand and gravel, peat.
Fayette	5,868	W	Stone, clays.
Forest	W	W	Sand and gravel, stone.
Franklin	W	W	Stone, sand and gravel.
Fulton	W	W	Do.
Huntingdon	W	W	Sand and gravel, stone.
Jefferson	W	W	Clays, stone.
Juniata	W	W	Stone.
Lackawanna	831	828	Stone, peat, sand and gravel.
Lancaster	W	W	Stone, clays.
Lawrence	W	W	Cement, stone, sand and gravel, clays, peat.
Lebanon	W	W	Lime, stone.
Lehigh	W	W	Cement, zinc, stone.
Luzerne	W	W	Sand and gravel, stone, clays, peat.
Lycoming	W	W	Sand and gravel, stone.
McKean	W	W	Clays, stone.
Mercer	W	W	Sand and gravel, stone.
Mifflin	987	1,042	Stone, sand and gravel, lime.
Monroe	W	W	Stone, sand and gravel, clays, peat.
Montgomery	W	15,925	Stone, lime, clays.
Montour	W	W	Stone.
Northampton	W	120,043	Cement, stone, sand and gravel.
Northumberland	W	W	Stone, sand and gravel, clays, tripoli.
Perry	W	W	Stone.
Philadelphia	W	W	Sand and gravel.
Pike	1,086	1,025	Sand and gravel, stone.
Schuylkill	W	W	Stone, sand and gravel.
Snyder	W	W	Stone.
Somerset	4,431	3,766	Stone, clays, sand and gravel.
Susquehanna	W	W	Stone, sand and gravel.
Tioga	995	W	Sand and gravel, stone.
Union	W	W	Stone, clays.
Venango	889	1,035	Sand and gravel.
Warren	1,359	1,733	Do.
Wayne	936	W	Stone, sand and gravel.
Westmoreland	W	W	Do.
Wyoming	W	W	Sand and gravel.
York	59,119	52,430	Cement, stone, lime, sand and gravel, clays.
Undistributed	r546,830	378,167	
Total[2]	721,720	667,606	

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]Greene, Indiana, Potter, Sullivan, and Washington Counties are not listed because no nonfuel mineral production was reported.

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

Table 3.—Indicators of Pennsylvania business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	5,341.0	5,386.3	+0.8
Unemployment	do	403.0	500.0	+24.1
Employment (nonagricultural):				
Mining[1]	do	49.0	45.2	-7.8
Manufacturing	do	1,328.2	1,299.7	-2.2
Contract construction	do	190.1	182.5	-4.0
Transportation and public utilities	do	263.3	258.3	-1.9
Wholesale and retail trade	do	988.3	986.1	-.2
Finance, insurance, real estate	do	236.6	240.6	+1.7
Services	do	974.1	1,006.2	+3.3
Government	do	723.3	705.4	-2.5
Total nonagricultural employment[1 2]	do	4,753.1	4,724.1	-.6
Personal income:				
Total	millions	$112,137	$123,137	+9.8
Per capita		$9,427	$10,373	+10.0
Construction activity:				
Number of private and public residential units authorized		30,561	23,724	-22.4
Value of nonresidential construction	millions	$1,025.1	$1,474.5	+43.8
Value of State road contract awards	do	$616.0	$300.0	-51.3
Shipments of portland and masonry cement to and within the State	thousand short tons	2,630	2,402	-8.7
Nonfuel mineral production value:				
Total crude mineral value	millions	$667.6	$633.1	-5.2
Value per capita, resident population		$56	$53	-5.4
Value per square mile		$14,727	$13,964	-5.2

[p]Preliminary.
[1]Includes coal (anthracite and bituminous), gas, and oil extraction.
[2]Data may not add to totals shown because of independent rounding.

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

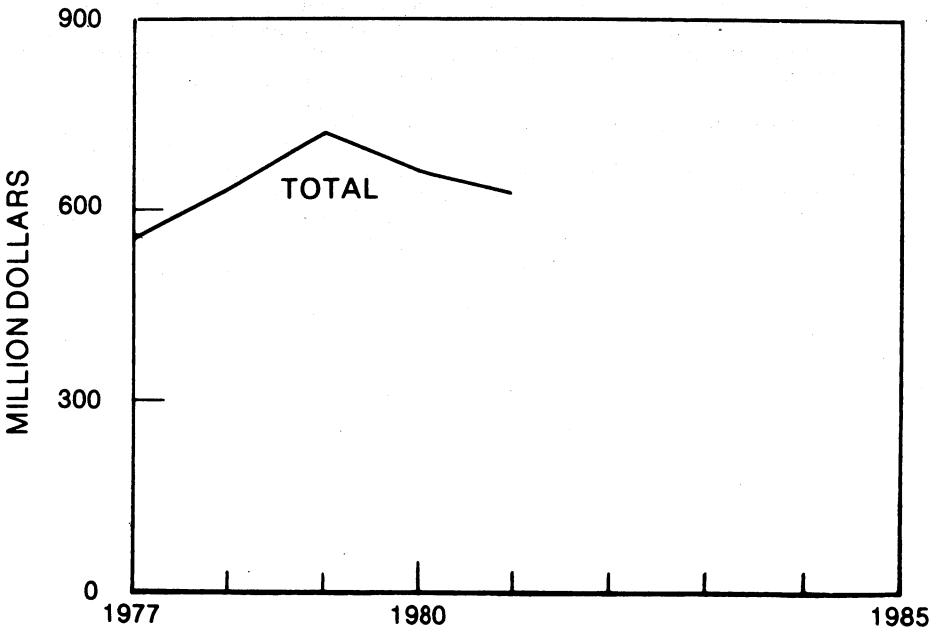

Figure 1.—Total value of nonfuel mineral production in Pennsylvania.

Trends and Developments.—A deepening recessionary trend affected nearly all mineral producers in the State. Manufacturing employment decreased compared with that of 1980, the greatest loss occurring in primary metals, followed by basic steel; employment in contract construction decreased 4%. Housing starts in Pennsylvania totaled 23,724 units in 1981, a decline of more than 22% compared with those of 1980 and more than 56% compared with those of a decade ago. With a reduction in housing starts, the cement, sand and gravel, and stone industries were adversely affected. Over the past decade, output of masonry cement has decreased approximately 47%; portland cement, 34%; sand and gravel, 22%; and stone, 5%.

At yearend, United States Steel Corp. announced closure of its massive Edgar Thomson Works near Pittsburgh for an indefinite period and suspension of operations at the hot strip mill of the company's Irvin Works, West Mifflin. Other steel companies reduced their work forces, temporarily idled operations, and closed marginal plants.

Emission control standards constituted a concern to Pennsylvania's steel industry. A study released by Arthur D. Little, Inc., in midyear indicates additional finances are needed by the Nation's steel industries to remove pollutants from smokestack emissions. The report also specifies the need for plant modernizations to increase productivity.

On a local level, the Allegheny County Board of Health was considering the "bubble concept" to control pollutants. The concept permits a company to use alternative strategies to control emissions within a plant, providing air quality in the general area does not deteriorate.

The transportation industry continued to play an important part in the State's economy. In late 1981, Consolidated Rail Corp. (Conrail) announced iron and steel rate reductions in order to compete with the deregulated trucking industry. The discounts apply to shipments exclusively on Conrail lines.

At yearend, mine operators and manufacturers were concerned by Conrail's planned abandonment of 22.5 miles of track in the Wilkes-Barre area. This abandonment, together with others totaling 102 miles, may be purchased by Pocono Northeast Railway, Inc.

Water transportation remained important to mineral producers using inland waterways to move products. Many locks and dams along the Allegheny, Ohio, and Monongahela Rivers are in need of repairs. Operating funds for the U.S. Army Corps of Engineers, which maintains and operates the locks and dams, have been reduced. In late 1981, the Governors of Pennsylvania, Ohio, and West Virginia met to obtain support for a $300 million waterway modernization project. At yearend, some Federal finances were made available, and the Corps of Engineers began repairing those locks and dams most in need of repairs. To raise additional finances for the waterways, suggestions ranged from a river users tax to additional tax on fuel used by barge lines.

Pennsylvania's cement industry was marked by an increase in foreign-owned plants. At yearend, General Portland, Inc., which purchased the Whitehall Cement Manufacturing Co. earlier in the year, was acquired by Canada Cement Lafarge Ltd. The acquisition makes Canada Cement Lafarge the largest cement producer in North America. Other foreign-owned companies include Hercules Cement Co. (IFI International of Italy), Coplay Cement Manufacturing Co. (Société des Ciments Français of France), and the Lehigh Portland Cement Co. (Heidelberger Zement AG of the Federal Republic of Germany).

In 1981, Pennsylvania was second to Kentucky in use of explosives. Of the 432 million pounds used, approximately 15% was for quarrying and nonmetal mining operations, 3% for construction activities and other purposes, and the remainder for coal operations. Types of explosives used in Pennsylvania were mainly unprocessed ammonium nitrate and ammonium nitrate fuel-mixed agents. Other types, in descending order by weight, were water gels and slurries, other high explosives, and permissible explosives.

Legislation and Government Programs.—During 1981, Pennsylvania surface coal mining regulations were revised to meet minimum standards required by the U.S. Office of Surface Mining Reclamation and Enforcement (OSM). If the revisions are approved by OSM, Pennsylvania will have responsibility to regulate and enforce surface coal mining activities within the State. Noncoal mining revisions were 25 Pa. Code, chapters 77.82, 97.31-97.35, and 97.72. These changes pertained to interim noncoal sur-

face regulations, river dredging, hazardous waste disposal, and underground waste disposal.

In late 1981, the Pennsylvania Department of Revenue adopted amendments to 61 Pa. Code, chapter 32, concerning exemptions to taxes on foundations used to support equipment, machinery, and parts used directly in mining. Another amendment involved exemption from the sales and use tax of the costs associated with backfilling and reclaiming mining facilities when required by law.

The Pennsylvania Bureau of Topographic and Geologic Survey conducted a number of mineral-related projects, including the revision of a report on characteristics of the State's rock formations for the new State geologic map published during the year. Also published were geologic maps for the Reading and Williamsport areas, with those for the Altoona, Lewisburg, and Hazleton areas near completion. County maps for Columbia and Schuylkill Counties were released during 1981. Currently, 26 county maps are available, with 10 others underway. Topics for mineral resource studies included Devonian sedimentary uranium occurrences, the Reading-Prong crystalline uranium occurrence, and whiting resources of southwestern Pennsylvania. Environmental publications included a geologic handbook for the Appalachian Trail within the State and a report on landslide hazard sites near Williamsport. Ground water resource studies were completed for Erie and Greene Counties; other studies pertained to the Susquehanna River Basin, Southern Anthracite Field, and Pike County. The water well data bank was updated, with approximately 16,000 new records added each year.

The U.S. National Oceanic and Atmospheric Administration approved Pennsylvania's Federal Coastal Zone Management Program. The program, designed to protect coastal areas of the State, will also influence mining of minerals, mainly sand and gravel.

In fiscal year 1981, the Federal Government returned $874,000 to the State for its share of funds generated by activities on the 510,000-acre Allegheny National Forest, in northwestern Pennsylvania. Fees were collected mainly for timbering and mineral leasing.

Also during fiscal year 1981, the U.S. Bureau of Mines had 152 active contracts valued at more than $15 million with Pennsylvania researchers. Much of the research was environment-related, such as a mine pollution project at Thorn Run Mine, Westmoreland County; a subsidence study at Scranton, Lackawanna County; and a mine refuse demonstration project at Allport, Clearfield County. Other projects pertained to improved mine health and safety.

Pennsylvania State University is one of 27 educational institutes throughout the Nation designated as a Mineral Institute Research Center by OSM. One project funded by OSM was the preparation of a "Handbook for State and Local Taxation of Minerals"; other project titles included "Processing of Dolomites for Refractory Applications" and "Cobalt Behavior in Ammonia Leaching Systems."

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Cement.—Despite decreased demand for cement in 1981, Pennsylvania ranked third nationally, behind Texas and California, in portland cement shipments and first in masonry cement shipments. Shipments of portland cement decreased nearly 8% in quantity and more than 9% in value, compared with 1980 levels. Portland cement was shipped from 16 plants in 7 counties; counties leading in tonnage shipped were Northampton and Lawrence. Principal producers were Société des Ciments Français (which owns the Coplay and Nazareth No. 1 and No. 2 plants) and Crane Co. (which owns the Wampum, White, and Gray plants).

Masonry cement shipments decreased nearly 10% in quantity and 27% in value, compared with 1980 levels. Shipments originated from 14 plants in 7 counties; counties leading in quantity shipped were Northampton, Lawrence, and Lehigh. Principal producers were Société des Ciments Français and Crane.

The drop in shipments of both portland and masonry cement was due mainly to curtailed residential, industrial, and commercial construction during the year. This, in turn, was attributed to high interest rates and continuing inflation.

Raw materials used in cement manufacture were cement rock, limestone, and shale, with lesser amounts of clay, sand, iron ore, and gypsum.

Penn-Dixie Industries, Inc., sold its cement plant in West Winfield, Butler County, in early May to Penn-West Cement Co., Inc., owned by a group of investors comprised mainly of former company executives. Penn-Dixie was in the process of selling certain assets in accordance with Federal bankruptcy requirements.

Lehigh Portland Cement, Allentown, Lehigh County, acquired the assets of Universal Atlas Cement, a division of United States Steel. The newly operating company is a unit of Heidelberger Zement of the Federal Republic of Germany. In another action, General Portland acquired Whitehall Cement Manufacturing in Lehigh County during midyear. Later, Canada Cement Lafarge acquired General Portland, making it the largest cement producer in North America. Other cement plants in eastern Pennsylvania with foreign ownership included Hercules Cement, owned by the American subsidiary of IFI International of Italy, and Coplay Cement Manufacturing, a subsidiary of Société des Ciments Français of France.

Fuller Co., Bethlehem, Northampton County, received a contract from Louisville Cement Co. for modernization of the Bessemer Cement Co. plant in Lawrence County. Improvements were to be made mainly to the No. 4 and No. 5 kiln systems. Fuller also received an $8 million contract from Saurashtra Cement & Chemical Industries Ltd. for modernization of kilns in India. In another action, the company hosted a four-member cement research team from China under a United Nations fellowship grant. Visits were made to various cement plants in the area.

A new cement distribution terminal was located at Tarentum, Allegheny County, along the Allegheny River northeast of Pittsburgh. The owner, Independent Cement Corp., Albany, N.Y., is a subsidiary of St. Lawrence Cement, Inc., a Holderbank Group company in Switzerland.

Four vibrating pile dischargers were installed by Vibranetics, Inc., at the Coplay Cement Manufacturing plant in Nazareth, Northampton County, to solve freezing material problems.

Mitchell Industries, Inc., Evans City, Butler County, formed a new subsidiary, Mitchell Fibercon, Inc., to produce Fibercon steel reinforcement fibers patented by United States Steel. The new fibers can be added to concrete mixes for increased resistance to severe temperature changes, eliminating the need for wire mesh. Annual production of the Fibercon steel was expected to be 7,000 tons annually.

In midyear, employees at Gulf + Western Industries, Inc.'s, Marquette Cement Co., Pittsburgh, signed a 34-month wage agreement with management providing annual wage increases, including productivity incentives, thought to be the first of its kind in the cement industry.

Crane's Medusa Corp. and the Pennsylvania Department of Environmental Resources signed a consent agreement requiring the company to improve various air pollution systems at its cement plant in West Manchester Township, York County.

Clays.—Production of clay and shale, excluding kaolin, totaled 1.2 million tons valued at nearly $7.5 million in 1981. This reflected a decrease in output and value of 24% and 38%, respectively, compared with those of 1980.

In 1981, 28 companies operated 63 clay and shale mines (3 fewer than in 1980) in 22 counties. Leading producing counties, in descending order of output, were Berks, Jefferson, and York.

The average unit value of clay and shale decreased by $1.33 to $6.01 per ton from 1980 to 1981. Clay and shale were used mainly in the manufacture of face brick, firebrick, and common brick.

Glen-Gery Corp., the leading clay and shale producer in the State, reopened six of its brick plants located in Clearfield, New Oxford, Shoemakersville, York, Reading, and Watsontown. Also during the year, a civil antitrust suit against Glen-Gery was dismissed when the U.S. Department of Justice ruled that the company's acquisition of Marion Brick Corp., Marion, Ohio, would not lessen competition. Glen-Gery is owned by Ibstock Johnson Ltd. of the United Kingdom.

Narvon Products, Inc., with one mine in Lancaster County, was the State's only kaolin producer. Kaolin was used mainly in the manufacture of fertilizers and paint products.

A new research center for the refractory industry was being constructed at State College, Centre County, near Pennsylvania State University.

Table 4.—Pennsylvania: Clays sold or used by producers, by use[1]

(Short tons)

Use	1980	1981
Common brick	128,081	29,617
Face brick	981,786	809,250
Firebrick, block and shapes	272,500	161,303
Flue linings	34,735	40,790
Mortar and cement, refractory	17,157	31,746
Portland and other cements	153,105	123,626
Tile: Drain, quarry, and structural	47,904	34,409
Other[2]	14,037	15,310
Exports: Mortar, cement, other refractories	286	333
Total	1,649,591	1,246,384

[1]Excludes kaolin.
[2]Includes fertilizers (1980), lightweight aggregates, paint, pottery (1980), roofing granules (1980), sewer pipe, and terra cotta (1980).

Coke.—Keystone Coke Co., a subsidiary of Alabama By-Products Corp., closed its 110-coke-oven battery at Conshohocken, near Philadelphia, in midyear. In the western part of the State, United States Steel closed 2 of the 11 coke ovens at its Clairton operations near Pittsburgh but continued construction on new ovens set for completion in mid-1982. Dravo Corp. received a contract for the design and construction of a cokeside emission control system for five coke oven batteries at the Pittsburgh Works of Jones & Laughlin Steel Corp. (J&L), a subsidiary of LTV Corp.

Gem Stones.—Gem stones and mineral specimens were collected mainly by amateur collectors and mineral dealers. Value of gem stones collected in 1981 was estimated at $5,000. During the year, three new Pennsylvania minerals were recognized and verified by the Commission of New Minerals and Mineral Names of the International Mineralogical Association. They are known as desautelsite, downeyite, and matulaite. Desautelsite was first collected at the Cedar Hill quarry, Lancaster County; downeyite, near a burning culm bank near Glen Lyon, Luzerne County; and matulaite, from the Bachman iron mine near Hellertown, Northampton County.

Graphite.—Synthetic graphite production in Pennsylvania increased significantly both in quantity and in value from 1980 to 1981. Synthetic graphite is made from petroleum coke, lampblack, carbon blacks, and various amounts of natural graphite, mixed with carbonaceous binders and heated to high temperatures. Of the 17 producers of carbon and graphite products in the State, the 3 largest employers were Airco Speer Carbon Co., Keystone Carbon Co., and The Stackpole Carbon Corp., all in St. Marys, Elk County.

Airco Speer Carbon Co. announced a $23 million modernization program, expected to increase electrode production by 20% when completed in mid-1982. Electrodes are used primarily in electric steelmaking furnaces.

Stackpole was the leading supplier of motor brushes to the U.S. automotive industry. In addition, the firm manufactured carbon-related products for the transportation, aerospace, chemical, utility, metals, communications, electronic, and appliance industries. Stackpole operations are also located in other States, Canada, and Taiwan.

Gypsum.—Raw gypsum mined by United States Gypsum Co. in Michigan and Nova Scotia was calcined at its Philadelphia facility; the operation employs about 150 workers. Production of calcined gypsum decreased in quantity and value from 1980 to 1981. Calcined gypsum was used mainly in the manufacture of prefabricated products, such as regular wallboard, type-X wallboard, and lath. These products were used extensively in home and commercial construction.

Iodine.—Whitmoyer Laboratories, Inc., in Lebanon County, and West Agro-Chemical, Inc., in Washington County, imported crude iodine for use in the manufacture of pharmaceuticals, catalysts, and sanitation products. Approximately 42% less iodine was consumed in Pennsylvania in 1981, compared with 1980 levels.

Iron and Steel Slag.—Pennsylvania ranked first nationally in 1981 in sales of iron and steel slag. Total slag processed amounted to 4.7 million tons valued at $21.4 million, a decrease of 17% in output and

10% in value, compared with those of 1980. The decline in slag output reflected a drop in the State's pig iron production. Of the total slag produced, 87% was iron slag, and 13%, steel slag.

Types of iron slag sold included air-cooled, expanded, and granulated. Major uses of air-cooled slag were for asphalt and concrete aggregate and as a road base material and fill; expanded slag was used as lightweight aggregate; and granulated slag was used for road base material and fill. Steel slag was used mainly for road base material. Principal slag processors included Duquesne Slag Co., Inc., Dunbar Slag Co., Inc., and Standard Slag Co.

Lime.—In 1981, Pennsylvania ranked third nationally behind Ohio and Missouri in lime production. State output totaled nearly 1.7 million tons, or slightly less than 9% of the national total. The average unit value of lime was $50.55 per ton, an increase of $2.89 over that of 1980.

Lime was produced at 10 plants in 8 counties. Centre, with three plants, was the leading lime-producing county in the State, accounting for nearly 34% of the State's output. Other counties, in descending order of output, were Lebanon, Butler, Adams, Chester, York, Montgomery, and Mifflin, each with one plant. Principal producers of lime were Bethlehem Steel Corp. (Annville plant, Lebanon County), Marblehead Lime Co. (Pleasant Gap plant, Centre County), Mercer Lime & Stone Co. (Branchton plant, Butler County), and Warner Co. (Bellefonte plant, Centre County).

Although consumption of lime by the steel industry continued to decline, the demand for water treatment purposes increased slightly.

Table 5.—Pennsylvania: Lime sold or used by producers, by use

Use	1980		1981	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Steel, basic oxygen furnace	698,721	$32,060	620,542	$30,890
Steel, electric	237,732	11,348	278,032	13,674
Sewage treatment	181,721	8,950	197,815	10,065
Water purification	140,805	6,979	110,531	5,930
Steel, open-hearth	124,761	6,297	81,585	3,333
Acid mine water	57,782	2,853	67,916	3,613
Mason's lime	74,896	3,773	49,433	2,261
Agriculture	34,007	1,386	29,456	1,562
Paper and pulp	15,607	753	20,657	991
Tanning	14,238	714	W	W
Brick, sand-lime	W	W	3,991	234
Metallurgy, other	W	W	3,934	176
Petroleum refining	W	W	3,408	187
Other[1]	188,130	9,178	222,427	12,502
Total	1,768,400	84,291	1,689,727	85,418

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes alkalies, explosives, glass, oil well drilling, ore concentration, other chemical and industrial uses, other construction uses, (1980); paint, petrochemicals, precipitated calcium carbonate, (1981); refractory dead-burned dolomite, silica brick, soil stabilization, sugar refining, (1980); sulfur removal from stack gases, and wire drawing.

Mica.—Only one company in the State produced crude mica in 1981. Gross Minerals Corp. near Aspers, Adams County, produced scrap and flake mica from an underground mining operation. Output and value both increased more than 11% from 1980 to 1981. The product was used in mica paper and other electrical insulating materials.

Mullite.—Production of synthetic mullite in 1981 increased slightly, but value decreased, compared with 1980 levels. A. P. Green Refractories, Philadelphia County, produced synthetic mullite by heating aluminum-silicate materials to high temperatures. Mullite, in general, is a heat-resistant material used in furnace linings, refractories, and glass products.

Peat.—In 1981, Pennsylvania ranked eighth nationally in peat sales. Sales decreased approximately 3% in quantity, but increased 17% in value, compared with 1980 figures. Four peat operations were in Luzerne County, two in Lackawanna County, and one each in Monroe, Erie, and Lawrence Counties. The largest producer in eastern Pennsylvania was Gouldsboro Wayne Peat Co., Lackawanna County; in western Pennsylvania, Corry Peat Products Co., Erie County. Processed humus and reed sedge peat sold for approximately $26.00 per ton, an increase of almost $5.00 above 1980 levels. Uses were for agricultural and horticultural purposes.

Perlite.—Crude perlite mined out of State

was shipped into Pennsylvania and expanded at six plants by five companies. The total amount of expanded perlite sold and used in 1981 was 36,300 tons valued at $4.8 million, reflecting a decrease of 6.7% in production and 7.3% in value, compared with those of 1980. Plants in western Pennsylvania were the Therm-O-Rock Div. of Allied Chemical Co. in New Eagle, Washington County, and Perlite Manufacturing Co. of Pittsburgh, Inc., in Carnegie, Allegheny County. Producers in eastern Pennsylvania were World Industries, Inc. (formerly Armstrong Cork Co.), Pennsylvania Perlite Corp., and United States Gypsum. Most of the perlite plants were relatively small, employing from 12 to 21 persons. Perlite was used mainly in plaster and cement aggregates and for horticultural purposes.

Pyrophyllite.—American Olean Tile Co. near Lansdale, Montgomery County, purchased raw pyrophyllite produced in other States. Purchase of raw ore increased more than 64% in quantity and value from 1980 to 1981. The ground product was used mainly in the manufacture of ceramic products.

Quartz Crystal.—Bliley Electric Co., at Erie, and P. R. Hoffman Co., a division of Norlin Corp., at Carlisle, imported lasca, a nonelectronic-grade quartz material used as feedstock for growing cultured quartz crystal. All cultured quartz crystal produced was used internally by both companies. Other consumers of cultured crystal in Pennsylvania were Anderson Electronics, Inc., Blair County; Dynamics Corp. of America, Cumberland County; Erie Frequency Div., Erie County; McCoy Electronics Co., Cumberland County; J. K. Miller, Allegheny County; and Piezo Crystal Co., Inc., Cumberland County. Major use of cultured quartz was for oscillators used in the manufacture of timepieces, televisions, and citizens band radios.

Sand and Gravel.—In late 1980, the U.S. Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but complete data on industrial sand and gravel. Estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Production of construction sand and gravel in Pennsylvania during 1981 totaled an estimated 14.3 million tons valued at $55.4 million, reflecting slight decreases in quantity and value compared with those of 1980. These declines were attributed to a downturn in housing starts and road and commercial construction. Based on 1980 data, approximately 114 companies produced sand and gravel from an estimated 130 pits in 41 of the State's 67 counties. Most of the operations were relatively small, producing less than 200,000 tons each and supplying local construction needs. Construction sand and gravel was used mainly for concrete aggregate, asphaltic concrete, and road base.

Pennsylvania ranked 12th of 38 States that produced industrial sand in 1981. Industrial sand was produced only in Allegheny and Huntingdon Counties, averaging $13.18 per ton, an increase of $1.39 over 1980 levels. Major uses were in glass manufacture, ferrous foundry operations, and chemical and metallurgical processes.

Several developments affected Pennsylvania's glass industry, a leading consumer of industrial sand. PPG Industries, Inc., announced it will build a fabrication unit in mid-1982, increasing capacity for architectural glass products, at its plant in Ford City, Armstrong County. Pennsylvania Float Glass planned to reopen a vacant glass plant in Jefferson Borough, south of Pittsburgh, in mid-1982. Products will be for the automotive, home, and construction industries. The Coca-Cola Bottling Co. of New York announced sale of its facility in Jeannette, Westmoreland County, which produced glass ceramic tableware.

Table 6.—Pennsylvania: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	8,293	$31,559	$3.81	NA	NA	NA
Gravel	6,261	24,324	3.88	NA	NA	NA
Total or average	14,554	55,883	3.84	[p]14,300	[p]$55,400	[p]$3.87
Industrial sand	1,049	12,374	11.79	W	W	13.18
Grand total or average	15,603	68,257	4.37	W	W	[p]4.46

[p]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.

Stone.—In 1981, Pennsylvania ranked third nationally, behind Texas and Florida, in total stone production, with output amounting to 53.3 million tons valued at $215 million. This represents a decrease of 13% in quantity and 4% in value, compared with those of 1980. Of the State's 212 quarries, 191 produced crushed stone, and the remainder, dimension stone. A total of 9 quarries produced more than 1 million tons each, 13 quarries produced between 500,000 and 1 million tons, 107 quarries produced between 100,000 and 500,000 tons, and 83 quarries produced less than 100,000 tons. Limestone accounted for almost 80% of total stone output. Other rock types quarried were granite, sandstone, and traprock.

Crushed stone was produced in 50 of the State's 67 counties. Leading producing counties were Northampton and Montgomery, each producing more than 4 million tons. Nearly 88% of the crushed stone was trucked to market; other means of transportation included railroad and waterway.

Dimension stone was quarried at 21 operations in 11 counties. Five quarries were located in Northampton County, four in Chester County, three in Montgomery County, two in Susquehanna County, and one each in Bucks, Butler, Delaware, Franklin, Lehigh, Potter, and Wayne Counties. Sandstone was the principal type of dimension stone produced; other types were granite and slate.

General Crushed Stone Co., a subsidiary of Koppers Co., Inc., cooperated with Trout Unlimited in maintaining optimum trout-hatching conditions in a stream near the company's Downingtown quarry in Chester County. Water used in quarry operations was returned to the creek silt-free and well oxygenated, which is beneficial for trout hatching.

In eastern Pennsylvania, the Jackson Township Concerned Taxpayers Group questioned endeavors by township officials to restrict quarrying by American Asphalt on property obtained prior to a township ordinance that zoned the land as agricultural. The group requested resolution of the problem to conserve township funds.

Table 7.—Pennsylvania: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	1,992	12,712	1,687	13,012
Poultry grit and mineral food	66	654	W	W
Concrete aggregate	4,916	18,002	3,869	15,267
Bituminous aggregate	5,588	20,334	4,796	18,746
Macadam aggregate	1,354	4,434	984	3,775
Dense-graded road base stone	11,899	39,802	9,889	35,916
Surface treatment aggregate	2,144	7,787	1,873	7,687
Other construction aggregate and road stone	14,659	46,025	13,047	45,784
Riprap and jetty stone	667	2,667	558	2,140
Railroad ballast	1,532	5,614	1,187	4,347
Filter stone	488	2,059	412	1,798
Manufactured fine aggregate (stone sand)	1,533	6,620	1,424	5,863
Terrazzo and exposed aggregate	263	1,230	W	W
Cement manufacture	7,378	17,250	6,815	17,466

See footnotes at end of table.

Table 7.—Pennsylvania: Crushed stone[1] sold or used by producers, by use —Continued

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Lime manufacture	2,768	10,470	2,886	12,127
Flux stone	2,307	10,846	2,157	11,615
Refractory stone	82	1,644	W	W
Mine dusting	154	2,030	97	1,322
Asphalt filler	101	759	112	1,302
Other fillers or extenders	107	1,969	127	2,253
Building products	90	262	64	218
Fill	2	6	3	8
Glass manufacture	W	681	W	W
Roofing granules	191	310	W	W
Other[2]	862	4,066	1,274	7,174
Total[3]	61,143	218,231	53,258	207,821

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, granite, sandstone, traprock, and other stone.
[2]Includes dead-burned dolomite, chemical stone for alkali works, abrasives (1981), whiting or whiting subtitute, paper manufacture (1981), and other uses not specified.
[3]Data may not add to totals shown because of independent rounding.

Table 8.—Pennsylvania: Dimension stone[1] sold or used by producers, by use

Use	1980			1981		
	Short tons	Cubic feet (thousands)	Value (thousands)	Short tons	Cubic feet (thousands)	Value (thousands)
Rough stone:						
Rough blocks	113	1	$16	45	(2)	$7
Irregular-shaped stone	5,805	74	179	17,855	229	715
Rubble	10,726	137	122	1,998	25	42
Monumental	4,007	40	581	4,682	47	734
Flagging	1,478	19	55	840	11	41
Dressed stone:						
Cut	17,815	228	793	W	W	W
Sawed	W	W	10	--	--	--
House stone veneer	W	W	1	--	--	--
Flagging	5,722	63	506	6,345	70	585
Roofing slate (standard)	2,761	30	1,267	2,803	31	1,355
Structural and sanitary	4,286	47	1,904	2,449	27	2,342
Flooring slate	W	W	W	523	6	134
Other[3]	12,686	140	963	13,290	161	1,237
Total[4]	65,399	780	6,397	50,830	607	7,193

W Withheld to avoid disclosing company proprietary data: included with "Other."
[1]Includes granite, sandstone, slate, and other stone.
[2]Less than 1/2 unit; included with "Other."
[3]Includes stone used in dressed construction, blackboards, bulletin boards and school slates, billiard table tops, and other uses not specified.
[4]Data may not add to totals shown because of independent rounding.

Sulfur.—Elemental sulfur was recovered at three petroleum refineries in Philadelphia and Delaware Counties, with lesser amounts from natural gas treatment by a steel company in Allegheny County. Shipments of recovered sulfur in Pennsylvania during 1981 amounted to 56,000 metric tons valued at $4.7 million, a slight decrease in quantity but a 36.8% increase in value compared with those of 1980. Principal uses were in the manufacture of sulfuric acid, for leaching of ores, and in chemicals, fibers, paints, and explosives.

Tripoli.—Keystone Filler & Manufacturing Co.'s Sheddy Mine in Northumberland County produced tripoli, which was used as an abrasive and filler.

Vermiculite.—Beneficiated vermiculite mined in other States was shipped into Pennsylvania and exfoliated by A-Tops Corp. (formerly J. P. Austin, Inc.) in Allegheny County and W. R. Grace & Co. in Lawrence County. Sales of vermiculite dropped more than 10% in quantity and 7%

in value from 1980 to 1981. Unit value of exfoliated vermiculite was nearly $255 per ton, an increase of $8.61 over that of 1980. Major uses were for lightweight concrete aggregate, loose fill insulation, horticultural purposes, and soil conditioning.

METALS

Abrasives, Manufactured.—Manufactured abrasives, consisting of steel shot and grit, were produced by Ervin Industries, Inc., and Pangborn, both in Butler, Butler County, and Durasteel Abrasives Co. in Mount Pleasant, Westmoreland County. Shipments increased more than 6% in quantity and 13% in value compared with 1980 levels. Finished products were used as abrasives. Silicon carbide, another manufactured product, was produced by Satellite Alloy Corp. in Springdale, Allegheny County, for nonabrasive applications.

Aluminum.—Aluminum Co. of America planned a demonstration aluminum continuous strip caster at its technical center near New Kensington, northeast of Pittsburgh. The research and development purposes of the project were to improve productivity of operating units.

NRD Mining Ltd., Vancouver, British Columbia, Canada, acquired Keystone Resources, a secondary aluminum producer with a plant at Mars, near Pittsburgh. Keystone recently completed a second reverberatory furnace that doubled capacity to 60 million pounds per year.

Beryllium.—Cabot Corp. changed the name of its former division, Kawecki Berylco Industries, to Cabot Berylco, Inc. (CBI). Within Cabot it is the Cabot Berylco Div., producing beryllium alloys at Reading, Berks County. Research and development facilities are also located in Boyertown and Reading.

Cadmium.—The primary producer of cadmium in 1981 was New Jersey Zinc Co. in Lehigh County. Cadmium, a byproduct of zinc smelting, was used for electroplating, plastic stabilizers, and pigments.

Ferroalloys.—In 1981, ferroalloys shipments in Pennsylvania totaled 6,251 tons valued at $68.6 million, reflecting decreases of 8% in quantity and 26% in value, compared with 1980 figures. Six ferroalloy plants were located in the State—two in Lawrence County, two in Washington County, and one each in Berks and Bucks Counties.

Reactive Metals & Alloys Corp. in West Pittsburg, Lawrence County, completed installation of a submerged-arc furnace for production of ferrozirconium silicide, ferroboron, and calcium silicide. All products are used in the manufacture of high-strength, low-alloy steels.

A unit of Union Oil Co. of California processed samarium concentrates, with the oxide shipped to the Molycorp, Inc., plant in Washington, Washington County. The 40-ton-per-year plant converted the oxide to samarium cobalt metals and alloys for use in production of audio equipment.

At yearend, the KBI Div. of Cabot in Revere, Bucks County, and Shieldalloy Corp. in Newfield, N.J., lowered their price for vacuum-grade ferrocolumbium. Reading Alloys, Inc., Robesonia, Berks County, also sold ferrocolumbium at the reduced rate.

Iron Oxide Pigments.—Pennsylvania led the Nation in value of finished iron oxide pigments in 1981 and ranked second in total shipments. Excluding regenerator oxides, shipments totaled 31,505 tons valued at more than $27 million. Finished iron oxide pigments were produced in Carbon, Chester, Montgomery, and Northampton Counties, all in the eastern part of the State. Regenerator oxides, including steel plant dust, were produced in Allegheny County. Iron oxide pigments were used mainly in paints and coatings, construction materials, and ferrites and other magnetic and electronic applications.

In 1981, Pfizer, Inc., announced a $50 million expansion program to increase production capacity for synthetic iron oxides. The company also planned a $1 million expansion of the research facilities at its plant in Easton, Northampton County, for magnetic particle research and development.

Iron and Steel.—In 1981, Pennsylvania ranked second of 14 States in pig iron shipments and value. Shipments amounted to almost 15 million tons valued at more than $3 billion, representing a decrease of 3% in quantity but a slight increase in value, compared with 1980 figures. Basic pig iron accounted for nearly 93% of total production. Other types of pig iron produced were bessemer, malleable, and direct castings.

All steel companies in Pennsylvania were affected by the sagging economy during 1981. Employment declined and plants temporarily closed. United States Steel announced at yearend temporary closure of its massive Edgar Thomson Works near Pittsburgh and suspension of hot strip mill operations at its Irvin Works. Colt Indus-

tries, Inc., Crucible Stainless & Alloy Div. at Midland, Beaver County, proposed layoffs of 2,000 of its 5,000 employees. Mesta Machine Co., West Homestead, one of the Nation's largest manufacturers of rolling mills and other steelmaking equipment, terminated several operations. J&L's Hazelwood Works in Pittsburgh closed its ingot mold foundry, and Bucyrus-Erie Co., its 80-year-old foundry in Glassport, Allegheny County. Bethlehem Steel's Johnstown plant reduced open hearth operations. Spang Industries, Inc., announced closure of its Fort Pitt Bridge and Electric Weld steel-fabricating operations at Canonsburg, Washington County.

To become more competitive, steel companies reorganized and modernized operations. A reorganization within United States Steel, the Nation's largest steel producer, established a fabricating and engineering unit and restructured the manufacturing and associated subsidiaries. State projects within the former unit included erection of a 42-story building in Pittsburgh, modernization of a coal-unloading and handling system in Philadelphia, and increased sucker rod production at a new facility in Oil City. United States Steel's modernization program at the national plant in McKeesport included two new quench and temper facilities to meet the increasing demand for oil country tubular products. The company's Fairless Hills plant in eastern Pennsylvania began a 5-year program to improve air pollution controls, with similar abatement programs planned for Pittsburgh area facilities.

Bethlehem Steel, the Nation's second largest steelmaker, improved structural mills at its plant in Bethlehem; installed a continuous bloom caster at its Steelton plant; upgraded the pickling and rinse line and the hot-dip galvanizing facilities, including a new fastener division at the Lebanon plant; commenced operation of electric furnaces at the Johnstown plant; and established a wire rope division at Williamsport.

J&L, a subsidiary of LTV and the third largest steel producer in the Nation, continued operations in the Pittsburgh area, but on a reduced basis. Out-of-State ventures included the purchase of McLouth Steel Corp.'s stainless steel division; a merger with Ohio-based Youngstown Sheet & Tube Co., another LTV unit; and purchase of four cold-finished bar mills and one grinding bar mill from Predco, Inc.

Modernizations by Sharon Steel Corp., a subsidiary of NVF Co., included repowering of electric furnaces, addition of six new soaking pits, and completion of a second basic oxygen upright steelmaking furnace. These improvements eliminated the need to purchase slabs from other steel companies. The Victor Posner Works in Farrell, Mercer County, represents the company's largest operation, with capacity in excess of 110,000 tons of steel per month.[3]

General Steel Industries, Inc., Avonmore, Westmoreland County, was installing a vertical centrifugal casting system scheduled for completion in mid-1982. The Avonmore plant manufactured cast iron and steel rolls for the steel industry.

J. Ray McDermott & Co. announced a modernization project for its Babcock & Wilcox Tubular Products Div. at Beaver Falls, northwest of Pittsburgh. Included is an electric furnace, vacuum-arc ladle refiner, and a four-strand continuous caster. A quench and temper heat-treat furnace was anticipated for the nearby Koppel facility.

Washington Steel Corp., south of Pittsburgh, doubled capacity of its hot strip mill to 140,000 tons of stainless steel per year. Contributing to the increase was a new continuous slab caster that became operational in December 1980 at the company's facility in Houston, Washington County.

Lukens Steel Co., Coatesville, Chester County, the largest independent plate producer in the Nation, restructured operations to offset increases in cost of gas and electricity, which has risen more than 60% in the last 2 years. Plant efficiency has reduced the company's energy costs per shipped ton of product by 28%, compared with figures of a similar period 8 years ago.

Davy Corp. Ltd., London, United Kingdom, purchased the Swindell Furnace Group, a subsidiary of Wheelabrator-Frye, Inc. Swindell Furnace designs heat-treating furnaces for both the steel and aluminum industries. The new company, based in Pittsburgh, will be known as Davy McKee Equipment Co.

The Universal Cyclops Specialty Steel Div. of Cyclops Corp., Bridgeville, Allegheny County, received an IR-100 award from Industrial Research and Development Magazine for development procedures used in the production of high-speed steel and superalloy parts from powders. These awards are presented annually to developers of outstanding new technical products.

Teledyne Vasco, Latrobe, Westmoreland County, marketed a maraging steel without cobalt and with less molybdenum, but with

titanium added for strength. Inco Research & Development Center, Inc., holds the patent for the new product.

Wheeling-Pittsburgh Steel Co. planned to install a continuous caster and expand its seamless tube mills at operations south of Pittsburgh. Recently, a modern rail mill was completed, producing 78-foot, high-speed rail sections.

After its first 12 months as a private company, Allegheny Ludlum Steel Corp., which was purchased from a company now known as Allegheny International, Inc., planned modernization projects to take place over the next 5 years. Included are improvements to the hot strip plant at Brackenridge, Allegheny County, increasing speciality sheet and strip capacity and improving cold roll finishing equipment.

Armco, Inc., made plans to increase output of tubular products at its facility in Ambridge, Beaver County. At Armco's Butler Works, north of Pittsburgh, a second continuous slab caster was expected to be operational by early 1982.

Carpenter Technology Corp., Reading, announced construction of a hot rolling mill, a rotary forge, and additional melting equipment for production of specialty steel products, increasing production capacity by 50%. Completion of the $165 million project was anticipated by 1984.

Latrobe Steel Co. planned to install an electroslag furnace, an argon oxygen refining vessel, and related facilities at its plant in Latrobe, Westmoreland County.

Nickel.—International Metals Reclamation Co., Inc., planned to complete construction of a $2 million nickel recovery plant by early 1982 at its Pittsburgh Pacific Processing Co. Div. on Neville Island, near Pittsburgh. The plant will be capable of processing about 25 million pounds per year of spent nickel catalysts, an industrial waste product.

Mallinckrodt, Inc., anticipated construction of a nickel recovery plant at its Erie facility. Spent catalyst from vegetable oil manufacturers is to be processed for nickel recovery. Completion date was set for early 1983.

Zinc.—Pennsylvania ranked fifth of 16 States that produced zinc in 1981. Compared with 1980 levels, zinc output increased almost 10% and value more than 30%, mainly owing to a higher unit price. Lehigh County, in eastern Pennsylvania, was the only county in which zinc was produced.

St. Joe Minerals Corp.'s smelter in Monaca, Beaver County, reopened after a 1-year closure owing to depressed zinc prices. Reopening corresponded to discovery of a large, high-grade zinc deposit near the company's zinc-producing Balmat and Edwards Mines in St. Lawrence County, N.Y. St. Joe also reactivated its zinc dust production facilities at the Monaca smelter.

[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]Liaison program assistant, Bureau of Mines, Pittsburgh, Pa.
[3]Sharon Steel Corp. 1981 Annual Report.

Table 9.–Principal producers

Commodity and company	Address	Type of activity	County
Abrasives:			
Durasteel Abrasives Co	Bridgeport Rd. Mount Pleasant, PA 15666	Plant	Westmoreland.
Ervin Industries, Inc	East Butler Rd. Butler, PA 16001	do	Butler.
Satellite Alloy Corp	Satellite Industrial Park Box 171 Springdale, PA 15144	do	Allegheny.
Cement:			
Crane Co	300 Park Ave. New York, NY 10022	do	Lawrence and York.
Louisville Cement Co	501 South 2d St. Louisville, KY 40202	do	Lawrence.
Penn-West Cement Co., Inc	R.D. 2 Cabot, PA 16023	do	Butler.
Société des Ciments Français	Tour Général, Quartier Villon Cédex 22 192088 Paris, La Défense France	do	Lehigh and Northampton.

See footnotes at end of table.

Table 9.–Principal producers —Continued

Commodity and company	Address	Type of activity	County
Clays:			
Glen-Gery Corp	Box 1542 Reading, PA 19603	Pit	Adams, Berks, Northumberland, Union, York.
Hanley Co	Box 376 Bradford, PA 16701	Pit	Jefferson and McKean.
Harbison-Walker Refractories Co	2 Gateway Center Pittsburgh, PA 15222	Pit	Clearfield and Somerset.
Narvon Products, Inc	Narvon, PA 17555	Pit	Lancaster.
Graphite, synthetic:			
Airco Speer Carbon Co	800 Theresia St. St. Marys, PA 15857	Plant	Elk.
Keystone Carbon Co	1935 State St. St. Marys, PA 15857	do	Elk.
The Stackpole Carbon Corp	St. Marys, PA 15857	do	Elk.
Gypsum, calcined:			
United States Gypsum Co.[1]	101 South Wacker Dr. Chicago, IL 60606	do	Philadelphia.
Iron oxide pigments:			
Pfizer Inc., Minerals, Pigments, & Metals Div	640 North 13th St. Box 548 Easton, PA 18042	do	Northampton.
Prince Manufacturing Co	700 Lehigh St. Bowmanstown, PA 18030	do	Carbon.
Reichard-Coulston, Inc	15 East 26th St. New York, NY 10010	do	Northampton.
Lime:			
Bethlehem Steel Corp	Martin Tower Bethlehem, PA 18016	do	Lebanon and Adams.
Marblehead Lime Co	300 West Washington St. Chicago, IL 60606	do	Centre.
Mercer Lime & Stone Co	1120 Porter Bldg. Pittsburgh, PA 15219	do	Butler.
Warner Co	Yellow Springs Rd. Devault, PA 19432	do	Centre.
Peat:			
Corry Peat Products Co	515 Turnpike Rd. Corry, PA 16407	Bog	Erie.
Gouldsboro Wayne Peat Co	Box 68 Gouldsboro, PA 18424	Bog	Lackawanna.
Lake Benton Peat Moss	622 South Blakely St. Dunmore, PA 18512	Bog	Do.
Perlite, expanded:			
Pennsylvania Perlite Corp	Box 2002 Lehigh Valley, PA 18001	Plant	Lehigh and York.
Perlite Manufacturing Co	Box 478 Carnegie, PA 15106	do	Allegheny.
World Industries, Inc	Lancaster, PA 17603	do	Lancaster.
Sand and gravel:			
Davison Sand & Gravel Co	3d Ave. and 4th St. New Kensington, PA 15068	Dredge	Westmoreland.
Dravo Corp	1 Oliver Plaza Pittsburgh, PA 15222	do	Beaver.
Erie Sand Steamship Co	Box 153 Erie, PA 16512	do	Erie.
Shippingport Sand & Gravel Co	1200 Stambaugh Bldg. Youngstown, OH 44503	Pit	Armstrong.
Warner Co.[2 3 4]	1721 Arch St. Philadelphia, PA 19103	Pit	Bucks.
Slag:			
Bethlehem Mines Corp.[2 3]	701 East 3d St. Bethlehem, PA 18016	Plant	Cambria.
Dunbar Slag Co	Box 666 Sharon, PA 16146	do	Mercer.
Standard Slag Co	1200 Stambaugh Bldg. Youngstown, OH 44503	do	Cambria.
Stone:			
G. & W. H. Corson, Inc.[3]	Plymouth Meeting, PA 19462	Quarry	Montgomery.
General Crushed Stone Co	Box 231 Easton, PA 18042	do	Bucks, Chester, Delaware, Lancaster, Luzerne, Perry.
Glasgow Quarry, Inc	Box 248 Glenside, PA 19038	do	Montgomery.
Martin Marietta Corp	Box 30013 Raleigh, NC 27612	do	Centre, Chester, Fayette, Northampton.

See footnotes at end of table.

Table 9.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Stone —Continued			
New Enterprise Stone & Lime Co., Inc	New Enterprise, PA 16664	Quarry	Bedford, Blair, Cumberland, Franklin, Huntingdon, Somerset.
Sulfur:			
Atlantic Richfield Co	3144 Passyunk Ave. Philadelphia, PA 19145	Plant	Philadelphia.
British Petroleum Corp., Ltd	Box 428 Marcus Hook, PA 19061	do	Delaware.
Gulf Oil Corp	Box 7408 Philadelphia, PA 19101	do	Philadelphia.
Tripoli:			
Keystone Filler & Manufacturing Co	Muncy, PA 17756	Pit	Northumberland.
Vermiculite, exfoliated:			
W. R. Grace & Co	62 Whittemore Ave. Cambridge, MA 02140	Plant	Lawrence.

[1]Also expanded perlite.
[2]Also stone.
[3]Also lime.
[4]Also slag.

The Mineral Industry of Puerto Rico, the Virgin Islands, and Pacific Island Possessions

The Puerto Rico section of this chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Department of Natural Resources of the Commonwealth of Puerto Rico for collecting information on all nonfuel minerals.

By Doss H. White, Jr.,[1] and Robert J. Tuchman[2]

PUERTO RICO

Mineral production in Puerto Rico in 1981 was valued at $208 million, a $3.8 million decrease from that of 1980. The 2-year decline in mineral output reflects the dependence of the island's mineral industry on construction activity.

Table 1.—Nonfuel mineral production in Puerto Rico[1]

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Cement, portland	thousand short tons	1,482	$102,872	1,226	$105,420
Clays	do.	291	677	200	474
Lime	do.	27	4,131	34	3,884
Sand and gravel	do.	NA	NA	NA	NA
Stone:					
Crushed	do.	23,917	101,908	20,473	96,223
Dimension	do.	129	2,271	105	2,040
Total		XX	[2]211,859	XX	[2]208,041

NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Total does not include value of items not available.

Table 2.—Value of nonfuel mineral production in Puerto Rico, by district

(Thousands)

District	1979	1980	Minerals produced in 1980 in order of value
Aguadilla	W	$1,084	Stone.
Arecibo	W	4,692	Do.
Guayama	--	336	Do.
Humacao	W	1,099	Do.
Mayaguez	$4,180	3,141	Do.
Ponce	W	W	Cement, stone, lime, clays.
San Juan	W	W	Cement, stone, clays.
Undistributed[1]	130,178	201,508	
Total[2]	134,358	[3]211,859	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Includes some stone that cannot be assigned to specific districts and values indicated by symbol W.
[2]Incomplete total; excludes value of sand and gravel.
[3]Data do not add to total shown because of independent rounding.

Trends and Developments.—The year was a dismal period for much of the island's industry in general and the construction and mineral industries in particular. Continued inflation and increased costs of construction and labor, coupled with high interest rates, forced new construction to a virtual standstill. At yearend, new building starts were severely curtailed and unemployment hovered around 28%, counting "desalentados" who had given up looking for work in the depressed economy. The number of unemployed construction workers was 2,000 above that reported in the previous year.

Some areas of the island felt the effects of the recession more acutely than others. The economy of the Ponce area was so depressed that the Senate Labor Committee considered requesting that the area be placed in an "emergency" status. During the third quarter, the area lost almost 3,000 jobs. Among these were 450 at the Commonwealth Oil Refining Co. (Corco) in Penuelas and 300 at the neighboring Union Carbide Corp. polyethylene plant. Unemployment in some towns in the area approached 40%.

The state of Puerto Rico's economy was not the only problem facing the island's industry. Toxic waste disposal has emerged as a major concern for a number of industrial operations. Puerto Rico's industry produces more than 140 million gallons of liquid waste and an estimated 43,000 tons of solid waste each year. Currently, industrial wastes are shipped to New Jersey and Louisiana for disposal, a costly procedure that could become a serious impediment to attracting new industry.

To help alleviate off-island waste shipments, the U.S. Environmental Protection Agency (EPA) provided $50,000 to San Juan Cement Co., Inc., for a demonstration test burn of fuel and liquid waste in the company's cement kilns. Fiscal austerity modified both the scope and length of the project. Original plans for burning 160,000 gallons of waste in 12 weeks were revised to 90,000 gallons in a 9-week period. By mid-December, two test burns of approximately 24-hour duration had been completed.

Rivaling waste disposal as a major problem was the concern over high power costs. The Economic Development Administration (Fomento) predicted that high electricity costs could result in 20 companies closing in the next 2 years, adversely affecting 3,000 jobs. High energy costs also affected the competitive market for new industry on the island. In an attempt to cut costs, the Puerto Rico Power Authority (PREPA) announced plans for the construction of a new, coal-fired generating plant at Aguada. However, plans for the new plant faced strong opposition. Critics of the venture cited frequent power outages at PREPA's existing facility and argued that the company would not be able to maintain the more advanced generation and pollution control equipment scheduled for the facility. The Governor opposed the plant on the grounds that the existing facility should be converted to burn coal.

Puerto Rico's construction industry was among the most severely affected by economic conditions. In an attempt to help the near-paralyzed industry, the Associated General Contractors adopted a 15-resolution package at their annual meeting asking for Government incentives and funding for new projects. The construction industry is one of the major markets for the island's aggregate producers.

Much of the island's tax on gasoline is used in highway construction and maintenance, both requiring significant tonnages of aggregate. Further depressing potential aggregate sales was a $9 million decrease in gasoline tax revenue during 1981. More fuel-efficient automobiles and less travel resulted in fewer tax dollars for road construction and maintenance.

One possible development that could boost the island's economy remained unresolved at yearend. During 1981, the Commonwealth continued to evaluate proposals to mine copper deposits in west-central Puerto Rico. However, the Taller de Arte y Cultura de Adjuntas Group began a campaign to resist development. The group was concerned with possible land disturbance and water pollution and contended that agricultural development in the area would provide the same number of jobs.

Legislation and Government Programs.—The U.S. Bureau of Mines signed a Memorandum of Understanding with the Commonwealth's Mineral Resource Development Corporation of Puerto Rico (CODREMI) to provide technical assistance in evaluating proposals by two U.S. firms to mine three copper deposits in west-central Puerto Rico. Plans for developing the Utrado-Adjuntas-Lares copper deposits have been proposed to the Puerto Rican Government by AMAX, Inc. and Kennecott Copper Corp. Under the Memorandum of Understanding, the Bureau reviewed financial, geological, and engineering data in mining proposals submitted by the two companies. The Bureau's evaluation was nearing completion at yearend.

Geologists with the U.S. Geological Survey (USGS) in San Juan continued work on the geological map of the Puerto Rico insular shelf. Detailed fieldwork on the island's primary offshore sand deposit, southwest of Cabo Rojo, was completed; detailed fieldwork on the second most extensive deposit, Escollo d'Arenas, near the island of Vieques, was largely completed. USGS map I-1265, "Marine Geological Map of the Puerto Rico Insular Shelf, Isla Cajo de Muertos Area," was published.

Ongoing construction by the U.S. Corps of Engineers provided a crucial market for the island's stone producers. The Corps continued the Portugues-Bucana multiple purpose project near Ponce, which will involve construction of two rock-filled dams to provide flood protection, recreation, and a 33-million-gallon reservoir for the Ponce region. Completed is the channelization of approximately 9 miles of river. River banks were stabilized with riprap and concrete retaining walls. Other projects included continued restoration of El Morro as part of the San Juan National Historic Site project, which entailed restoration of San Cristobal Fortress and various coastal walls in Old San Juan. During the year, the Corps developed plans for the dredging of Ponce, Mayaguez, and Arecibo harbors, and announced a $64 million improvement for San Juan harbor. Funding for the latter project was pending at yearend.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Cement.—The island's cement industry consisted of two producers—Puerto Rican Cement Co., Inc., at Ponce, and San Juan Cement at Dorado. Shipments of cement, the leading mineral commodity in Puerto Rico, decreased 256,000 tons from 1980 to 1981. This was attributed to the decline in construction activity due to high interest rates and Federal program cuts.

Both cement companies were afflicted with increasing energy costs during the year. EPA began an experiment in October to burn toxic wastes as a fuel source at San Juan Cement's plant, which was expected to result in considerable energy savings. More significantly, both companies made preparations toward yearend to convert from oil to more cost-efficient coal, a possible aid toward stabilizing the price of cement. The new systems were expected to be on-line by 1983.

Clays.—The two cement companies operated clay pits to obtain raw material used in the cement manufacturing process. Production fell as the demand for cement weakened.

Table 3.—Puerto Rico: Portland cement salient statistics

(Short tons unless otherwise specified)

	1980	1981
Number of active plants	2	2
Production	1,484,937	1,222,389
Shipments from mills:		
Quantity	1,482,162	1,226,147
Value	$102,872,414	$105,420,481
Stocks at mills, Dec. 31	39,987	36,229

Graphite.—Puerto Rico ranked third among the 16 U.S. States and possessions that produced synthetic graphite in 1981, contributing 15.6% to the total U.S. output. Union Carbide at Yabucoa produced synthetic graphite electrodes for use in steel in electric arc furnaces. Petroleum coke, used in the electrode manufacturing process, was obtained from the company's plant at Penuelas. Quelling rumors of operations curtailments and significant layoffs, Union Carbide announced a $40 million expansion program. The program included the instal-

lation of an enclosed coke conditioning system, a new pitch impregnation system, two central incinerator systems, a coke storage system, and new hydraulic lifts for the graphitizing area. Most of the facility's output is exported.

Lime.—Chemical-grade lime was produced by Puerto Rican Cement at the Ponce facility from stone mined in the Ponce area. Sales, primarily for water purification, S-type mason's lime, and bauxite and sugar refining were concentrated in Puerto Rico and the Virgin Islands. Lime is used in the refining of sugar, and the possibility of a curtailed operation schedule by the Government Sugar Corp. could have a negative effect on lime production.

Salt.—The island's major salt producer, Cabo Rojo Enterprises, was back in operation after being forced to close in 1980 because of damage from Hurricane David. To meet contracts, the company exported salt from South America at a loss, while repairing and expanding its evaporative salt facility. In 1981, the company spent $150,000 to divide and deepen the 45 acres of crystallizers. Major consumers are pharmaceutical and petrochemical firms, tuna packers, feed and sugar mills, and curing and tanning plants. The only other saltworks in Puerto Rico is a small operation in La Parguera.

Sand and Gravel.—Silica sand was produced by Owens Illinois during the year. Production and value information is company proprietary. A number of other companies produced sand-size material by crushing and grinding coral and limestone; production and value data for these operations are reported with stone.

Stone.—Historically, stone production has accounted for approximately 40% of the value of Puerto Rico's mineral production. This was true in 1981 although production declined and sales fell 14% below those reported in 1980.

Sulfur.—Both Corco and Puerto Rico Sun Oil Co. recovered elemental sulfur from the desulfurization process during oil refining.

U.S. VIRGIN ISLANDS

The U.S. Virgin Islands, located 34 miles east of Puerto Rico, consist of 3 large and 62 smaller islands. The total land mass of the island group is 133 square miles.

Trends and Developments.—Extractive mineral production on the islands is limited to aggregate, and output by the aggregate producers paralleled the misfortune of the construction industry. In June, an Internal Revenue Service (IRS) ruling forced a number of companies with plans for new plants on the islands to look elsewhere. The IRS ruling, a revocation of Regulation 1-1441-4(D), states that a person or business receiving income from the U.S. Virgin Islands is liable for a 30% withholding tax to the Virgin Islands Government.

In other developments adversely affecting the construction and aggregate industries, opposition appeared in the St. Croix business community to a proposal by the islands' administration to locate a Government industrial park adjacent to the Alexander Hamilton Industrial Airport. Opponents favored a site closer to the economically depressed town of Frederiksted if the park is constructed and voiced a lack of confidence in the ability of the Government agencies to provide the necessary services.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Cement.—Cement for industrial, residential, and airport construction was imported from Puerto Rico, the Dominican Republic, and the French West Indies in 1981.

Clays.—Artistic Ceramics Corp., an Italian firm, opened a ceramics and porcelain plant at Salt River on St. Croix's north shore. Clay was imported from Italy.

Sand and Gravel.—St. Croix Stone & Sand Corp. excavated sand from Sandy Point near Frederiksted.

Stone.—Crushed basalt, produced by Devcon International Crop. and St. Croix Stone & Sand, was the only mineral commodity extracted on the islands. The companies operated two quarries on St.Croix and one on St. Thomas.

Sulfur.—The islands ranked 11th among the 31 U.S. States and possessions that recovered elemental sulfur during 1981. All output originated from the Amerada Hess Corp. refinery on St. Croix.

METALS

Bauxite.—Martin Marietta Corp., a St. Croix alumina producer, recently completed

a $46 million expansion, increasing capacity to 700,000 tons per year. The company is seeking a partner to help finance further capacity expansion to 1.5 million tons annually, which would cost $500 million. Martin Marietta also engaged in work to convert its power generation facility from oil to coal, a $75 million project scheduled for completion in 1983.

PACIFIC ISLAND POSSESSIONS

American Samoa and the islands of Canton, Enderburg, Guam, Jarvis, Johnson, Midway, Palmyra, and Walker comprise the U.S. Pacific Island Possessions. American Samoa, at the southern end of the Mariana Island Group, 2,200 miles southwest of Hawaii and 1,600 miles northeast of New Zealand, and Guam, approximately 1,500 miles north of New Guinea, were the only islands reporting mineral production.

Trends and Developments.—Power outages throughout the year interrupted residential and industrial activity, including aggregate production. One or more of Samoa's seven electrical generators were normally off-line awaiting spare parts. In August, outages forced a 2-week period of power rationing.

Marlex Petroleum began feasibility studies on building a 10,000-barrel-capacity oil refinery in American Samoa. Construction of a refinery complex would create a strong demand for aggregate.

The Japanese Geological Survey vessel *Hakurei Maru* docked for 2 days in American Samoa during a 60-day marine mineral resources study of the Central Pacific Basin. The cruise was part of an ongoing resource evaluation that began in 1974. The study area was centered in the North and South Pacific from east of Wake Island to west of Tahiti. The 1981 work was to develop data on the environment of manganese nodule formation and mining technology for marine resource recovery.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Stone.—During 1981, the American Samoan Government operated a traprock quarry to produce aggregate for concrete and road construction. On Guam, four producers operated four quarries to mine and crush limestone for concrete and bituminous aggregate, road base material, and filter, riprap, and jetty applications.

TRUST TERRITORY OF THE PACIFIC ISLANDS

The trust territory, commonly termed Micronesia, covers approximately 3 million square miles of the western Pacific Ocean ranging from about 1° to 22° north latitude and 130° to 172° east longitude. The territory, consisting of three major archipelagos (the Marshalls, Marianas, and Carolinas), comprises of more than 2,000 islands and islets.

The Northern Marianas, with Saipan as the capital, is a commonwealth of the United States, as is Puerto Rico. In 1979, the Marshalls Archipelago became the Government of the Marshall Islands, and Truk, Ponape, Yap, and Kosrae united to form the Federated States of Micronesia.

Trends and Developments.—In 1947, the territory became a United Nations trusteeship administered by the United States. In the 1970's, the United States initiated a 5-year improvement program as the trusteeship nears termination. Many of the improvements will involve construction and use of the islands' aggregate resources.

A variety of mineral commodities occur throughout Micronesia, but generally, exploitation has been limited by the size of the deposits. Clays, phosphate, sulfur, bauxite, copper, limonite, and manganese have been mined and exported, primarily to the Japanese mainland. However, the only mineral production reported in 1981 was that of sand and gravel and stone. Micronesian mineral occurrence is summarized in table 4.

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[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]Liaison program assistant, Bureau of Mines, Pittsburgh, Pa.

Table 4.—Mineral occurrence and past exports in the Pacific Trust Territories

Mineral	District					
	Marianas[1]	Marshall	Palau	Ponape	Truk	Yap
Nonmetallic:						
Asbestos						O
Clays	O		E	O		
Phosphate	E	E	E		O	E
Sand	O	O	O	O	O	O
Stone	O	O	O	O	O	O
Sulfur	E					
Metallic:						
Antimony			O			
Bauxite	O		E	O	O	O
Copper			O			E
Gold	O		O		O	O
Iron oxides	O					
Limonite	O		E	E	O	E
Manganese	E		E			O
Silver	O					
Zinc	O		O			

E Occurrence and exportation. O Occurrence only.
[1]Excludes Guam.

Source: Department of Resources and Development, Trust Territory of the Pacific Islands.

The Mineral Industry of Rhode Island

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Rhode Island Department of Environmental Management for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.[1]

The value of nonfuel mineral production in Rhode Island in 1981 was $5.3 million, a decrease of about $900,000 from that of 1980. Commodities produced were sand and gravel and stone; minor quantities of gem stones were recovered by collectors. Sand and gravel mining accounted for over three-fourths of the value of mineral production in 1981. Nationally, the State ranked 49th in the value attributed to mineral production.

Trends and Developments.—In 1981, tonnage handled at the Port of Providence totaled 6.7 million tons, an increase of about 20% over that of 1980. Imports increased from 4.7 million to 6.1 million tons; leading nonfuel commodities received at the port were cement (254,000 tons) and steel (87,000 tons). Exports declined from 925,000 to 590,000 tons. Metal scrap was again the major export in 1981.[2]

During the year, a number of the State's metal manufacturing firms went on strike, while others closed because of poor economic conditions. Brown & Sharpe Manufacturing Co., a leading New England machine tool producer, remained on strike at year-end. The strike by 1,600 workers began on October 19 when union and management failed to reach a new contract agreement.

United Wire & Supply Corp., on strike since mid-May, was considering permanently closing its facilities, which would eliminate 500 jobs. The company, in operation for 112 years, produced copper, brass, and aluminum tubing.

Table 1.—Value of nonfuel mineral production in Rhode Island, by county[1]

(Thousands)

County	1980	1981	Minerals produced in 1981 in order of value
Kent	$953	W	Sand and gravel.
Newport	W	W	Stone, sand and gravel.
Providence	W	W	Sand and gravel, stone.
Washington	W	W	Do.
Undistributed[2]	5,216	[p]$5,279	
Total	[3]6,170	[p]5,279	

[p]Preliminary. W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Bristol County is not shown because no nonfuel mineral production was reported.
[2]Includes gem stones and values indicated by symbol W.
[3]Data do not add to total shown because of independent rounding.

Table 2.—Indicators of Rhode Island business activity

	1980	1981[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ---- thousands	463.6	471.7	+1.8
Unemployment ---- do	29.6	36.9	+24.7
Employment (nonagricultural):			
Mining ---- do	([1])	([1])	--
Manufacturing ---- do	128.2	126.3	-1.5
Contract construction ---- do	12.7	11.9	-6.3
Transportation and public utilities ---- do	13.0	13.1	+.8
Wholesale and retail trade ---- do	80.9	81.4	+.6
Finance, insurance, real estate ---- do	20.8	21.0	+1.0
Services ---- do	[2]83.5	[2]88.4	+5.9
Government ---- do	59.2	58.4	-1.4
Total nonagricultural employment ---- do	398.3	400.5	+1.0
Personal income:			
Total ---- millions	$8,952	$9,973	+11.4
Per capita	$9,429	$10,466	+11.0
Construction activity:			
Number of private and public residential units authorized	3,004	3,184	+6.0
Value of nonresidential construction ---- millions	$63.3	$79.9	+26.2
Value of State road contract awards ---- do	$30.0	$51.0	+70.0
Shipments of portland and masonry cement to and within the State ---- thousand short tons	131	122	-6.9
Nonfuel mineral production value:			
Total crude mineral value ---- millions	$6.2	$5.3	-14.5
Value per capita, resident population	$7	$6	-14.3
Value per square mile	$5,082	$4,348	-14.4

[p]Preliminary.
[1]Included with "Services."
[2]Includes mining.

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

Late in the year, employees at Kaiser Aluminum & Chemical Corp. in Portsmouth ratified a new contract after a 3-month strike. The plant employs about 250 workers and manufactures aluminum electrical wires and cables.

New England Malleable Iron Co. closed its facilities at Warwick, citing poor economic conditions. About 200 workers were affected by the shutdown. At yearend, efforts were continuing by the owner, Roy T. Morgan Corp., to find a buyer. Malleable iron castings were the company's major product.

Washburn Wire Co., East Providence, also closed during the year. The totally integrated wire and rod mill facility had employed about 500 workers. The company produced ingot molds, ingots, billets, rod, and wire.

Legislation and Government Programs.—During the year, a final report on the current state of exploration of anthracite-carbonaceous shale deposits in the Narragansett Basin of Rhode Island and Massachusetts was completed. The material was last commercially mined for coal in 1954, but one operation in Plainville, Mass., still quarries the material to produce a lightweight aggregate. The report was prepared by the University of Rhode Island and funded by the U.S. Department of Energy (DOE).

Rhode Island's Department of Environmental Management (DEM) received a $85,000 grant from the Office of Surface Mining (OSM) under Title IV of the Surface Mining Control and Reclamation Act of 1977 for abandoned mine reclamation at Valley Falls, Providence County. DEM also applied for a $145,000 grant from OSM to draft legislation for regulating open pit mines (coal) in the State. Although no coal is mined in Rhode Island, findings from a limited exploration program identified resources estimated at about 17 million tons of anthracite material.[3]

Brown University, Providence, received $175,000 from DOE for a study on the development of a combined macroscopic-microscopic approach to the fracture of metals. The University of Rhode Island received $700,400 from the National Science Foundation to establish a national center for research on robotics systems used in industrial applications.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Gem Stones.—Collection of gem stones by hobbyists added a minor amount to the State's value of mineral production in 1981.

Sand and Gravel.—The U.S. Bureau of Mines, to reduce reporting burden and costs, implemented new sand and gravel canvassing procedures for the survey of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel operators will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Production of construction sand and gravel in 1981 decreased to 1.9 million tons (based on preliminary data), the lowest tonnage mined in Rhode Island since 1973. Although output declined, sand and gravel was again the leading mineral commodity produced in Rhode Island. About $4.1 million of the $5.3 million attributed to the State's value of mineral production came from sand and gravel mining. One company in Providence County produced industrial sand sold for molding and foundry applications.

During the year, one of the State's leading producers, Rhode Island Sand & Gravel Co., Inc., closed because reserves were depleted. The company had produced over 500,000 tons of sand and gravel in 1980 and had been in operation for nearly 50 years. The plant site located on a 30-acre tract near Warwick in Kent County was acquired by Dimeo Construction Co. Dimeo plans to construct an industrial park and an office building at the site in 1982.

Table 3.—Rhode Island: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	1,038	$2,123	$2.04	NA	NA	NA
Gravel	1,468	2,822	1.92	NA	NA	NA
Total or average	2,506	4,945	1.97	p1,900	p$4,100	p$2.16
Industrial sand	--	--	--	W	W	3.00
Grand total or average	2,506	4,945	1.97	W	W	p2.16

pPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.

Stone.—Output in 1981 dropped 62,000 tons compared with that of 1980. Over a 3-year period from 1978 to 1981, production has declined about 150,000 tons.

Crushed stone was mined by four companies, each operating one quarry. Granite, limestone, and graywacke were the types of stone quarried. Production in 1981 was reported from Newport and Providence Counties. One company mined dimension granite in Washington County for use in monument manufacture.

During the year, the State's leading producer, M. A. Gammino Construction Co., was purchased by the British firm Thomas Tilling Inc. and renamed Tilcon Gammino Inc. Tilcon, Inc., the U.S. subsidiary of Thomas Tilling, acquired the operation for $3 million, which included one of only two active crushed granite quarries in Rhode Island. In the last 4 years, the firm has invested over $400 million in U.S. acquisitions.[4] In addition to the Rhode Island operation, Tilcon, Inc., now has operations in Connecticut, Massachusetts, Maine, New Jersey, and New York.

[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]Rhode Island Statewide Planning Program Monthly Progress Report No. 209, January 1982, pp. 18-19.
[3]University of Rhode Island. Planning a Comprehensive Program for Exploration of the Anthracite Deposits of the Narragansett Basin of Massachusetts and Rhode Island. Final Report, Phase I and II. Prepared for U.S. Department of Energy under contract No. AC 01-79RA20036. February 1981, 102 pp., plus appendices.
[4]Rock Products. August 1981, p. 18.

Table 4.—Rhode Island: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Concrete aggregate	32	122	1	W
Bituminous aggregate	34	128	1	W
Dense-graded road base stone	W	W	11	W
Railroad ballast	--	--	13	W
Filter stone	39	148	36	W
Manufactured fine aggregate	24	85	13	W
Other[2]	73	725	64	1,116
Total[3]	203	1,208	141	1,116

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, granite, and other stone.
[2]Includes stone used in agricultural limestone, other construction aggregate and road stone, riprap and jetty stone, flux stone, other fillers or extenders, and roofing granules.
[3]Data may not add to totals shown because of independent rounding.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Sand and gravel:			
A. Cardi Construction Co., Inc.	451 Arnold Rd. Coventry, RI 02816	Pit	Kent.
J. H. Lynch & Sons, Inc.	Box 325 Ashton, RI 02864	Pit	Providence.
Material Services, Inc	Greenville Rd. North Smithfield, RI 02895	Pit	Do.
V. J. Paolino Construction Co.	Box 383 Slatersville, RI 02876	Pit	Do.
Rhode Island Sand & Gravel Co., Inc.	Kilvert St. Warwick, RI 02886	Pit	Kent.
River Sand & Gravel Co	Box 101 Pawtucket, RI 02861	Pit	Washington.
South County Sand & Gravel Co., Inc.	North Rd. Peace Dale, RI 02878	Pit	Do.
Tasca Sand & Gravel Co	Box 113, R.F.D. 4 Esmond, RI 02917	Pit	Providence.
Stone:			
The Conklin Limestone Co., Inc.	R.F.D. 1 Lincoln, RI 02865	Quarry	Do.
G. J. T. Realty, Inc	Tiverton, RI 02878	do	Newport.
Peckham Bros. Co., Inc	Box 193 Newport, RI 02840	do	Do.
Tilcon, Inc	875 Phenix Ave. Cranston, RI 02920	do	Providence.

The Mineral Industry of South Carolina

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the South Carolina Geological Survey, State Division of Research and Statistical Services, for collecting information on all nonfuel minerals.

By James R. Boyle[1] and Norman K. Olson[2]

The value of nonfuel minerals production in South Carolina was $205.5 million in 1981, an increase of $10.7 million from that of 1980. Unit value of most mineral commodities increased. Major contributors to total value were cement, stone, clays, and sand and gravel.

The State ranked second nationally in the production of kaolin and vermiculite, third in flake mica, fifth in ferroalloys, and sixth in fuller's earth and masonry cement. South Carolina became 1 of 14 States that recovered gold during 1981.

Nationwide economic conditions continued to adversely affect the State's mineral industry. Several industries supplying mineral commodities to the construction, paper, rubber, and steel industries experienced reduced demand during the year.

By yearend, the unemployment rate, as reported by the State's Employment Security Commission, was 9.9%, compared with 7.0% for yearend 1980. Although little change was noted in employment statistics for the mining industry, the construction industry suffered employment losses of 5,500 over the year. The relatively constant level of mining employment was due to inventory buildup and shorter workweeks at mining operations.

Table 1.—Nonfuel mineral production in South Carolina[1]

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Cement, portland	thousand short tons	1,704	$74,539	1,765	$79,407
Clays[2]	do.	2,211	25,169	1,632	28,600
Gem stones		NA	5	NA	10
Manganiferous ore	thousand short tons	20	W	23	W
Sand and gravel	do.	5,556	22,855	p5,303	p23,531
Stone:					
Crushed	do.	16,107	49,207	14,825	49,830
Dimension	do.	12	703	18	1,109
Combined value of cement (masonry), clays (fuller's earth), copper (1981), gold (1981), mica (scrap), silver (1981), vermiculite, and values indicated by symbol W		XX	22,301	XX	22,989
Total		XX	194,779	XX	205,476

pPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. 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 with "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Abbeville	--	$2,173	Stone.
Aiken	$19,221	19,722	Clays, sand and gravel.
Anderson	W	1,206	Stone.
Bamberg	W	--	
Berkeley	W	W	Stone.
Charleston	787	W	Sand and gravel.
Cherokee	3,090	3,769	Stone, clays, manganiferous ore, sand and gravel.
Chesterfield	W	W	Sand and gravel, stone.
Clarendon	140	--	
Colleton	W	W	Sand and gravel.
Dillon	W	W	Do.
Dorchester	56,230	52,926	Cement, stone, clays, sand and gravel.
Edgefield	W	W	Clays.
Fairfield	W	W	Stone.
Florence	W	W	Sand and gravel.
Georgetown	W	W	Stone.
Greenville	W	W	Stone, sand and gravel.
Greenwood	W	W	Stone, clays, sand and gravel.
Horry	W	W	Stone, sand and gravel, clays.
Jasper	W	W	Sand and gravel.
Kershaw	W	5,604	Sand and gravel, clays, stone.
Lancaster	W	W	Mica, clays, sand and gravel.
Laurens	W	W	Vermiculite, stone.
Lexington	W	W	Sand and gravel, stone, clays.
Marion	W	W	Sand and gravel, clays.
Marlboro	W	W	Do.
Oconee	297	318	Stone.
Orangeburg	42,421	41,501	Cement, stone, clays, sand and gravel.
Pickens	W	W	Stone.
Richland	W	W	Stone, clays, sand and gravel.
Saluda	84	71	Clays.
Spartanburg	W	3,303	Stone.
Sumter	W	W	Sand and gravel, clays.
Union	W	W	Sand and gravel.
York	W	W	Stone, clays.
Undistributed[2]	79,376	64,187	
Total[3]	201,650	194,779	

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: Allendale, Barnwell, Beaufort, Calhoun, Chester, Darlington, Hampton, Lee, McCormick, Newberry, and Williamsburg.

[2]Includes gem stones and values indicated by symbol W.

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

Mineral commodities were produced in all but three counties in the State. Aiken County led in the number of operating mines with 35, followed by Cherokee with 23 and Charleston and Spartanburg with 21 each. During 1981, the Division of Mining and Reclamation, South Carolina Land Resources Commission, issued permits to 33 new mining operations, 9 of which were to companies new in the State. Of the 33, 22 were sand or sand and clay; 5, stone; 3, clay; 2, vermiculite; and 1, gold.

Trends and Developments.—During 1981, mineral imports through the facilities of the South Carolina State Port Authority were as follows: colemanite (Turkey), charcoal (Ecuador), clinker (Spain), alumina (Australia), and chromite (Japan). Mineral exports were zircon (South America), kaolin (worldwide), and feldspar (South America). Georgetown Steel Corp. received imports of pelletized and lump iron ore from South America. The ore, unloaded at Wilmington, N.C., was transferred to barges and shipped to Georgetown.

Airco Inc. announced plans for construction of a $128 million plant at Ridgeville to manufacture graphite electrodes for electric arc furnace steelmakers.

Carolina Metals, owned by Nuclear Metals, Inc., of Concord, Mass., announced plans to build a $5 million depleted uranium plant in Barnwell County. Construction was expected to begin early in 1982. Depleted uranium metal will be used in medical and aviation equipment.

Gold mining returned to the State in 1981, and exploration in the northwestern part of the State increased. At least four companies conducted exploration activities, ranging from leasing of lands to basic geologic investigations. American Selco, Inc., a subsidiary of Selection Trust, Ltd., London, established an office in Camden and initiat-

Table 3.—Indicators of South Carolina business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	1,299.9	1,331.3	+2.4
Unemployment	do	91.0	131.4	+44.4
Employment (nonagricultural):				
Mining	do	(1)	(1)	--
Manufacturing	do	391.9	388.2	-.9
Contract construction	do	73.4	71.2	-3.0
Transportation and public utilities	do	53.0	53.8	+1.5
Wholesale and retail trade	do	225.1	231.3	+2.8
Finance, insurance, real estate	do	47.7	49.5	+3.8
Services[2]	do	161.3	163.1	+1.1
Government	do	236.4	234.4	-.9
Total nonagricultural employment	do	1,188.8	1,191.5	+.6
Personal income:				
Total	millions	$22,715	$25,491	+12.2
Per capita		$7,265	$8,050	+10.8
Construction activity:				
Number of private and public residential units authorized		23,694	18,578	-21.6
Value of nonresidential construction	millions	$188.7	$237.4	+25.8
Value of State road contract awards	do	$34.5	$122.0	+253.6
Shipments of portland and masonry cement to and within the State	thousand short tons	990	994	+.4
Nonfuel mineral production value:				
Total crude mineral value	millions	$194.8	$205.5	+5.5
Value per capita, resident population		$62	$66	+6.5
Value per square mile		$6,272	$6,616	+5.5

[p]Preliminary.
[1]Included with "Services".
[2]Includes "Mining."

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

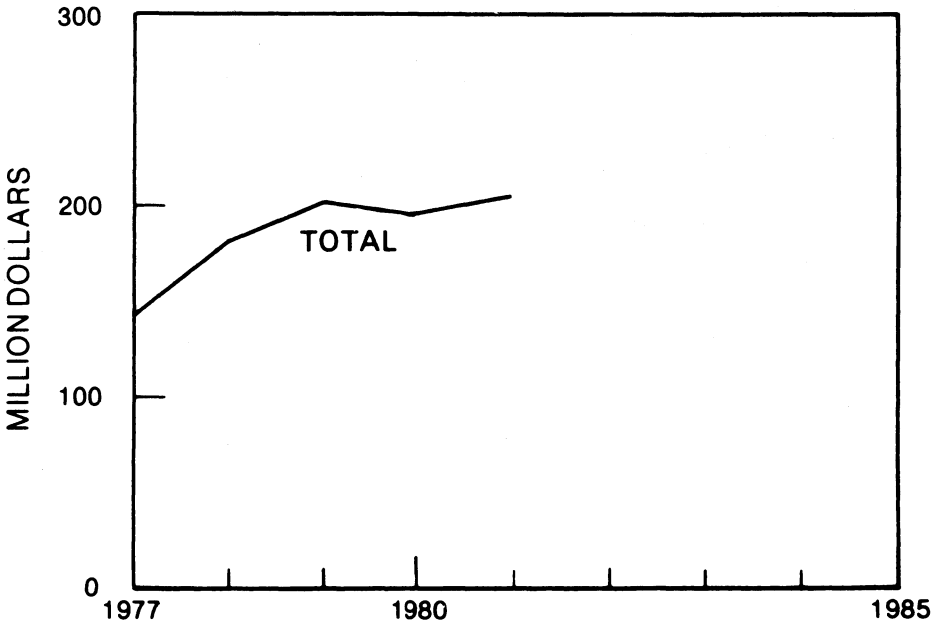

Figure 1.—Total value of nonfuel mineral production in South Carolina.

ed an exploration program for gold and massive sulfides. Hatley Mining Co., York County, attempted to recover gold from a small pit east of Clover. Newport Minerals, Inc., Cripple Creek, Colo., planned to start recovery operations near the Brewer Mine.

Legislation and Government Programs.—The Mining and Reclamation Division of the State Land Resources Commission continued administration of the South Carolina Mining Act. During the year, a geotechnical study was centered on a limestone operation near Jamestown to determine the relationship between the mine and increased subsidence. Also, the Commission continued work under a grant from the U.S. Bureau of Mines to examine the feasibility of monitoring mining and reclamation activities in the State by means of computer analysis of Landsat satellite data. The final report was scheduled for next fiscal year.

Midrex Corp. was awarded a grant to cover about one-half of the $1.7 million cost of a feasibility study for a multiuser coal gasification plant in Georgetown. The primary use of the plant would be to replace natural gas as a feedstock for the direct reduction of iron ore at Georgetown Steel Corp.

During 1981, the South Carolina Geological Survey had 9 full-time and 15 part-time staff members. Activities of the survey were divided into two general areas, mineral industry assistance and basic geology projects. In response to mineral industry requests, geologic aid was provided and centered on massive sulfides, gold, and kaolin. Inquiries also covered phosphate, limestone, silica sand, tin, marble, and clays. About 30 field projects were in progress or near completion during the year. Some of the more significant projects in progress were (1) a geologic map of South Carolina, (2) a computerized resources information bank, and (3) geologic mapping of Hollow Creek, Graniteville, and Jackson Quadrangles, Aiken County. Projects completed and in preparation for publication included a directory of South Carolina mineral producers and several geologic maps covering specific quadrangles.

The U.S. Geological Survey conducted various investigations in the State in 1981, including (1) geochemical exploration of the Haile-Brewer area, (2) mineral resource assessment in northern South Carolina, (3) seismic assessment of regional earthquake hazards, and (4) geologic study of the Charleston area. A map, "Seismicity Map of the State of South Carolina" (Map MF-1225) was published.

The U.S. Bureau of Mines reported that the apparent consumption of industrial explosives and blasting agents in the State in quarrying and nonmetal mining was 4.0 million pounds in 1981. Of that total, the top two types, ammonium nitrate fuel mixed blasting agents and water gels and slurries, accounted for 98% of the explosives used.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Nonmetals accounted for the bulk of the value of South Carolina's total mineral production.

Cement.—Cement continued to rank first in value among South Carolina's mineral commodities. Production of portland cement remained about the same as that of 1980, while masonry cement decreased. Portland cement was produced in southern South Carolina by Giant Portland & Masonry Cement Co. and Gifford-Hill & Co., Inc., in Dorchester County, and by Santee Portland Cement Corp. in Orangeburg County. Giant and Santee also produced masonry cement.

Marl and clay were the main raw materials for cement manufacture. Other raw materials used were iron ore, fly ash, and gypsum. Most of the portland cement shipped was type I or II. Principal uses were in ready-mix concrete, concrete products, highway construction, and building materials.

Santee continued construction of a $13 million, 3,500 horsepower cement mill at its Holly Hill plant; this will be the company's fourth cement grinding mill, which will give them a rated capacity of 1.2 million tons of cement per year. The new cement grinding facility was to be installed in conjunction with a new clinker storage and handling system and is expected to be operational by late 1982. Santee is owned by Dundee Cement Co., a subsidiary of Holderbank Financiere Glaris S.A. of Switzerland.

Giant started a project at its Harleyville plant to convert its kiln fuel from natural gas to coal; completion was scheduled for

mid-1982. The wet-process plant has four kilns and will obtain coal from the Tennessee-Kentucky area.

Clays.—Clay production included kaolin, common clay, and fuller's earth. In 1981, clays were mined by 21 companies at 43 pits in 16 counties. Leading producers were Richtex Corp., J. M. Huber Corp., Gifford-Hill & Co., Inc., Santee Portland Cement Corp., and Southern Brick Co.

South Carolina ranked second in the Nation in the production of kaolin, with output increasing in 1981. Kaolin was produced in Aiken, Kershaw, Lexington, and Richland Counties by 10 firms operating 14 mines. Kaolin deposits are located in a belt that extends in a northeast-southwest line. Air-floated kaolin was used principally in rubber products, paints, high-quality paper, fertilizer, and pesticides. Water-washed kaolin was produced at one plant and was sold for paper filling and coating. Unprocessed kaolin was used in manufacturing refractories, in brick as a colorant, and in the manufacture of cement.

South Carolina ranked 10th nationally in the production of common clay, which was produced from 28 mines in 13 counties. Principal use was in the manufacture of brick. Demand, tied closely to construction, dropped sharply, but unit value increased. Southern Brick Co., at Ninety Six, S.C., one of the largest brick producers in the State, completed conversion of kilns to utilize sawdust as fuel. Operating experience indicates that sawdust is 15% better for fuel efficiency than natural gas, based on sawdust with 8,000 British thermal units (Btu) per pound. Southern was firing at 1,125 Btu per pound of brick. Waste heat from the kilns was piped to the dryer to assist drying, and a bark burner was under consideration for furnishing heat to the dryer to replace natural gas.

Table 4.—South Carolina: Kaolin sold or used by producers, by kind and use

(Short tons)

Kind and use	1980	1981
Air-floated:		
Adhesives	13,802	17,766
Animal feed and pet-waste absorbent	1,444	--
Ceramics[1]	23,395	117,941
Fertilizers	20,383	15,444
Fiberglass	105,709	98,427
Paint	1,146	841
Paper coating and filling	4,292	3,292
Pesticides and related products	15,135	17,075
Plastics	11,499	13,966
Rubber	191,059	122,625
Other refractories[2]	7,213	5,202
Other uses[3]	7,268	50,744
Exports[4]	56,612	50,747
Total	458,957	514,070
Unprocessed: Face brick; firebrick, block, shapes; miscellaneous	198,795	210,654
Grand total	657,752	724,724

[1]Includes floor and wall tile; glazes, glass, and enamels (1980); pottery; roofing granules; and sanitary ware.
[2]Includes refractory grogs and crude, and mortar and cement.
[3]Includes common brick, crockery and other earthenware (1980), ink (1980), roofing tile (1981), structural tile (1980), and miscellaneous.
[4]Includes ceramics, paper filling, pesticides and related products, rubber, and miscellaneous.

Fuller's earth was produced by one operator, South Carolina SCA Services, Inc., in Sumter County, and sold chiefly for use as an absorbent in various oil, grease, and pet products; output increased substantially. Fuller's earth, a light-colored opaline claystone, upon calcining at high temperatures, has great absortive capacities for oils, odor, and water. South Carolina SCA Services also operated a hazardous waste disposal area using fuller's earth to solidify liquid wastes. The company mines about 60 feet of fuller's earth and leaves about 20 feet in the pit as a base for the hazardous waste. Owing to increased demand for fuller's earth, a doubling of production was planned by installing screens to aid dryers, which restrict processing.

Colemanite.—Industrial Minerals, Inc., York, S.C., processed colemanite (calcium

borate) ore imported from Turkey at its York County plant. The ore was ground, dried, and shipped to PPG Industries, Inc., and to Owens-Corning Fiberglas Corp. for use in glass fiber manufacture.

Feldspar.—Spartan Minerals Corp., a division of Lithium Corp. of America, used flotation cell tailings from the Lithium Corp. spodumene operation in North Carolina. The processed tailings produced a feldspar-silica mixture used in manufacturing glass containers, ceramic whiteware, and latex fillers. Also recovered was mica used in caulking. Although sales decreased, Spartan plans to add another grinding circuit in 1982.

Mica (Sericite).—South Carolina ranked third in the Nation in the production of sericite. Output was from one mine in Lancaster County; sales increased slightly. Sericite was dry milled to produce a micaceous product that was sold mainly for use as an inert filler in paint, expansion-joint cement, and in electronics. Spartan Minerals Corp. recovered mica at its Pacolet plant using tailings from Lithium's spodumene operation in North Carolina.

Sand and Gravel.—To reduce reporting burdens and costs, the Bureau of Mines implemented new canvassing procedures for its 1981 surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but contains complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Production of both construction and industrial sand and gravel decreased, while unit value increased. Industrial sand was used primarily in glassmaking, sand blasting, foundry, and filtration applications.

Stone.—The value of the State's stone production continued to rank second behind that of cement. Crushed stone production decreased, while that of dimension stone increased.

Table 5.—South Carolina: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	3,460	$6,817	$1.97	NA	NA	NA
Gravel	1,278	6,410	5.02	NA	NA	NA
Total or average	[1]4,737	13,227	2.79	[p]4,500	[p]$13,000	[p]$2.89
Industrial sand	819	9,628	11.76	803	10,531	13.11
Grand total or average	5,556	22,855	4.11	[p]5,303	[p]23,531	[p]4.44

[p]Preliminary. NA Not available.
[1]Data may not add to total shown because of independent rounding.

Table 6.—South Carolina: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	W	W	271	1,917
Concrete aggregate	3,045	9,521	2,422	10,049
Bituminous aggregate	1,860	6,298	1,891	6,910
Macadam aggregate	1,076	3,859	W	W
Dense-graded road base stone	1,984	5,556	2,377	7,755
Surface-treatment aggregate	268	837	410	1,719
Other construction aggregate and road stone	3,663	11,680	2,811	10,165
Riprap and jetty stone	171	639	190	889

See footnotes at end of table.

Table 6.—South Carolina: Crushed stone[1] sold or used by producers, by use —Continued

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Railroad ballast	572	1,872	627	2,177
Filter stone	W	W	1	W
Manufactured fine aggregate (stone sand)	726	1,818	601	1,204
Cement manufacture	2,308	4,564	2,724	5,495
Other[2]	434	2,562	500	1,551
Total[3]	16,107	49,207	14,825	49,830

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, granite, and marl.
[2]Includes stone used in asphalt filler (1981) and sulfur removal from stack gases.
[3]Data may not add to totals shown because of independent rounding.

Granite, limestone, and marl were mined and crushed for a variety of uses. Granite was also quarried for use as dimension stone. In 1981, stone was produced by 20 companies from 35 quarries in 20 counties. Granite was produced by 14 companies from 26 quarries in 14 counties; limestone, by 5 companies from 6 quarries in 4 counties; and marl, by 3 companies from 3 quarries in 2 counties.

In 1981, 91% of the State's crushed stone tonnage was produced by the 8 largest producing companies from 23 quarries. Four quarries had production in excess of 1 million tons each during 1981. Crushed stone was shipped by truck (74.8%), railroad (6.1%), and by other means (19.1%). Leading producing counties were Richland, Orangeburg, Berkeley, Dorchester, and Lexington. The leading producers were Martin Marietta Aggregates, with six quarries; Vulcan Materials Co., with five quarries; and Lone Star Industries, Inc., with four quarries.

Production decreased from individual crushed stone operations up to 66%. A severe decrease in heavy construction and reduced highway construction and road maintenance programs severely affected demand, which resulted in reduced workweeks and increased inventories. Business was not expected to pick up until late 1982 or early 1983; most crushed stone operations experience a 6- to 8-month lag after any economic recovery begins.

Dimension granite was produced by Coggins Granite Industries, Inc., Mercer Granite Industries, and Comolli Granite Co., from three quarries in Kershaw County.

Vermiculite.—The Nation's crude vermiculite was mined in Montana, South Carolina, and Virginia. Production in the State decreased 9.5%; unit value increased. Vermiculite ore was mined by W. R. Grace & Co., in Greenville County, and Patterson Vermiculite Co., in Laurens County. Groups of deposits, usually a few feet thick and several hundred feet long, were open pit mined and beneficiated by a wet concentrator process. The ore was exfoliated at two plants by W. R. Grace & Co. and at one plant by Patterson Vermiculite Co.

Vermiculite, a group of hydrated micaceous materials, has the property of expanding 20 to 30 times its original volume when heated. Principal sales were for soil conditioning additives, for the manufacture of lightweight aggregates (concrete, plaster, and fireproofing), and in loose fill and block insulation.

W. R. Grace won the 1980-81 Mined Land Reclamation award from the South Carolina Land Resources Commission. The award was for outstanding reclamation of the L. B. Casey Mine in Spartanburg County, an active producer from 1964 to 1980 and reclaimed in 1981.

METALS

Although only limited mining of metals was reported, production of aluminum, ferroalloys, iron, and steel from imported ores was significant in the State's economy in 1981. Ores were imported through the South Carolina State Port Authority facilities at Charleston and via barge from Wilmington, N.C.

Aluminum.—Alumax, Inc., had its first full year of operation at its primary reduction plant in Berkeley County. The plant has a capacity of about 200,000 tons per year. The plant operated at near capacity through the year, but because of reduced demand, inventories increased. About 400,000 tons of alumina per year is imported from Australia, about one ship per month (36,000 tons). The plant has two potlines, with the products (billets, slabs, and ingots) shipped to finishing plants. Energy

costs of over $1 million per month, with the possibility of increasing, may cause problems in the future. The company has made application for permits to construct another potline and increase capacity by 50%.

Jim Walter Corp. began production of aluminum coil early in the year at its new aluminum rolling mill at Mt. Holly. The plant was expected to be operating at capacity by mid-1982.

Ferroalloys.—Ferrochrome alloys were produced by Macalloy Corp., Charleston, using imported ores. Shipments and value decreased. South Carolina ranked fifth nationally in shipments of ferroalloys and was 1 of 16 States with a recorded production. During the year, Macalloy shut down one of its two furnaces for overhaul for several months. Production at the facility was as high as 85% of capacity; capacity is about 120,000 long tons of ferrochrome per year. The plant closed in December, but tentative plans were to start up one of the two furnaces by spring 1982.

Gold.—Gold, copper, and silver were recovered from the Chris Hill Mine in Cherokee County by Diversified Machine Products Inc. Although production was limited, it was the first reported recovery of precious and base metals from the State since the World War II era. Exploration continued for gold in the northwestern part of the State.

Iron and Steel.—Steel was produced in Georgetown by the Georgetown Steel Corp., a subsidiary of Korf Industries of the Federal Republic of Germany. Georgetown Steel was one of the Nation's major producers of wire rod. Pelletized ore and natural lump ore averaging 68% iron from South America were imported through Wilmington, N.C., and barged to Georgetown. Sponge iron was produced from the ore by the MIDREX direct-reduction process by the company's companion firm, Georgetown Ferreduction. Sponge iron (95%) is mixed with scrap and various ferroalloys and fed to the electric furnace. The product from the continuous caster is a 4-inch by 4-inch by 46-foot billet for use in various wire and rod products. The plant operated near capacity during the year, with demand down slightly.

Georgetown Steel Corp. purchased 50% of Addlestone International Corp., with an option to purchase the remaining 50%. Addlestone, a ferrous metals broker, operates scrap yards in Georgetown and Augusta, Ga. The purchase will insure an adequate source of ferrous scrap for the electric furnaces.

Manganiferous Ore.—Manganiferous schist was mined by three companies in Cherokee County; production and value increased over that of 1980. The mines were operated intermittently with the output used by brick manufacturers in South Carolina and North Carolina for coloration.

Zircon.—Milled zircon (zirconium silicate) was produced by M & T Chemicals, Inc., in Georgetown County, using raw materials obtained from Florida and Australia. Zircon concentrates were processed by fine grinding and shipped for foundry, wall tile, whiteware, and general ceramic uses.

[1]State Liaison Officer, Bureau of Mines, Tuscaloosa, Ala.
[2]State geologist, South Carolina Geological Survey, Columbia, S.C.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum smelters:			
Alumax, Inc	Box 1000 Goose Creek, SC 29445	Plant	Berkeley.
Cement:			
Giant Portland & Masonry Cement Co.	Box 218 Harleyville, SC 29448	do	Dorchester.
Gifford-Hill & Co., Inc	Box 326 Harleyville, SC 29448	do	Do.
Santee Portland Cement Corp	Box 698 Holly Hill, SC 29059	do	Orangeburg.
Clays:			
Common clay and shale:			
Gifford-Hill & Co., Inc	Box 326 Harleyville, SC 29448	Mine	Dorchester.
Palmetto Brick Co.[1]	Box 430 Cheraw, SC 29520	do	Marlboro.
Richtex Corp.[1]	Box 3307 Columbia, SC 29230	do	Kershaw, Richland, Sumter.
Santee Portland Cement Corp	Box 698 Holly Hill, SC 29059	do	Orangeburg.
Southern Brick Co	Box 208 Ninety Six, SC 29666	do	Greenwood, Newberry, Saluda.

See footnotes at end of table.

Table 7.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Clays —Continued			
Fuller's earth:			
South Carolina SCA Services, Inc	Route 1, Box 55 Pinewood, SC 29125	Mine and plant	Sumter.
Kaolin:			
Dixie Clay Co	Box B Bath, SC 29816	____do_____	Aiken.
J. M. Huber Corp	Box 306 Langley, SC 29834	____do_____	Do.
Colemanite:			
Industrial Minerals, Inc	Box 459 York, SC 29745	Plant	York.
Feldspar, crude:			
Spartan Minerals Corp., a division of Lithium Corp. of America.	Box 520 Pacolet, SC 29372	____do_____	Spartanburg.
Gold:			
Diversified Machine Products Inc.[2]	Box 188 Roebuck, SC 29376	Mine	Cherokee.
Manganiferous ore:			
Ashe Brick Co	Van Wyck, SC 29744	____do_____	Do.
Broad River Brick Co., a division of Boren Clay Products.	Box 368 Pleasant Garden, NC 27313	____do_____	Do.
Fletcher Brick Co., a division of Moland-Drysdale Corp.	Box 2150 Hendersonville, NC 28739	____do_____	Do.
Mica (sericite):			
Mineral Mining Corp	Box 458 Kershaw, SC 29067	Mine and plant	Lancaster.
Sand and gravel:			
Asphalt Products Corp	Mineral Springs Rd. Darlington, SC 29532	Pit and plant	Chesterfield, Dillon, Florence.
Becker Sand and Gravel Co., Inc	Box 848 Cheraw, SC 29520	Pits and plants	Chesterfield, Dorchester, Florence, Marlboro, Sumter.
Brewer Sand Co. Inc	Route 2 Lancaster, SC 29720	Pit and plant	Lancaster.
Foster-Dixiana Sand Co	Box 5447 Columbia, SC 29250	____do_____	Lexington.
Pennsylvania Glass Sand Corp	Box 84 Cayce, SC 29033	____do_____	Do.
Stone:			
Granite, crushed and broken:			
Lone Star Industries, Inc	Box 5185 Columbia, SC 29205	Quarry and plant	Fairfield, Greenwood, Richland.
Martin Marietta Aggregates	Box 1758 Columbia, SC 29202	____do_____	Fairfield, Lexington, Richland, York.
Vulcan Materials Co	Drawer 8834 Greenville, SC 29604	____do_____	Greenville, Laurens, Pickens, Spartanburg.
Granite, dimension:			
Comolli Granite Co	R.F.D. 2, Box 297 Kershaw, SC 29067	Quarry	Kershaw.
Matthews International, Corp	Penn Circle East Pittsburgh, PA 15206	____do_____	Do.
Limestone, crushed:			
Martin Marietta Aggregates	Box 1758 Columbia, SC 29202	Quarry and plant	Berkeley and Georgetown.
Vulcan Materials Co	Drawer 8834 Greenville, SC 29604	____do_____	Cherokee.
Ware Brothers Construction Co	Box 626 Moncks Corner, SC 29461	Quarry	Berkeley.
Marl, crushed:			
Giant Portland & Masonry Cement Co.	Box 218 Harleyville, SC 29448	Pit	Dorchester.
Gifford-Hill & Co., Inc	Box 326 Harleyville, SC 29448	____do_____	Do.
Santee Portland Cement Co	Box 698 Holly Hill, SC 29059	____do_____	Orangeburg.
Vermiculite, crude and exfoliated:			
W. R. Grace & Co	Route 1 Enoree, SC 29335	Mine and plant	Greenville and Laurens.
Patterson Vermiculite Co	____do_____	____do_____	Laurens.

[1]Also kaolin.
[2]Also silver and copper.

The Mineral Industry of South Dakota

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the South Dakota Geological Survey for collecting information on all nonfuel minerals.

By James H. Aase[1]

Nonfuel mineral production in South Dakota during 1981 was valued at $193.4 million, a 15% decrease from the 1980 record high. This decrease was attributed principally to lower prices for gold, coupled with reduced output for most of the other mineral commodities.

Among the 12 nonfuel minerals produced during 1981, 7 increased in output value and 4 gained in production over those of 1980. Gold, the leading commodity produced in terms of value, constituted 66% of the State's total nonfuel mineral value. Among the nonmetallic minerals, stone led in output value, followed by cement and sand and gravel.

South Dakota was ranked 33d nationally in 1981 for the value of its nonfuel mineral production. Of the Nation's total gold output, the State contributed 20% in value but less than 1% of the Nation's total value of cement, clays, feldspar, gem stones, gypsum, lime, mica, sand and gravel, silver, and stone.

Table 1.—Nonfuel mineral production in South Dakota[1]

Mineral	1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry thousand short tons	6	$377	6	$454
Portland do	459	23,042	450	23,290
Clays[2] do	169	283	116	209
Gem stones	NA	50	NA	70
Gold (recoverable content of ores, etc.) troy ounces	r267,642	r163,947	278,162	127,854
Mica, scrap thousand short tons	(3)	4	W	W
Sand and gravel do	4,209	8,243	p4,000	p7,900
Silver (recoverable content of ores, etc.) thousand troy ounces	51	1,058	56	587
Stone:				
Crushed thousand short tons	3,151	8,942	2,985	9,085
Dimension do	42	15,035	50	17,543
Combined value of beryllium concentrate (1981), clays (bentonite), feldspar, gypsum, iron ore (1980), lime, and value indicated by symbol W	XX	6,873	XX	6,382
Total	XX	r227,854	XX	193,374

pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes bentonite; value included in "Combined value" figure.

[3]Less than 1/2 unit.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Beadle	$43	$54	Sand and gravel.
Brookings	718	463	Do.
Brown	461	278	Do.
Brule	W	W	Do.
Butte	W	W	Clays, sand and gravel.
Campbell	W	W	Sand and gravel.
Charles Mix	216	227	Do.
Clark	W	76	Do.
Clay	44	48	Do.
Codington	498	W	Do.
Corson	11	10	Do.
Custer	W	W	Stone, feldspar, sand and gravel.
Davison	101	246	Sand and gravel.
Day	121	82	Do.
Deuel	W	95	Do.
Dewey	54	--	
Douglas	W	W	Sand and gravel.
Fall River	968	433	Sand and gravel, stone.
Faulk	75	67	Sand and gravel.
Grant	W	W	Stone, sand and gravel.
Gregory	51	218	Sand and gravel.
Haakon	18	--	
Hamlin	W	W	Sand and gravel.
Hand	W	W	Do.
Hanson	W	W	Stone, sand and gravel.
Hughes	W	W	Sand and gravel.
Hutchinson	92	W	Do.
Hyde	150	50	Do.
Jerauld	54	43	Do.
Jones	35	31	Do.
Kingsbury	22	W	Do.
Lake	W	222	Do.
Lawrence	77,429	166,606	Gold, silver, iron ore, stone, sand and gravel.
Lyman	44	49	Sand and gravel.
McCook	W	--	
McPherson	W	W	Sand and gravel.
Marshall	W	W	Do.
Meade	W	W	Gypsum, sand and gravel, stone.
Miner	19	35	Sand and gravel.
Minnehaha	W	3,586	Stone, sand and gravel.
Moody	159	W	Sand and gravel.
Pennington	W	W	Cement, lime, stone, sand and gravel, clays, mica.
Perkins	230	W	Sand and gravel.
Potter	113	67	Do.
Roberts	W	W	Do.
Sanborn	W	W	Do.
Spink	133	W	Do.
Sully	34	347	Do.
Tripp	5	220	Sand and gravel, stone.
Turner	W	74	Sand and gravel.
Union	156	79	Do.
Walworth	106	43	Do.
Yankton	429	W	Sand and gravel, stone.
Ziebach	W	--	
Undistributed[2]	66,103	54,109	
Total[3]	148,686	227,854	

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: Aurora, Bennett, Bon Homme, Buffalo, Edmunds, Harding, Jackson, Lincoln, Mellette, Shannon, Stanley, and Todd.

[2]Includes gem stones, sand and gravel 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 South Dakota business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	325.5	334.9	+2.9
Unemployment	do	16.9	15.8	-6.5
Employment (nonagricultural):				
Mining[1]	do	2.8	2.9	+3.6
Manufacturing	do	26.1	25.8	-1.2
Contract construction	do	10.7	9.9	-7.5
Transportation and public utilities	do	13.3	12.8	-3.8
Wholesale and retail trade	do	65.1	64.4	-1.1
Finance, insurance, real estate	do	11.1	11.3	+1.8
Services	do	50.3	51.5	+2.4
Government	do	58.6	58.2	-.7
Total nonagricultural employment[1]	do	238.0	236.8	-.5
Personal income:				
Total	millions	$5,408	$6,028	+11.5
Per capita		$7,818	$8,793	+12.5
Construction activity:				
Number of private and public residential units authorized		3,100	1,613	-48.0
Value of nonresidential construction	millions	$63.1	$69.9	+10.8
Value of State road contract awards	do	$57.5	$60.5	+5.2
Shipments of portland and masonry cement to and within the State	thousand short tons	263	243	-7.6
Nonfuel mineral production value:				
Total crude mineral value	millions	$227.9	$193.4	-15.1
Value per capita, resident population		$330	$280	-15.2
Value per square mile		$2,955	$2,510	-15.1

[p]Preliminary.
[1]Includes oil and gas extraction.

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

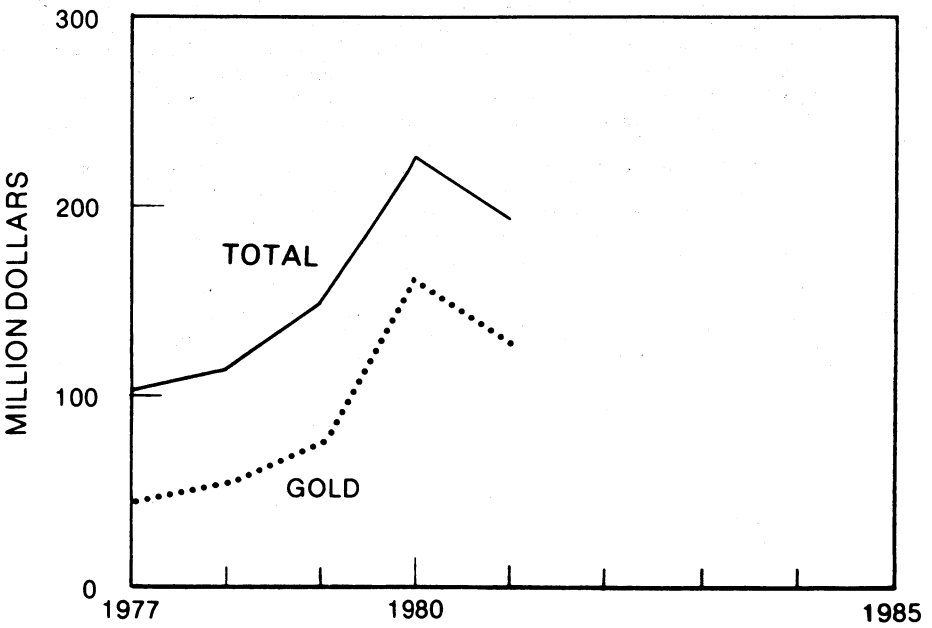

Figure 1.—Value of mine production of gold and total value of nonfuel mineral production in South Dakota.

Employment.—According to preliminary figures released by the South Dakota Department of Labor, average employment in the mining industry during 1981 totaled 2,900 workers, a 7.4% increase compared with that of 1980. Mining industry workers represented about 1.2% of the State's total nonagricultural workforce. During the last quarter of 1981, those engaged in mining received average weekly earnings of $414, a 10% increase over that for the same period in 1980.

Trends and Developments.—In 1981, the State issued 15 nonfuel mineral exploration permits, about the same number as in 1980. Most of the permits were issued for precious metals.

At the Homestake gold mine in Lead, the company continued to expand bulk-mining techniques, first introduced in 1978, to offset and control rising costs in the labor-intensive cut-and-fill mining method being used. During 1981, the Homestake Mine derived approximately 43% of its production from bulk mining. In addition, the company mechanized certain cut-and-fill stopes with new types of equipment designed to increase efficiency and continued planning for deep-level mining where exploration was encouraging. Ore was produced in more than 100 different areas of the mine to a depth of 6,800 feet. Production from the 7,100-foot level was scheduled to commence in 1982. The company continued work on an engineering design for deepening an internal shaft, the No. 4 winze, to the 8,000-foot level.[2]

Early in the year, Homestake Mining Co. announced that it was considering a surface mining operation for gold on property adjoining its underground mine in Lead. Known locally as the "Open Cut," the area is the site of the original gold discovery and mining activity in the northern Black Hills and has not been worked for approximately 35 years. The area is a surface occurrence of low-grade gold reserves partly overlying abandoned underground workings. The company estimated that 10 tons of ore would be required to recover 1 ounce of gold.

In early March, South Dakota enacted legislation setting a severance tax of 6% of the gross yield from the sale of precious metals (gold and silver) severed in the State. The new tax replaced a net profits production tax on precious metal production. In August, Homestake Mining Co. filed a lawsuit against South Dakota, challenging the 1-month-old tax. In its suit, Homestake alleged the legislation unconstitutionally discriminated against its Lead operation, the only one in the State subject to the tax.

A Canadian company, Wharf Resources, Ltd., of Vancouver, British Columbia, began experimenting with a process to extract gold by sprinkling a cyanide solution over low-grade ore. If the so-called "heap leaching" process proves to be economically feasible for treating the ore, the company indicated that commercial development of the estimated 5-million-ton ore reserve could begin in 1982. Wharf Resources, Ltd., is the second company to recently experiment with heap leaching of gold in the Black Hills area. Cyprus Exploration Co., a subsidiary of Amoco Minerals Co., tried the process in 1980 on ore tailings at the Gilt Edge Mine on Strawberry Hill near Deadwood. Cyprus was reportedly studying the results of these tests during the year.

In cooperation with the Upper Great Lakes Regional Commission and the State of South Dakota, the U.S. Geological Survey (USGS) completed a project identifying and summarizing environmental and land use permits the State required for developing energy, mineral, and other related natural resources. The findings, published as a guidebook[3] available to all interested groups, provide concise, easy-to-use information on the State regulations that govern the development of such resources.

Throughout 1981, the Geologic Division of the USGS continued a program investigating the State's mineral resources and its underlying geology. Among the various projects underway or completed by the Geologic Division during the year were reports on the origin of lithium-rich magmas and on iron in spodumene in the Keystone pegmatite area of the Black Hills; a study of the mineral resource potential on Indian lands; and a study of geology, geophysics, and mineral potential of buried Precambrian rock.

Legislation and Government Programs.—Among the bills the 1981 session of the South Dakota legislature enacted that affect the mining industry and mineral-resource development activities in the State were the following:

HB 1311.–Precious Metals Tax.—Changes precious metals tax from a tax on net profits to a severance tax of 6% of gross yield from sales of precious metals severed in the State, retroactive to January 1, 1981. The measure exempts producers of

less than 1,000 ounces per year.

Senate Concurrent Resolution 19.—Mining Law Study.—Requests that an interim committee be established to study the mining laws of the State and to report to the next session of the legislature.

Throughout most of the year, the Legislative Research Council Select Committee on Mining directed efforts toward revising, updating, and consolidating the State mining laws. After holding numerous public hearings with various interest groups, the committee completed its investigative work near yearend and recommended a series of changes in the exploration, mining, and milling laws for the 1982 legislature's consideration.

By Executive Order 81-02, the Governor transferred the functions of the surface mining program (including oil and gas exploration) from the Department of Agriculture to the Department of Water and Natural Resources, effective July 1, 1981.

REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Beryllium.—Bland Mining reported a small amount of beryllium ore production from the Roosevelt and Beecher Mines in Custer County during 1981.

Gold.—South Dakota was ranked second nationally behind Nevada in gold production for the year, with the Homestake Mine at Lead yielding most of the State output. Minor amounts of gold were produced from a placer operation near Deadwood in Lawrence County. Although the quantity of gold produced in 1981 increased about 4% over 1980 output, the value of 1981 production was about 22% lower, owing to major declines in gold prices during the year; the average price dropped about $153 per troy ounce to $460.

The average recovery grade of the 1,848,303 tons of lode mine ore processed in 1981 was 0.15 ounce per ton of gold content, and that of the approximately 5,000 cubic yards of placer ore washed was about 0.04 ounce per cubic yard of material handled.

According to the Homestake Mining Co. 1981 annual report, ore reserves at the Homestake Mine in Lead were estimated at 19,335,000 tons in 1981 with an average grade of 0.204 ounce per ton. Average cost per ounce of gold produced at the mine increased to $342 in 1981 from $308 in 1980, resulting primarily from increased labor costs and higher severance taxes. The severance tax paid to the State on gold sold from the Lead operation was $27.31 per ounce, totaling $7,493,000, nearly 23% of the mine's operating earnings in 1981.

Table 4.—South Dakota: Mine production of gold and silver in terms of recoverable metal

Year	Mines producing		Material sold or treated[1] (thousand metric tons)	Gold (lode and placer)		Silver (lode and placer)	
	Lode	Placer		Troy ounces	Value (thousands)	Thousand troy ounces	Value (thousands)
1977	1	1	1,432	304,846	$45,212	69	$317
1978	1	--	1,442	285,512	55,261	53	287
1979	1	--	1,297	245,912	75,618	58	643
1980	1	r1	1,621	r267,642	r163,947	51	1,058
1981	1	1	1,677	278,162	127,854	56	587
1876-1981	NA	NA	NA	37,808,733	1,677,111	13,505	14,601

rRevised. NA Not available.
[1]Excludes placer gravel.

Silver.—The State's entire silver production during the year was obtained as a coproduct with the gold produced at the Homestake Mine in Lead. Output in 1981 increased 10% in quantity but fell 45% in total value from that of 1980 because of lower silver prices; the average price dropped 49% to $10.52 per troy ounce.

NONMETALS

Cement.—Cement manufactured in South Dakota during 1981 came exclusively from the State-owned plant at Rapid City. Cement shipments during the year, consisting of four types of portland cement and a prepared masonry cement, decreased 2% in

quantity but increased slightly in value over that of the previous year. The average unit values of both the portland and masonry cement sold in 1981 reached record highs of $51.73 per ton and $79.63 per ton, respectively.

Ready-mix concrete companies were the largest users of portland cement, consuming 63% of the 1981 shipments. Approximately 840,000 tons of State-produced nonfuel minerals was consumed in manufacturing the cement produced in South Dakota during 1981.

Clays.—American Colloid Co. operated the State's only bentonite processing plant, near Belle Fourche in Butte County. The plant processed crude material obtained from sources within the State and from Montana and Wyoming. Output from the plant increased both in quantity and value over the levels attained in 1980.

The processed bentonite was marketed for many uses: As an ingredient in oil and gas drilling mud; as a binder for animal feed; as waterproofing sealants; as a binder for iron ore pellets; in foundry sand; and for other miscellaneous uses. Bentonite accounted for the greatest percentage of the total clay value credited to the State in 1981.

Common clay and shale output dropped in quantity and value from that of 1980. Production in 1981 was from pits the South Dakota Cement Commission and Dakota Block Co. operated in Pennington County. Most of the output was used in cement manufacturing, and the remainder, in concrete blocks and structural concrete products.

Feldspar.—Pacer Corp. processed hand-cobbed crude feldspar, obtained from mines in Custer County, at its grinding mill at Custer. The quantity and value of crude feldspar mined decreased from levels attained in 1980.

Among the end uses of the processed material marketed during the year were pottery and enamel. The processed material was shipped to more than a dozen States as well as to foreign countries.

Gem Stones.—No commercial operations for mining gem stones were reported in South Dakota in 1981. Although no precise value is known for material that rockhounds, mineral collectors, and other hobbyists collected, it is estimated that the amount did not exceed $70,000.

Gypsum.—State gypsum production in 1981 came from a single mine the South Dakota Cement Commission operated in Pennington County. Production, less in quantity and value than in 1980, was used exclusively in cement manufacturing.

Lime.—The State's entire lime production during 1981 was from the Pete Lien & Sons, Inc., plant in Rapid City. Output for the year was down slightly in quantity but was higher in total value compared with that of 1980.

Lime consumption in South Dakota, obtained from all domestic sources, was approximately 22,000 tons in 1981.

Mica.—Concepts West, Inc., and Pacer Corp. reported mica production from the Tin Crown and Brite-X Mines, respectively, in Custer County, and Pendleton Mining Co. reported production from the Woodtin Mine in Pennington County. The material produced was used primarily in well drilling and in manufacturing roofing products.

Sand and Gravel.—To reduce reporting burdens and costs, the Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for 1981 production of construction sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and made final the following year.

Table 5.—South Dakota: Construction sand and gravel sold or used by producers

	1980			1981[p]		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Sand	1,168	$2,941	$2.52	NA	NA	NA
Gravel	3,041	5,302	1.74	NA	NA	NA
Total or average	4,209	8,243	1.96	4,000	$7,900	$1.98

[p]Preliminary. NA Not available.

Stone.—Granite, limestone, and sandstone or quartzite were produced in the State during 1981. Of all nonmetallic minerals produced during the year, stone was ranked first in value, accounting for 41% of the State's total value of nonmetallic mineral output.

Stone production dropped slightly in quantity but rose modestly in value compared with 1980 levels. In 1981, 15 firms mined stone from 20 quarries in 9 counties. Pennington County led in crushed stone output; all dimension stone came from Grant County.

Table 6.—South Dakota: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Concrete aggregate	1,222	4,437	1,159	4,327
Bituminous aggregate	275	801	337	1,130
Dense-graded road base stone	217	W	W	W
Surface-treatment aggregate	42	108	35	117
Other construction aggregate and road stone	W	46	50	99
Riprap and jetty stone	98	429	112	491
Railroad ballast	187	542	171	567
Lime manufacture	210	398	179	359
Other[2]	901	2,181	941	1,994
Total[3]	3,151	8,942	2,985	9,085

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone and sandstone.
[2]Includes stone used as agricultural limestone, in cement manufacture, other uses not specified, and data indicated by symbol W.
[3]Data may not add to totals shown because of independent rounding.

Table 7.—South Dakota: Stone sold or used by producers, by kind

(Thousand short tons and thousand dollars)

Kind of stone	1980		1981	
	Quantity	Value	Quantity	Value
Dimension stone, total[1]	42	15,035	50	17,543
Crushed and broken:				
Limestone	2,237	5,428	2,048	5,278
Sandstone	914	3,515	937	3,807
Total	3,193	[2]23,977	3,035	26,628

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

Limestone output, exceeding that of any other rock type, came from 10 quarries in Custer, Fall River, Lawrence, Meade, Pennington, and Yankton Counties. The mined material was crushed and used most extensively as an aggregate in concrete and in cement manufacturing.

Six companies quarried granite at seven sites in Grant County. Most of the output was dimension granite used for monuments. Three companies produced sandstone or quartzite at three sites in Hanson and Minnehaha Counties. Most of the output was used as an aggregate for concrete; lesser amounts were used as bituminous aggregate, railroad ballast, riprap, and surface-treatment aggregate.

Approximately three-fourths of South Dakota's 1981 stone production was from the operations of four firms. The range of output from individual quarry operations in 1981 varied widely, with 10 quarries producing less than 25,000 tons; 5 quarries, between 25,000 and 200,000 tons; 3 quarries, between 200,000 and 500,000 tons; and 2 quarries producing in excess of 500,000 tons. Approximately 70% of the crushed stone produced during the year was transported by truck; the remainder was handled by rail.

[1]State Liaison Officer, Bureau of Mines, Minneapolis, Minn.
[2]Homestake Mining Co. 1981 Annual Report, p. 12.
[3]U.S. Geological Survey. South Dakota Permit Requirements for Natural Resources Development. September 1981, 76 pp.

Table 8.—Principal producers

Commodity and company	Address	Type of activity	County
Beryllium concentrate:			
Bland Mining	Rte. 3, Box 18 Custer, SD 57730	Mines	Custer.
Cement:			
South Dakota Cement Commission.	Box 360 Rapid City, SD 57709	Four rotary kilns	Pennington.
Clays:			
American Colloid Co	5100 Suffield Ct. Skokie, IL 60076	Open pit mine and plant	Butte.
Dakota Block Co	Box 2920 Rapid City, SD 57709	____do	Pennington.
South Dakota Cement Commission.	Box 360 Rapid City, SD 57709	Open pit mine	Do.
Feldspar:			
Pacer Corp	Box 912 Custer, SD 57730	Open pit mines and dry-grinding plant.	Custer.
Gold:			
Homestake Mining Co	Box 875 Lead, SD 57754	Underground mine, cyanidation mill, refinery.	Lawrence.
Strawberry Hill Mining Co	Box 645 Deadwood, SD 57732	Placer	Do.
Gypsum:			
South Dakota Cement Commission.	Box 360 Rapid City, SD 57709	Open pit mine	Pennington.
Lime:			
Pete Lien & Sons, Inc	Box 440 Rapid City, SD 57709	1 rotary kiln, 1 vertical kiln, continuous-hydrator plant.	Do.
Mica:			
Concepts West, Inc	Box 706 Rapid City, SD 57709	Mine and dry-grinding plant.	Custer.
Pacer Corp	Box 912 Custer, SD 57730	____do	Do.
Pendleton Mining Co	Box 286 Keystone, SD 57751	Mine	Pennington.
Sand and gravel (1980):			
Birdsall Sand & Gravel Co., Inc.	Box 767 Rapid City, SD 57709	Pits and plants	Fall River, Pennington, Sully.
Concrete Materials, Inc	Summit, SD 57266	Pit and plant	Roberts.
L. G. Everist, Inc	302 Paulton Bldg. Sioux Falls, SD 57102	Pits and plants	Brookings, Pennington, Yankton.
Fodness Gravel	Route 5 Sioux Falls, SD 57101	Pit and plant	Minnehaha.
Luke Construction Co	Kimball, SD 57355	____do	Brule.
F. J. McLaughlin Co	Box 13 Watertown, SD 57201	____do	Codington.
N & M Construction, Inc	Box 337 Sturgis, SD 57785	____do	Meade.
Reynolds Construction Co	Box 689 Sioux Falls, SD 57101	____do	Minnehaha.
Silver:			
Homestake Mining Co	Box 875 Lead, SD 57754	*See* Gold	Lawrence.
Stone:			
Granite:			
Cold Spring Granite Co	Cold Spring, MN 56320	Quarries	Grant.
Dakota Granite Co	Box 1351 Milbank, SD 57252	Quarry	Do.
Delano Granite Works, Inc	Delano, MN 55328	____do	Do.
Robert Hunter Granite Co., Inc.	501 East Drake St. Milbank, SD 57252	____do	Do.
Limestone:			
Centennial Quarry Co	Box 311 Spearfish, SD 57783	Quarry and plant	Lawrence.
Pete Lien & Sons, Inc	Box 440 Rapid City, SD 57709	Quarries and plants	Custer and Pennington.
Northwestern Engineering Co. (Hills Materials Co.).	Box 1392 Rapid City, SD 57709	____do	Fall River, Meade, Pennington.
South Dakota Cement Commission.	Box 360 Rapid City, SD 57709	Quarry and plant	Pennington.
Sandstone:			
Concrete Materials Co	3000 West Madison St. Sioux Falls, SD 57102	____do	Minnehaha.
L. G. Everist, Inc	302 Paulton Bldg. Sioux Falls, SD 57102	____do	Do.
Spencer Quarries, Inc	Box 25 Spencer, SD 57374	____do	Hanson.

The Mineral Industry of Tennessee

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

By Donald K. Harrison[1] and Robert W. Johnson[2]

The value of Tennessee's nonfuel mineral production in 1981 was $417.6 million, $23.8 million more than that of 1980. Construction mineral commodities (cement, clays, sand and gravel, and stone) accounted for nearly 50% of the State's nonfuel mineral value. Other mineral commodities produced included barite, copper, lime, phosphate rock, pyrites, zinc, and byproduct silver and gold. In addition, imported mineral commodities including alumina, perlite, rare earths, titanium, and vermiculite were processed into higher value products.

In 1981, Tennessee was the Nation's leading producer of zinc, ball clay, and pyrites ranked second in ferroalloy shipments and synthetic graphite production, fourth in phosphate rock production, and fifth in primary aluminum output.

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

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:					
Masonry	thousand short tons	132	$7,241	66	$3,209
Portland	do.	1,304	58,827	974	39,378
Clays	do.	1,188	22,844	1,047	23,134
Gem stones		NA	1	NA	5
Phosphate rock	thousand metric tons	1,582	12,765	1,328	16,201
Sand and gravel	thousand short tons	8,921	24,930	[p]7,942	[p]26,210
Stone:					
Crushed	do.	38,584	126,993	[2]32,497	[2]113,729
Dimension	do.	10	883	11	1,063
Zinc (recoverable content of ores, etc.)	metric tons	[r]111,754	[r]92,218	117,684	115,597
Combined value of barite, copper, gold (1981), lime, pyrites, silver, and stone (crushed, 1981)		XX	47,133	XX	79,092
Total		XX	[r]393,835	XX	417,618

[p]Preliminary. [r]Revised. NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes some crushed stone; value included with "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Anderson	W	W	Stone, clays.
Bedford	W	W	Stone.
Benton	W	W	Stone, sand and gravel.
Bledsoe	$106	$114	Stone.
Blount	W	W	Do.
Bradley	W	W	Do.
Campbell	W	W	Stone, sand and gravel.
Cannon	W	W	Stone.
Carroll	W	W	Sand and gravel, clays.
Carter	W	W	Stone.
Claiborne	W	W	Do.
Clay	W	W	Do.
Cocke	192	219	Do.
Coffee	W	W	Stone, sand and gravel.
Cumberland	W	W	Do.
Davidson	W	W	Stone, cement, clays.
Decatur	W	W	Stone, sand and gravel.
DeKalb	W	W	Stone.
Dickson	W	W	Do.
Dyer	217	364	Sand and gravel.
Fayette	108	W	Do.
Fentress	W	811	Stone, sand and gravel.
Franklin	W	W	Stone, cement, clays.
Gibson	W	W	Clays.
Giles	W	W	Phosphate rock, stone, sand and gravel.
Grainger	W	W	Zinc, stone.
Greene	W	W	Stone, sand and gravel.
Grundy	W	186	Stone.
Hamblen	W	W	Do.
Hamilton	29,824	28,502	Cement, stone, sand and gravel, clays.
Hardeman	1	W	Sand and gravel.
Hardin	W	W	Stone, sand and gravel.
Hawkins	W	W	Stone.
Henry	9,303	7,687	Clays, sand and gravel.
Hickman	W	W	Phosphate rock.
Humphreys	W	W	Sand and gravel, stone.
Jackson	W	W	Stone.
Jefferson	42,534	58,959	Zinc, stone.
Johnson	W	W	Stone.
Knox	33,689	52,403	Cement, stone, zinc, lime, sand and gravel, clays.
Lauderdale	92	W	Sand and gravel.
Lawrence	1,000	685	Stone, sand and gravel.
Lincoln	W	W	Stone.
Loudon	W	W	Barite, stone.
McMinn	W	W	Lime, stone.
McNairy	W	W	Sand and gravel.
Macon	W	W	Stone.
Madison	W	51	Sand and gravel.
Marion	W	8,955	Cement, stone, sand and gravel.
Marshall	W	430	Stone.
Maury	W	W	Phosphate rock, stone.
Meigs	W	W	Stone.
Monroe	W	1,438	Do.
Montgomery	W	W	Do.
Moore	W	669	Do.
Morgan	--	54	Do.
Obion	817	578	Sand and gravel.
Overton	W	W	Stone, sand and gravel.
Pickett	25	75	Stone.
Polk	43,321	40,170	Copper, pyrites, zinc, silver.
Putnam	W	W	Stone, sand and gravel.
Rhea	W	W	Stone.
Roane	W	W	Stone, sand and gravel.
Robertson	W	W	Stone.
Rutherford	2,667	2,504	Do.
Sequatchie	W	W	Do.
Sevier	W	W	Stone, sand and gravel.
Shelby	9,785	8,113	Sand and gravel.
Smith	W	W	Zinc, stone.
Stewart	1,581	W	Stone, sand and gravel.
Sullivan	W	18,239	Cement, stone, clays.
Sumner	W	W	Stone.
Tipton	968	1,318	Sand and gravel.
Unicoi	W	W	Stone, sand and gravel.
Union	4,124	4,746	Do.
Van Buren	--	110	Stone.
Warren	W	W	Do.
Washington	253	W	Stone, clays.
Wayne	W	W	Sand and gravel.

See footnotes at end of table.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Weakley	W	$13,295	Clays.
White	W	W	Stone.
Williamson	W	W	Phosphate rock, stone.
Wilson	W	992	Stone.
Undistributed[2]	$205,140	142,169	
Total[3]	385,744	393,835	

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: Cheatham, Chester, Crockett, Hancock, Haywood, Henderson, Houston, Lake, Lewis, Perry, Scott, and Trousdale.

[2]Includes gem stones and values indicated by symbol W.

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

Table 3.—Indicators of Tennessee business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	2,004.5	2,055.7	+2.6
Unemployment	do	147.1	214.7	+46.0
Employment (nonagricultural):				
Mining[1]	do	10.1	10.2	+1.0
Manufacturing	do	502.7	506.7	+.8
Contract construction	do	81.2	76.6	-5.7
Transportation and public utilities	do	86.6	85.6	-1.2
Wholesale and retail trade	do	379.7	372.8	-1.8
Finance, insurance, real estate	do	78.7	78.1	-.8
Services	do	291.0	306.8	+5.4
Government	do	317.2	308.7	-2.7
Total nonagricultural employment[1]	do	1,747.2	1,745.5	-.1
Personal income:				
Total	millions	$35,444	$39,682	+12.0
Per capita		$7,702	$8,604	+11.7
Construction activity:				
Number of private and public residential units authorized		19,746	11,121	-43.7
Value of nonresidential construction	millions	$571.2	$529.4	-7.3
Value of State road contract awards	do	$160.0	$169.0	+5.6
Shipments of portland and masonry cement to and within the State	thousand short tons	1,503	1,300	-13.5
Nonfuel mineral production value:				
Total crude mineral value	millions	$393.8	$417.6	+6.0
Value per capita, resident population		$89	$91	+2.2
Value per square mile		$9,654	$9,886	+2.4

[p]Preliminary.

[1]Includes bituminous coal and oil and gas extraction.

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

Trends and Developments.—In Tennessee, as in the rest of the Nation, construction activity continued in a downward trend during the year. In particular, residential construction remained severely depressed. The number of private and public residential units authorized declined nearly 44% in 1981. Value of nonresidential construction also decreased 7.3% in the same period. As a result of these declines, output of most construction mineral commodities (cement, clays, sand and gravel, and stone) was lower in 1981.

Construction contract decreases would have been greater had not several areas experienced a rise over 1980 levels. World's Fair construction almost doubled local building activity in the Knoxville area. Construction activity included the building of hotels, exhibition centers, and a $225 million interstate highway improvement project in and around the city.

The sale of the Kingsport and Richard City cement plants of Penn-Dixie Industries, Inc., to a subsidiary of Moore McCormack Cement, Inc., of Stamford, Conn., was approved by the Federal Bankruptcy Court early in the year. In 1980, Penn-Dixie filed a Chapter 11 petition seeking court protection from creditors while trying to develop a plan for repayment of debts.

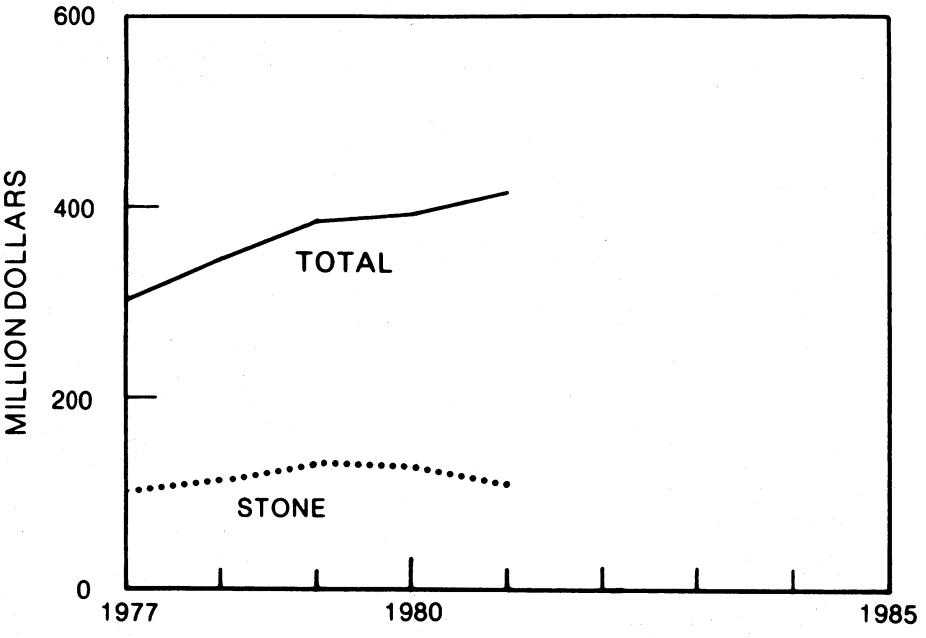

Figure 1.—Value of stone and total value of nonfuel mineral production in Tennessee.

Near yearend, Gulf + Western Industries, Inc. (G+W), announced the closing of the Idol Mine in Grainger County, citing high labor costs and depleted zinc ore reserves. Concurrently, Jersey Minière Zinc Co. (JMZ), a joint venture of G+W and Union Minière S.A. of Belgium, announced plans to double zinc concentrate output at its Middle Tennessee district operations. The expansion program would result in the completion of the Gordonsville mining and milling complex, which would eventually produce 6,000 tons of zinc concentrate per day. The existing Elmwood mining and milling complex, which has been operating at 3,000 tons per day, would be gradually phased out.

In May, Cities Service Co. announced that it was seeking a buyer for its Industrial Chemical Div. at Copperhill. The division, which employs about 400 people, produces mainly sulfuric acid, sulfur dioxide, and copper sulfate. Also included in the proposed sale was the company's copper mining and smelting operations.

Legislation and Government Programs.—Section 503 of the Federal Surface Mine Control and Reclamation Act allowed the State to enact its own legislation to implement and enforce the Federal Surface Mining Law. Near yearend, Tennessee Division of Surface Mining officials were preparing to submit the State regulation plan to the Federal Office of Surface Mining for approval by the Secretary of the Interior. If approved, the State would take over full responsibility for regulating strip mining in the State.

Since 1963, the State of Tennessee has given preferential treatment to trucking firms carrying coal, sand and gravel, and other commodities. Trucks carrying these commodities were allowed to exceed axle weight limits if they were under total maximum weight limits. In early 1981, a new truck weight law removing the exemptions went into effect, and shippers were subject to fines as high as $1,000. However, in response to protests, the law was amended in July, giving truckers a continued exemption until March 31, 1982.

In October, The New Jersey Zinc Co. (NJZ) received a ruling by an east Tennessee court on its lawsuit concerning ownership of mineral rights versus oil and gas leases. The case involved 130 acres in Jefferson County and 100 acres in Grainger County where NJZ purchased the mineral rights in the 1960's and learned in 1980 that an oil company had acquired oil and gas leases

from the surface owners of the two parcels. NJZ filed suit to protect its oil and gas rights in the parcels as well as in 14,000 other acres of mineral rights in the area.

The court ruled that NJZ was the "untrammeled owner" of all the "mineral estates" in the lands "including, but not limited to, oil and gas." Also, the court ruled that a Tennessee statute limiting oil and gas leases to 10 years did not apply to the oil and gas rights included in the ownership of the mineral rights.[3]

In December, the Tennessee Geological Survey celebrated its 150th anniversary, an occasion marked by the publication of the history of the Survey, "State Geological Surveys and State Geologists of Tennessee," Bulletin 81. During 1981, the Survey continued geologic mapping in the Kingsport area of upper east Tennessee and detailed gravity mapping of far west Tennessee. Also, an environmental geology atlas for Maury County was near completion. The Survey continued to update its Surface Mining Computer Program. Data on surface mining activities were up to date through 1980, with 3,700 operations in the system at yearend. Data on underground mining were up to date through 1978 and were being entered into the U.S. Geological Survey Computerized Resources Information Bank (CRIB).

A report on the mineral resources of Little Frog Mountain RARE II Area, Polk County, was placed on open file (MLA 23-81) by the U.S. Bureau of Mines. The report, part of a series of Mineral Land Assessment reports, is available for consultation at the Bureau's Washington Office and at its Eastern Field Operations Center, Pittsburgh, Pa.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Barite.—A. J. Smith Co. was the sole producer of barite in Tennessee in 1981. The company, which began production in 1979, operated an open pit mine and plant in Loudon County. The barite was shipped out of State for use primarily in the manufacture of paint and chemicals. In October 1980, C. R. Wood Co., Inc., discontinued mining barite at an open pit operation in Loudon County because of depleted ore reserves. As a result, production in the State dropped in 1981.

Cement.—Three companies operated four cement plants in the State in 1981. All four plants produced portland cement; three produced masonry cement. Wet-process plants were operated by General Portland, Inc., at Chattanooga and by Dixie Cement Co., Inc., a subsidiary of Moore McCormack Cement, Inc., of Stamford, Conn., at Kingsport and Richard City. Ideal Basic Industries, Inc., operated a dry-process plant in Knoxville.

Shipments of both portland and masonry cement were lower in 1981. Portland cement shipments decreased 25% while masonry cement shipments dropped 50% from that of 1980. One of the reasons for the decline was the closing of the G + W plants at Cowan and Nashville in 1980. Most of the cement was sold to ready-mix concrete companies, followed by concrete product manufacturers, highway contractors, and building material dealers.

Table 4.—Tennessee: Portland cement salient statistics

(Short tons unless otherwise specified)

	1980	1981
Number of active plants	6	4
Production	1,328,170	1,049,411
Shipments from mills:		
Quantity	1,304,075	973,594
Value	$58,827,066	$39,378,495
Stocks at mills, Dec. 31	97,483	104,726

Table 5.—Tennessee: Masonry cement salient statistics

(Short tons unless otherwise specified)

	1980	1981
Number of active plants	5	3
Production	144,041	63,731
Shipments from mills:		
Quantity	132,407	66,488
Value	$7,241,345	$3,209,305
Stocks at mills, Dec. 31	22,403	9,342

In early 1981, the Federal Bankruptcy Court approved the sale of the two Penn-Dixie cement plants at Richard City and Kingsport to Dixie Cement. The sale price was nearly $7.6 million with additional payment for inventories on hand on the closing date. In April 1980, Penn-Dixie filed a Chapter 11 petition seeking court protection from creditors while developing a plan for debt repayment.

At yearend, General Portland became a wholly owned subsidiary of Canada Cement Lafarge, Ltd., which is owned principally by Lafarge Coppee S.A. of Paris, France, one of the world's leading producers of cement. To obtain Federal Trade Commission approval of the acquisition, an agreement was reached whereby Canada Cement Lafarge must divest itself of the Signal Mountain plant in Chattanooga. The company was taking steps to sell the 477,000-ton-per-year plant, which serves the Tennessee and north Georgia markets.[4]

Clays.—Tennessee produced ball clay, bentonite, common clay, and fuller's earth. Although total clay output decreased in 1981, value remained essentially the same because of higher unit values.

The western Tennessee-Kentucky ball clay region is the major domestic source of ball clay. In 1981, nearly two-thirds of the Nation's ball clay was produced in Tennessee. The clay was mined by 4 companies at 19 operations in Carroll, Gibson, Henry, and Weakley Counties in the northwestern part of the State. Both airfloat and unprocessed ball clay was produced by Kentucky-Tennessee Clay Co. (nine operations), H. C. Spinks Clay Co., Inc. (eight operations), Cyprus Industrial Minerals Co. (one operation), and Old Hickory Clay Co. (one operation). Ball clay was used principally in the manufacture of pottery, floor and wall tile, sanitary ware, china dinnerware, oil refining catalysts, ceramics, and electrical porcelain.

Common clay and shale was produced by seven companies in eight counties. Production dropped approximately 19% in 1981 compared with that of 1980. With the exception of an increase in 1979, common clay and shale production has steadily decreased in the last 5 years; 1981 sales were only 68% of those reported in 1976.

Leading counties, in descending order of output, in 1981 were Hamilton, Knox, Sullivan, and Washington. Principal producers were General Shale Products Corp., General Portland, and Ideal Basic Industries. Common clay was used principally in the production of face and common brick, portland cement, and as a lightweight aggregate for concrete.

Table 6.—Tennessee: Clays sold or used by producers

Year and type	Quantity (short tons)	Value	
		Total	Average per ton
1980:			
Ball clay	605,584	$17,531,928	$28.95
Common clay and shale	499,809	1,171,215	2.34
Total	1,105,393	18,703,143	XX
1981:			
Ball clay	559,468	17,964,171	32.11
Common clay and shale	403,330	939,808	2.33
Total	962,798	18,903,979	XX

XX Not applicable.

Table 7.—Tennessee: Ball clay sold or used by producers, by kind and use

(Short tons)

Use	1980			1981		
	Airfloat	Unprocessed	Total	Airfloat	Unprocessed	Total
Fine china and dinnerware	28,913	--	28,913	28,967	--	28,967
Electrical porcelain	21,405	--	21,405	17,295	--	17,295
Floor and wall tile, ceramic	W	W	62,064	W	W	61,056
Pottery	W	W	174,240	W	W	152,218
Sanitary ware	W	W	66,429	W	W	60,908
Other[1]	r267,367	r184,559	[2]149,193	257,143	171,280	[2]154,241
Exports	56,459	46,881	103,340	13,751	71,032	84,783
Total	r374,144	r231,440	605,584	317,156	242,312	559,468

rRevised. W Withheld to avoid disclosing company proprietary data; included with "Other."

[1]Includes common brick; catalysts (oil refining, 1980); crockery and other earthenware; fire brick, block, and shapes; floor and wall tile; fertilizers (1980); fiberglass (1980); high-alumina refractories; rubber; mortars and cement; adhesives; pesticides and related products; kiln furniture; animal feed (1980); mineral wool and insulation (1980); chemical manufacturing textiles (1980); asphalt tile; waterproofing and sealing (1980); and uses indicated by symbol W.

[2]Incomplete total; remainder included with individual totals.

Table 8.—Tennessee: Common clay sold or used by producers, by use

(Short tons)

Use	1980	1981
Brick	279,073	217,222
Portland cement	220,736	186,108
Total	499,809	403,330

Tennessee ranked fifth among nine States that produced fuller's earth in 1981. Lowes, Inc., Henry County, operated the only fuller's earth operation in the State. The clay was used as oil and grease absorbents, as carriers for insecticides and fungicides, and as pet litter.

Fluorspar.—United States Borax & Chemical Corp., a subsidiary of Borax Holdings Ltd. of the United Kingdom, continued assessing its fluorite-barite-zinc ore body near Sweetwater in eastern Tennessee.

Graphite (Synthetic).—Synthetic graphite was manufactured by Union Carbide Corp. at plants near Columbia, Maury County, and Clarksville, Montgomery County. The company's Clarksville plant came onstream in 1981. The primary use of graphite was in the manufacture of electric-furnace electrodes. High-modulus graphite fibers were produced by the Great Lakes Carbon Corp. at a plant in Elizabethton in Carter County.

During the year, Union Carbide announced the closing of one of its Niagara Falls, N.Y., graphite plants and that the graphite specialties operations were to be moved to the Clarksburg, W. Va., facility. As part of an expansion and modernization program, some electrode production facilities were to be moved from the Clarksburg plant to the Columbia, Tenn., plant.

Lime.—Two companies produced lime in Tennessee in 1981. Tenn-Luttrell Lime Co. produced both quicklime and hydrated lime at Luttrell, near Knoxville, and Bowaters Southern Paper Corp. produced quicklime at Calhoun, McMinn County. Total lime production in the State increased 8% over 1980 levels. The lime was used principally in the steel industry and for water purification and sewage treatment.

Perlite (Expanded).—Chemrock Corp., the only producer in the State, expanded perlite at its Nashville plant from crude perlite shipped by rail from New Mexico. Most of the expanded perlite was bagged and shipped by truck; some was shipped bulk by rail. Principal uses for the product were as cavity-fill insulation, for horticultural purposes, concrete and plaster aggregate, and as a filter aid.

Phosphate Rock.—Tennessee ranked fourth in the Nation in tonnage and value of phosphate rock in 1981. The ore was produced by three companies from surface mines in four counties (Hickman, Maury, Giles, and Williamson) in the Columbia-Mount Pleasant district of south-central Tennessee. Average grade of the mined ore was 20.3% P_2O_5.

Hooker Chemical Co., Monsanto Industrial Chemicals Co., and Stauffer Chemical Co. mined and beneficiated phosphate rock for reduction to elemental phosphorus in electric furnaces. The phosphorus was subsequently converted into a wide variety of industrial chemicals.

In April, the Tennessee Valley Authority (TVA) sold the mineral rights on 1,319 acres in Williamson County to Stauffer Chemical for $29.9 million. TVA originally acquired the land in the 1930's to supply phosphate rock to its fertilizer operations at Muscle Shoals, Ala.[5]

Table 9.—Tennessee: Phosphate rock sold or used by producers

Year	Quantity (thousand metric tons)		Value	
	Rock	P_2O_5 content	Total (thousands)	Average per ton
1977	1,723	436	$14,064	$8.16
1978	1,688	434	13,833	8.19
1979	2,140	545	17,008	7.95
1980	1,665	432	13,330	8.01
1981	1,379	357	17,401	12.62

Table 10.—Tennessee: Production of phosphate rock

Year	Mine production (thousand metric tons)		Marketable production (thousand metric tons)		Value, marketable production	
	Rock	P_2O_5 content	Rock	P_2O_5 content	Total (thousands)	Average per ton
1977	3,307	665	1,747	442	$14,253	$8.16
1978	3,052	646	1,709	442	14,047	8.22
1979	3,211	670	1,873	467	14,770	r7.89
1980	2,981	602	1,582	410	12,765	8.07
1981	2,547	516	1,328	340	16,201	12.20

rRevised.

Pyrites.—Although production dropped 6% in 1981, Tennessee continued to lead the Nation in the production of pyrites, producing most of the U.S. output. Cities Service Co. at Copperhill, Polk County, was the sole producer. Pyrites were recovered by flotation from sulfide ore mined at the company's underground and surface operations. Concentrates from the plant were processed into industrial chemicals, primarily sulfuric acid. Some of the acid was used at the plant to produce other chemicals, and the remainder was shipped to other industries.

Sand and Gravel.—The U.S. Bureau of Mines, to reduce reporting burdens and costs, implemented new sand and gravel canvassing procedures for the survey of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel operators will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but contains complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Based on these preliminary estimates, output of construction sand and gravel decreased 22% in 1981, and average value per ton increased from $2.63 per ton in 1980 to $3.03 in 1981. Principal uses were for concrete and asphaltic aggregates, road base, and fill.

Industrial sand was produced by three companies in Benton, Campbell, and Carroll Counties. Principal uses were for flat glass and foundry and coal washing.

Near yearend, UNIMIN Corp. of New Canaan, Conn., was evaluating sandstone formations in Hawkins County for industrial sand applications. The company currently produces silica sand for use in fiberglass.

Table 11.—Tennessee: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	4,668	$11,689	$2.50	NA	NA	NA
Gravel	4,008	11,134	2.78	NA	NA	NA
Total or average	8,676	[1]22,824	2.63	pe6,800	pe$20,600	pe$3.03
Industrial sand	244	2,106	r8.63	1,142	5,610	4.91
Grand total or average	[1]8,921	24,930	2.79	pe7,942	pe26,210	pe3.30

pePreliminary. rRevised. NA Not available.
[1]Data do not add to total shown because of independent rounding.

Stone.—Stone ranked second, after zinc, in nonfuel mineral sales, accounting for 27% of the State's nonfuel mineral value. Crushed limestone accounted for virtually all of the stone produced in the State. In 1981, 83 companies operated 129 quarries in 65 counties. Leading producers were Vulcan Materials Co.; American Limestone Co.;

Ralph Rogers & Co., Inc.; and Koppers Co. Principal uses were for road base, concrete, bituminous and macadam aggregates, and agricultural limestone.

Dimension sandstone was produced by four companies in Cumberland and Fentress Counties. The four producers were Turner Bros. Stone of Crossville, Inc.; Crab Orchard Stone Co., Inc.; Ross L. Brown Cut Stone Co., Inc.; and the Mountain Stone Co. Principal uses were for rubble, house stone veneer, and cut stone.

Both crushed and dimension marble were produced in the State. John J. Craig Co. operated a quarry in Blount County, and Imperial Black Marble Corp. quarried marble in Grainger County. Crushed marble was used as terrazzo and exposed aggregate; dimension marble was sold or used as rough block and sawed stone.

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

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	1,864	5,973	1,702	5,562
Poultry grit and mineral food	448	2,271	242	1,598
Concrete aggregate	5,182	16,933	4,142	14,392
Bituminous aggregate	2,817	8,860	2,574	8,780
Macadam aggregate	2,034	6,320	1,794	5,988
Dense-graded road base stone	11,888	37,951	9,900	32,492
Surface-treatment aggregate	1,492	4,773	1,595	5,275
Other construction aggregate and road stone	7,477	23,142	5,562	17,974
Riprap and jetty stone	595	1,842	495	1,648
Railroad ballast	218	660	215	723
Filter stone	255	873	209	756
Manufactured fine aggregate (stone sand)	1,127	4,647	1,006	4,607
Terrazzo and exposed aggregate	W	W	(2)	1
Cement manufacture	1,783	5,383	1,564	5,195
Lime manufacture	324	1,171	235	1,076
Flux stone	—	—	58	290
Refractory stone	W	W	22	107
Asphalt filler	W	W	57	273
Whiting	W	W	10	94
Other fillers or extenders	W	W	636	4,494
Glass manufacture	246	983	310	1,548
Waste materials	W	W	18	41
Other[3]	835	5,214	151	815
Total[4]	38,584	126,993	32,497	113,729

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]1980 figures include limestone and marble.
[2]Less than 1/2 unit.
[3]Includes stone used in mine dusting, roofing granules (1980), sulfur removal from stack gases, other uses not specified (1980), and items indicated by symbol W.
[4]Data may not add to totals shown because of independent rounding.

Table 13.—Tennessee: Dimension stone[1] sold or used by producers, by use

Use	1980			1981		
	Short tons	Cubic feet (thousands)	Value (thousands)	Short tons	Cubic feet (thousands)	Value (thousands)
Rough stone:						
Irregular-shaped stone	150	2	$5	90	1	$2
Rubble	3,680	47	166	W	W	W
Flagging	652	8	29	W	W	W
Dressed stone:						
Cut stone	1,412	18	323	1,527	20	425
Sawed stone	739	8	159	W	W	W
House stone veneer	W	W	W	W	W	74
Monumental	6	(2)	1	W	W	W
Flagging	73	1	18	W	W	16
Other[3]	3,606	41	184	9,304	109	544
Total[4]	10,318	125	883	10,921	130	1,063

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes marble and sandstone.
[2]Less than 1/2 unit.
[3]Includes stone used in rough blocks.
[4]Data may not add to totals shown because of independent rounding.

Vermiculite (Exfoliated).—Construction Products Div. of W. R. Grace & Co. exfoliated crude vermiculite at its plant in Nashville. The crude vermiculite was shipped from the company's mining operations in Montana and South Carolina. Principal uses were for block and loose-fill insulation, concrete aggregate, horticulture, and plaster aggregate.

METALS

Aluminum.—Tennessee ranked fifth in the Nation in primary aluminum output, dropping from fourth place in 1980. Aluminum Co. of America (Alcoa), Blount County, and Consolidated Aluminum Corp. (Conalco), Humphreys County, produced primary aluminum from alumina shipped in from out of State.

Weak demand from the automobile and construction markets forced most aluminum producers to curtail production. Near yearend, Conalco shut down a 35,500-ton-per-year potline at its 142,000-ton-per-year New Johnsonville smelter and delayed plans to build an aluminum sheet rolling mill at the site. The company also decided to delay a proposed expansion at its Jackson sheet rolling mill facilities.

Reduced demand for aluminum also forced Alcoa to announce plans to eliminate 55,000 tons, or 25%, of the Alcoa, Tenn., smelter's capacity in early 1982. The shutdown will result in the layoffs of approximately 200 workers at the company's fabricating plant and smelter.

Copper.—Tennessee and Michigan were the only copper-producing States in the Eastern United States. Cities Service, Polk County, was Tennessee's only producer. The company operated the Copperhill facilities, which included two underground mines (Calloway and Cherokee), an open pit mine, an ore beneficiation plant, and a metallurgical-chemical processing complex. A third underground mine (Boyd) was closed in early 1981. The Cherokee Mine is the major underground operation with a production capacity of 1 million tons per year.[6] Overall mining and milling capacity at Copperhill was estimated at 2.2 million tons per year. Proven and probable ore reserves as of September 1981 were calculated to be 23 million tons containing 0.92% copper and 23.8% sulfur.[7]

At Copperhill, the ore was separated into copper, pyrite, and zinc concentrates. Copper smelting facilities consisted of a copper roaster, electric furnace, and twin converters. The combined gas streams from the copper smelter and iron roasters were then processed at two large double-absorption sulfuric acid plants.[8]

In 1981, copper output increased 3%, although value dropped 14% compared with that of 1980. Value decreased because of low demand and weak copper prices, which were said to be below production costs for the entire year.[9]

In May, Cities Service announced that it was seeking a buyer for its Industrial Chemical Div. at Copperhill, which includes the copper mining and smelting operations.

Table 14.—Tennessee: Mine production (recoverable) of gold, silver, copper, and zinc

	1979	1980	1981
Mines producing: Lode	11	11	11
Material sold or treated:			
Ore:			
Copper-zinc thousand metric tons	1,901	1,901	1,784
Zinc do.	3,256	r4,335	4,512
Total[1] do.	5,157	r6,237	6,295
Production:			
Quantity:			
Gold troy ounces	--	--	W
Silver do.	W	W	W
Copper metric tons	W	W	W
Zinc do.	85,119	r111,754	117,684
Value:			
Gold thousands	--	--	W
Silver do.	W	W	W
Copper do.	W	W	W
Zinc do.	$69,995	r$92,218	$115,597

rRevised. W Withheld to avoid disclosing company proprietary data.
[1]Data may not add to totals shown because of independent rounding.

Ferroalloys.—Tennessee ranked second in the Nation, behind Ohio, in shipments of ferroalloys in 1981. Six companies shipped 181,148 tons of ferrophosphorus, ferrosilicon, ferrovanadium, ferromanganese, and ferrochromium. Shipments in 1981 were up 6% over those of 1980. Principal uses were as additives and alloying elements in the manufacture of steel.

Roane, Ltd., a wholly owned subsidiary of South African Manganese Amcor, Ltd. (SAMANCOR), announced plans to produce 50% ferrosilicon at its Rockwood ferroalloy plant. In 1981, the plant produced silicomanganese and ferromanganese in four furnaces.[10]

Gold.—A small amount of gold was produced as a byproduct from the Cities Service copper refining operations at Copperhill.

Iron and Steel.—In September, Florida Steel Corp. began production at its new minimill in Jackson. When fully operational, the $50 million mill was projected to produce about 350,000 tons of finished steel products including angles, flats, channels, and smooth rounds. At full capacity, the new mill would be the largest producer of the five plants that the company operates.[11]

Manganese.—Foote Mineral Co. produced electrolytic manganese at its plant in New Johnsonville, and Inco Electro Energy Corp. produced electrolytic manganese dioxide (EMD) at the company's Lavino plant in Covington.

In October, Foote Mineral announced plans to modernize the New Johnsonville electrolytic manganese plant at an estimated cost of $850,000. The project, expected to be completed in mid-1982, would improve operating efficiencies, lower power consumption, and improve metal recovery. The company also announced plans to construct a pilot plant to produce EMD at the facility at an estimated cost in excess of $500,000. The pilot plant would operate for 6 months to develop the necessary technology for the production of EMD for the alkaline battery industry. Following the pilot plant operation, Foote Mineral expected to convert a portion of the electrolytic manganese metal plant to the production of EMD. Annual plant capacity was expected to be 6,200 tons.[12]

In December, Foote Mineral halted production of manganese metal at its New Johnsonville plant for 1 month to hold inventory levels in line with reduced sales demand. Prior to the curtailment, the plant had been operating at 50% capacity.[13]

Rare Earths and Thorium.—Davison Specialty Chemical Co., a subsidiary of W. R. Grace, processed Australian monazite into rare-earth polishing compounds and catalyst materials at Chattanooga. The company processed monazite to extract thorium and stored it as residues at the plantsite.

Silver.—Silver was recovered as a byproduct from copper refining at the Cities Service operations at Copperhill in Polk County.

Titanium.—E. I. du Pont de Nemours & Co., Inc., produced titanium dioxide pigment at its New Johnsonville plant from domestic and imported ilmenite concentrates. The plant produced a major portion of the firm's titanium dioxide. Pigments were used mainly in paints, varnishes, lacquers, paper, and plastics.

Zinc.—Tennessee continued to rank first in the Nation in output and value of zinc in 1981, producing nearly 38% of the Nation's total. In 1981, there were 12 active mines operating in the eastern and central parts of the State. Output and value increased 5% and 25%, respectively, compared with 1980 levels.

In the Mascot-Jefferson City zinc district in the eastern part of the State, ASARCO Incorporated operated four mines (Coy, Immel, New Market, and Young). In the same district, NJZ operated the Jefferson City Mine and nearby Beaver Creek Mine in Jefferson County and the Idol Mine in the Copper Ridge District in Grainger County. United States Steel Corp. continued to produce zinc at the company's Zinc Mine Works in Jefferson County.

At yearend, NJZ shut down the Idol Mine because of high labor costs, diminishing ore reserves, and costs of meeting environmental regulations. The Idol Mine, first opened in the 1960's, became fully operational in 1977.[14] Reserves at the mine in 1980 were estimated at 2.58 million tons containing 3.5% zinc.[15]

In August, workers at NJZ ratified a new 3-year contract with the company. The new contract, which will expire August 1, 1984, covers workers at the company's Idol and Jefferson City Mines.[16]

In the Middle Tennessee Zinc District, JMZ, a joint venture of G + W and Union Minière S.A. of Belgium, operated the Elmwood Mine in Smith County. In September, JMZ announced plans to double zinc concentrate output at its Middle Tennessee operations. The company was to complete the Gordonsville mining and milling complex and gradually increase production to 6,000 tons of zinc concentrate per day. The

adjacent Elmwood complex, which has been producing 3,000 tons of concentrate per day, was to be phased out. Ore from Gordonsville would be concentrated to 64% zinc and then refined to zinc metal at the company's 90,000-ton-per-year electrolytic refinery at Clarksville.

Near yearend, JMZ was considering building a plant at the Clarksville refinery to extract germanium concentrate from zinc residues. Earlier in the year, the company sold 4,000 tons of zinc residues containing 16 tons of germanium to Metallurgie Hoboken Overpelt S.A. of Belgium, a producer of germanium for use in night vision lenses and other products. With the additional output from the Gordonsville complex, worldwide germanium production was expected to be substantially increased.[17]

Cities Service continued recovering zinc sulfide from its mines in Polk County. The ore was processed at the nearby Copperhill plant.

[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]Chief geologist, Tennessee Division of Geology, Knoxville, Tenn.
[3]Nashville Tennessean. Oct. 7, 1981.
[4]General Portland, Inc. 1981 Form 10-K. P. I-4.
[5]Nashville Tennessean. May 22, 1981.
[6]Mining Congress Journal. January 1981, p. 20.
[7]Cities Service Co. 1981 Annual Report. P. 49.
[8]Engineering and Mining Journal. June 1981, p. 9.
[9]Work cited in footnote 7.
[10]American Metal Market. June 18, 1981.
[11]———. Sept. 17, 1981.
[12]Foote Mineral Co. 1981 Annual Report. P. 2.
[13]American Metal Market. Dec. 7, 1981.
[14]Knoxville Journal. Oct. 8, 1981.
[15]American Metal Market. Oct. 28, 1981.
[16]———. Aug. 5, 1981.
[17]———. Oct. 5, 1981.

Table 15.—Tennessee: Tenor of zinc ore milled and concentrates produced

	1980[r]	1981
Total material ---- metric tons	4,335,365	4,511,557
Metal content of ore:[1] Zinc ---- percent	2.49	2.56
Concentrates produced and average content:		
Zinc ---- metric tons	186,077	193,747
Average zinc content ---- percent	62.86	62.99

[r]Revised.
[1]Figure represents recoverable metal of crude ore as contained in the concentrate.

Table 16.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum smelters:			
Aluminum Co. of America	Box 158 Alcoa, TN 37701	Plant	Blount.
Consolidated Aluminum Corp	1102 Richmond St. Jackson, TN 38301	do	Humphreys.
Barite:			
A. J. Smith Co	Route 3 Sweetwater, TN 37874	Open pit mine	Loudon.
Cement:			
General Portland, Inc.[1 2]	1300 American National Bank Bldg. Chattanooga, TN 37402	Plant	Hamilton.
Ideal Basic Industries, Inc.[1 2]	Box 6238 Knoxville, TN 37914	do	Knox.
Moore McCormack Resources, Inc.[1 2]	One Landmark Sq. Stamford, CT 06901	Plants	Marion and Sullivan.
Clays:			
W. G. Bush & Co	1136 2d Ave. North Nashville, TN 37208	Pits and plants	Davidson and Weakley.
Cyprus Industrial Minerals Co	Box 111 Gleason, TN 38229	do	Carroll and Weakley.
General Shale Products Corp	Box 3547 CRS Johnson City, TN 37601	do	Anderson, Hamilton, Knox, Sullivan, Washington.
Kentucky-Tennessee Clay Co	Box 449 Mayfield, KY 42066	do	Carroll, Gibson, Henry, Weakley.
Lowes, Inc	Box 819 Paris, TN 38242	do	Henry.
Old Hickory Clay Co	Box 188 Gleason, TN 38229	do	Henry and Weakley.
H. C. Spinks Clay Co., Inc	Box 820 Paris, TN 38242	do	Carroll, Henry, Weakley.
Copper:			
Cities Service Co.[3]	Copperhill, TN 37317	Underground mines, surface mine, plant.	Polk.

See footnotes at end of table.

Table 16.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Ferroalloys:			
Chromium Mining & Smelting Co.	Box 28538 Memphis, TN 38128	Plant	Shelby.
Roane, Ltd., a subsidiary of South African Manganese Amcor, Ltd.	Box 298 Rockwood, TN 37854	____do	Roane.
TAC Alloys Div., a division of International Minerals & Chemical Corp.	Route 2 Jasper, TN 37347	____do	Marion.
Graphite, artificial:			
Great Lakes Carbon Corp	Box 1031 Elizabethton, TN 37643	____do	Carter.
Union Carbide Corp	Box 513 Columbia, TN 38401	____do	Maury.
Lime:			
Bowaters Southern Paper Corp	Calhoun, TN 37309	____do	McMinn.
Tenn-Luttrell Lime Co	Box 69 Luttrell, TN 37779	____do	Union.
Manganese:			
Foote Mineral Co	Route 100 Exton, PA 19341	____do	Humphreys.
Perlite, expanded:			
Chemrock Corp	Osage St. Nashville, TN 37208	____do	Davidson.
Phosphate rock:			
Hooker Chemical Co	Box 591 Columbia, TN 38401	____do	Do.
Monsanto Industrial Chemicals Co.[4]	Columbia, TN 38401	____do	Do.
Stauffer Chemical Co.[4]	Box 472 Mt. Pleasant, TN 38474	____do	Do.
Sand and gravel:			
Clyde Owen Sand & Gravel Inc	10636 Shelton Rd. Collierville, TN 38017	Pits	Shelby.
Memphis Stone & Gravel Co	Box 1683 Memphis, TN 38101	____do	Benton, Dyer, Shelby.
Ralph Rogers & Co., Inc	720 Argyle Ave. Nashville, TN 37203	____do	Tipton.
Standard Construction Co., Inc.	Box 38289 Germantown, TN 38138	Pit	Shelby.
Stone:			
Limestone:			
American Limestone Co	Box 2389 Knoxville, TN 37901	Quarries	Jefferson, Knox, Sullivan.
Koppers Co. (Stoneman, Inc.)	Box 2098 Chattanooga, TN 37409	____do	Bedford, Hamilton, Rutherford, Warren.
Ralph Rogers & Co., Inc. (Mid-South Pavers, Inc.).	720 Argyle Ave. Nashville, TN 37203	____do	Various.
Vulcan Materials Co	Box 7 Knoxville, TN 37901	____do	Do.
Marble:			
John J. Craig Co	Box 9300 Knoxville, TN 37920	Quarry	Blount.
Imperial Black Marble Corp.	801 Bluff Dr. Knoxville, TN 37919	____do	Grainger.
Sandstone:			
Ross L. Brown Cut Stone Co., Inc.	Box 398 Crab Orchard, TN 37723	____do	Cumberland.
Crab Orchard Stone Co., Inc.	Drawer J Crossville, TN 38555	____do	Do.
Crossville Limestone Co., Inc	Box 485 Crossville, TN 38555	____do	Do.
Mountain Stone Co	Box 246 Jamestown, TN 38556	____do	Fentress.
Vermiculite, exfoliated:			
W. R. Grace & Co	4061 Powell Ave. Nashville, TN 37204	Plant	Davidson.
Zinc:			
ASARCO Incorporated[2]	Mascot, TN 37806	Underground mines and plant.	Jefferson and Knox.
Jersey Minière Zinc Co	Elmwood, TN 38560	Underground mines	Smith.
The New Jersey Zinc Co	Box 32 Jefferson City, TN 37760	____do	Grainger and Jefferson.
United States Steel Corp.[2]	Jefferson City, TN 37760	Underground mine	Jefferson.

[1]Also clays.
[2]Also stone.
[3]Also silver, gold, zinc, and pyrites.
[4]Also ferroalloys.

The Mineral Industry of Texas

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Bureau of Economic Geology, The University of Texas at Austin, for collecting information on all nonfuel minerals.

By Albert E. Ward[1]

Total value of nonfuel minerals declined 4.4% in 1981, compared with the nearly 24% increase in 1980. Texas was the leading producer of cement, gypsum, magnesium chloride, native asphalt, stone, and sulfur and number two in clay and salt.

Final census figures show a Texas population of 14,228,383 in 1980, up 27% over that of 1970. Indications were that population growth was continuing strong in 1981. Fabricated metals, oil and gas, electronics, and agriculture were the dominant sectors of the State's robust economy. Solidly entrenched as the second leading State in foreign commerce, Texas exported about 13% of the Nation's total and imported about 14%, accounting for approximately 14% of U.S. foreign trade.

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

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
Cement:				
Masonry thousand short tons	241	$18,310	229	$15,699
Portland do	9,517	535,690	10,262	567,391
Clays do	3,763	27,022	4,172	29,135
Gem stones	NA	160	NA	200
Gypsum thousand short tons	1,681	14,124	1,783	14,900
Helium (high-purity) million cubic feet	35	805	238	6,188
Lime thousand short tons	1,515	67,075	1,393	67,158
Salt do	9,978	93,414	8,397	84,240
Sand and gravel do	46,704	171,576	p45,442	p178,492
Stone:				
Crushed do	76,483	220,265	72,454	219,086
Dimension do	37	7,095	42	5,543
Sulfur (Frasch) thousand metric tons	4,810	W	3,674	W
Talc and soapstone thousand short tons	401	4,295	282	4,127
Combined value of asphalt (native), fluorspar (1981), helium (crude), iron ore, magnesium chloride, magnesium compounds, sodium sulfate, and values indicated by symbol W	XX	574,820	XX	466,044
Total	XX	1,734,651	XX	1,658,203

pPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Andrews	W	--	
Angelina	--	W	Clays.
Armstrong	W	$2,844	Sand and gravel.
Atascosa	$1,460	1,580	Do.
Bailey	W	W	Stone.
Bastrop	599	W	Clays.
Bell	4,016	3,726	Stone, sand and gravel.
Bexar	W	W	Cement, stone, lime, sand and gravel, clays.
Borden	W	W	Sand and gravel.
Bosque	W	W	Lime, stone.
Bowie	495	547	Sand and gravel.
Brazoria	W	W	Magnesium chloride, salt, magnesium compounds, sand and gravel.
Brazos	W	W	Sand and gravel.
Brewster	W	262	Stone.
Brown	W	W	Stone, clays.
Burleson	W	W	Stone, sand and gravel.
Burnet	W	W	Do.
Calhoun	W	W	Stone, lime.
Callahan	W	124	Stone.
Camp	W	W	Clays.
Carson	W	--	
Cass	W	W	Iron ore.
Chambers	W	W	Salt, sand and gravel, clays.
Cherokee	1,123	1,153	Clays.
Coke	W	W	Sand and gravel.
Coleman	W	W	Clays.
Collin	W	329	Stone.
Colorado	32,049	30,478	Sand and gravel.
Comal	W	W	Stone, cement, lime, sand and gravel.
Comanche	22	26	Stone.
Cooke	W	W	Stone, sand and gravel.
Coryell	W	1,152	Sand and gravel, stone.
Crockett	410	W	Stone.
Crosby	W	W	Sand and gravel.
Culberson	W	W	Sulfur, talc, stone.
Dallas	W	W	Cement, sand and gravel, stone, clays.
Deaf Smith	W	W	Lime.
Denton	W	W	Sand and gravel, clays.
Duval	W	W	Sand and gravel, salt.
Eastland	W	W	Clays, stone.
Ector	W	W	Cement, stone.
Edwards	--	W	Stone.
Ellis	W	W	Cement, stone, clays.
El Paso	W	W	Cement, stone, sand and gravel.
Falls	665	--	
Fannin	W	W	Sand and gravel.
Fayette	W	W	Clays, sand and gravel.
Fisher	W	W	Gypsum, clays.
Floyd	--	385	Stone.
Fort Bend	24,596	W	Sulfur, salt, clays.
Freestone	W	W	Stone, clays.
Gaines	W	W	Sodium sulfate, stone.
Galveston	W	W	Clays, sand and gravel.
Gillespie	W	W	Gypsum, stone, sand and gravel.
Gonzales	W	W	Clays.
Grayson	1,086	W	Stone.
Gregg	364	W	Sand and gravel.
Grimes	W	W	Stone.
Guadalupe	W	W	Sand and gravel, clays.
Hall	263	W	Sand and gravel.
Hansford	W	W	Helium, stone.
Hardeman	W	W	Gypsum.
Hardin	W	W	Sand and gravel.
Harris	128,370	136,814	Cement, sand and gravel, salt, lime, clays.
Harrison	W	W	Clays, sand and gravel.
Haskell	--	464	Stone.
Hays	2,751	W	Cement, sand and gravel, stone.
Henderson	W	W	Sand and gravel, iron ore, clays.
Hidalgo	W	W	Sand and gravel, stone.
Hill	W	W	Lime, stone.
Hockley	352	--	
Hood	W	411	Stone.
Hopkins	W	W	Clays.
Houston	W	--	
Howard	W	W	Sand and gravel, stone.
Hudspeth	W	W	Talc, stone, gypsum.
Hunt	48	--	
Hutchinson	W	W	Sand and gravel, salt.
Jack	1,348	W	Stone.
Jasper	--	220	Do.

See footnotes at end of table.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Jefferson	W	W	Salt.
Jim Wells	W	$57	Stone.
Johnson	W	W	Lime, sand and gravel, stone.
Jones	W	W	Sand and gravel, stone.
Karnes	W	2,126	Stone.
Kaufman	$1,610	1,903	Do.
Kent	4	--	
Kerr	W	W	Sand and gravel.
Kimble	W	W	Do.
Lamar	W	--	
Lamb	W	W	Stone.
Lampasas	143	W	Sand and gravel.
Liberty	W	W	Sulfur, sand and gravel.
Limestone	W	W	Stone, clays, sand and gravel.
Live Oak	W	W	Stone, sand and gravel.
Llano	W	741	Stone.
Lubbock	362	442	Do.
Lynn	W	386	Do.
McCulloch	W	W	Sand and gravel.
McLennan	W	W	Cement, sand and gravel, stone, clays.
McMullen	217	W	Stone.
Marion	W	W	Clays.
Martin	--	W	Stone.
Mason	5	--	
Matagordo	W	W	Salt.
Maverick	W	W	Sand and gravel.
Medina	W	W	Stone, sand and gravel, clays.
Midland	W	W	Stone.
Mitchell	W	W	Sand and gravel.
Montague	W	260	Stone.
Montgomery	W	W	Sand and gravel.
Moore	874	805	Helium.
Morris	W	W	Iron ore.
Motley	W	269	Sand and gravel.
Nacogdoches	W	W	Clays.
Navarro	W	W	Do.
Newton	W	W	Sand and gravel.
Nolan	33,816	43,979	Cement, gypsum, stone, sand and gravel, clays.
Nueces	W	W	Cement, lime, sand and gravel.
Oldham	1,917	2,554	Sand and gravel.
Orange	W	W	Cement, sand and gravel, clays.
Palo Pinto	W	W	Sand and gravel, clays.
Parker	W	W	Stone, sand and gravel, clays.
Pecos	W	W	Sulfur.
Polk	151	161	Sand and gravel.
Potter	17,824	W	Cement, stone, sand and gravel, clays.
Presidio	W	--	
Randall	W	1,201	Stone.
Reeves	W	W	Sand and gravel.
Runnels	--	W	Do.
Rusk	W	W	Clays.
San Patricio	W	W	Stone, clays.
San Saba	W	2,622	Stone.
Scurry	W	--	
Smith	1,487	W	Sand and gravel, clays.
Somervell	W	W	Sand and gravel.
Starr	W	--	
Stonewall	W	W	Gypsum.
Tarrant	W	W	Cement, sand and gravel, stone.
Taylor	W	W	Stone, sand and gravel, clays.
Terry	W	W	Sodium sulfate.
Tom Green	W	W	Stone.
Travis	W	W	Lime, sand and gravel, stone.
Upshur	4	20	Sand and gravel.
Uvalde	W	W	Stone, asphalt, sand and gravel.
Val Verde	W	W	Sand and gravel, stone.
Van Zandt	W	W	Salt, clays.
Victoria	W	W	Sand and gravel.
Walker	W	W	Stone, clays.
Ward	W	W	Sand and gravel.
Webb	W	W	Sand and gravel, stone.
Wharton	W	W	Sulfur.
Wheeler	W	--	
Wichita	6	6	Sand and gravel.
Williamson	19,865	26,070	Stone.
Wilson	39	W	Clays.
Winkler	W	W	Salt.
Wise	W	W	Stone, sand and gravel, clays.

See footnotes at end of table.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Wood	W	W	Sand and gravel, clays.
Yoakum	W	W	Salt.
Young	W	W	Stone, sand and gravel.
Zavala	$40		
Undistributed[2]	1,126,258	$1,470,531	
Total	1,404,639	[3]1,734,651	

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: Anderson, Aransas, Archer, Austin, Bandera, Baylor, Bee, Blanco, Briscoe, Brooks, Caldwell, Cameron, Castro, Childress, Clay, Cochran, Collingsworth, Concho, Cottle, Crane, Dallam, Dawson, Delta, De Witt, Dickens, Dimmit, Donley, Erath, Foard, Franklin, Frio, Garza, Glasscock, Goliad, Gray, Hale, Hamilton, Hartley, Hemphill, Irion, Jackson, Jeff Davis, Jim Hogg, Kendall, Kenedy, King, Kinney, Kleberg, Knox, La Salle, Lavaca, Lee, Leon, Lipscomb, Loving, Madison, Menard, Milam, Mills, Ochiltree, Panola, Parmer, Rains, Reagan, Real, Red River, Refugio, Roberts, Robertson, Rockwall, Sabine, San Augustine, San Jacinto, Schleicher, Shackelford, Shelby, Sherman, Stephens, Sterling, Sutton, Swisher, Terrell, Throckmorton, Titus, Trinity, Tyler, Upton, Waller, Washington, Wilbarger, Willacy, and Zapata.

[2]Includes gem stones and values indicated by symbol W.

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

Table 3.—Indicators of Texas business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	6,458.0	6,689.3	+3.6
Unemployment	do	308.0	301.8	-2.0
Employment (nonagricultural):				
Mining[1]	do	241.7	288.8	+19.5
Manufacturing	do	1,056.9	1,107.4	+4.8
Contract construction	do	423.0	431.1	+1.9
Transportation and public utilities	do	365.8	383.8	+4.9
Wholesale and retail trade	do	1,435.3	1,506.4	+5.0
Finance, insurance, real estate	do	335.0	346.7	+3.5
Services	do	1,015.4	1,085.0	+6.9
Government	do	978.1	994.9	+1.7
Total nonagricultural employment[1]	do	5,851.2	6,144.1	+5.0
Personal income:				
Total	millions	$135,901	$158,629	+16.7
Per capita		$9,528	$10,743	+12.8
Construction activity:				
Number of private and public residential units authorized		127,975	135,194	+5.6
Value of nonresidential construction	millions	$4,360.8	$6,207.5	+42.3
Value of State road contract awards	do	$710.0	$307.7	-56.7
Shipments of portland and masonry cement to and within the State	thousand short tons	9,063	9,421	+4.0
Nonfuel mineral production value:				
Total crude mineral value	millions	$1,734.7	$1,658.2	-4.4
Value per capita, resident population		$122	$117	-4.1
Value per square mile		$6,489	$6,203	-4.4

[p]Preliminary.

[1]Includes oil and gas extraction.

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

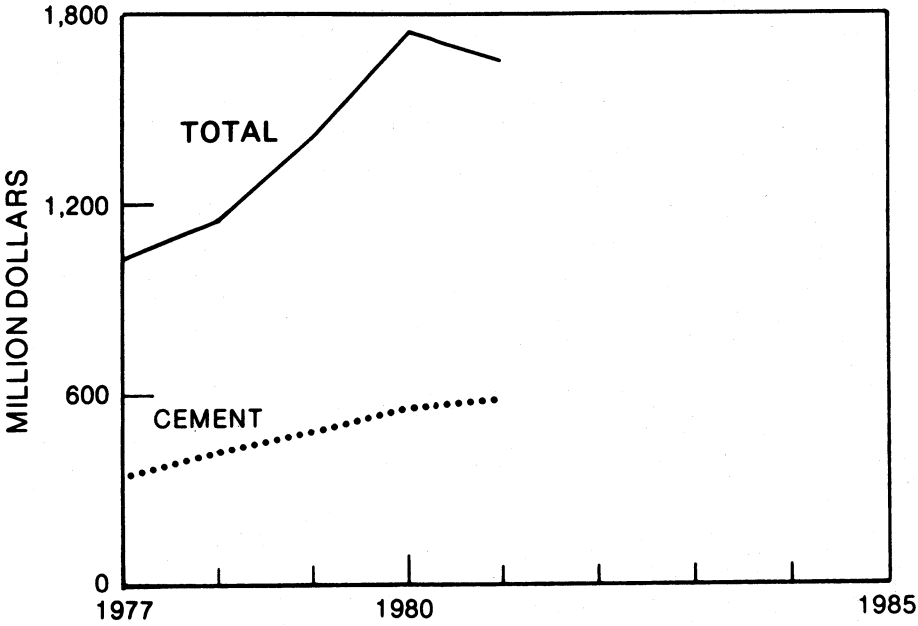

Figure 1.—Value of cement and total value of nonfuel mineral production in Texas.

Legislation and Government Programs.—Most mineral-related legislative actions dealt with environmental problems related to the temporary shutdown or closure of uranium mines in south-central Texas and with the oncoming expansion of lignite mining in east Texas. The Texas Energy and Natural Resources Advisory Council (TENRAC) will fund studies at Texas A & M for revegetating lignite mine spoils in Milam County. TENRAC will fund the investigation of deep-basin lignite at select locations in east Texas to be conducted by the Bureau of Economic Geology, University of Texas at Austin. The Bureau of Mines will participate in the study through its clay-testing cooperative agreement with Texas. Clays enclosing deep-basin lignite that may be subject to in situ gasification in the future are to be cored and then analyzed at the Bureau's Tuscaloosa Research Center in Alabama. The Civil Engineering Department of the University of Texas at Austin will study hydrologic impacts of deep-basin lignite recovery by deep pits and in situ gasification.

The Texas Parks and Wildlife Commission amended rules governing shell dredging on the Texas gulf coast. The department director is, with certain exceptions, authorized to issue shell-dredging permits in all Texas coastal waters. Owing to the diminishing quantity of recoverable shell in portions of San Antonio Bay and because of potential improvement of existing oyster resources, no permittee is authorized to operate more than one dredge at a time in San Antonio Bay, and not more than one dredge will be operated at one time in the bay, regardless of the number of permittees. Dredging is authorized only in certain State tracts within the bay. The commission raised the fee on dredged shell to $1.25 per cubic yard, up from the 25 cents per cubic yard established in 1973. The commission also established a price of 20 cents per cubic yard on sand and gravel removed from State-owned submerged tidelands.

Surface owners of mineral-classified lands receive one-half the proceeds of State oil and gas leases and 40% of the proceeds of leases for State-owned coal, sulfur, uranium, and certain other minerals. A bill proposing a 40% share of bonuses and royalties from hard-rock minerals to surface-land owners of mineral-classified lands died in Senate committee.

Trends and Developments.—Research

projects at the University of Texas Bureau of Economic Geology in 1981 included (1) a study of the salinity of deep-formation waters, Texas gulf coast, (2) the application and transfer of remote-sensing technology for statewide needs in Texas, (3) a comprehensive environmental geologic analysis of river basins in southwest Texas, (4) a study to determine the origin of silver and copper deposits in clastic sedimentary rocks in Trans-Pecos Texas, (5) a study of mineralization associated with calderas in Trans-Pecos Texas, (6) an analysis of the importance of mining in the Texas economy, (7) a study of U.S. dependence on imported sources of nonfuel minerals, (8) geologic and geohydrologic investigations of potential nuclear-waste repositories in the Texas Panhandle, (9) geologic and geohydrologic investigations in the east Texas Basin, and (10) a study of Pennsylvanian and Permian facies of the Eastern Shelf in north-central Texas.

The Bureau of Economic Geology also worked on the following maps: (1) the Geologic Atlas of Texas, scale 1:250,000, (2) a geologic map of Texas, scale 1:500,000, (3) geologic maps of 7-1/2-minute quadrangles in central Texas, (4) a tectonic map of Texas, and (5) a gravity and magnetic map of Texas, scale 1:250,000.

Of the 2.1 million acres in the Texas university system more than 900,000 are under minerals lease and more than 400,000 yield minerals. Very conservatively valued at $10 million, the land, mostly in west Texas, was ceded to the university system by the State in 1876 and 1883. The university permanent fund, derived from bonuses and royalties from oil, gas, and other minerals, now exceeds $1.2 billion. First payment to the fund was made in 1923 with the discovery of the Santa Rita No. 1 well that opened west Texas to major oil production. Besides oil and gas, sulfur and water are important sources of mineral income.

Bonuses, royalties, lease extensions, and other transactions now exceed $200 million annually, including an annual payment of $3 million to $4 million from the Texasgulf, Inc., Comanche Creek sulfur mine in Pecos County. Mineral income from the leased lands is invested in a portfolio of stocks and bonds in the university permanent fund. Two-thirds of the annual income is distributed to the University of Texas system and one-third to the Texas A & M system. Because of this mineral income, the University of Texas, with its conservatively appraised $1.5 billion endowment, is the second most highly endowed university in the Nation.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Asphalt (Native).—Naturally occurring asphalt-impregnated limestone continued to be mined in Uvalde County and was used chiefly for road surfacing. Yielding more than 90% of the Nation's total, Texas again led the asphalt-producing States.

Barite.—Texas produces no barite. Barite ores for grinding mills in Texas are shipped in primarily from Nevada and overseas sources, including ore from China. Although the oil glut that developed in 1981 relieved the tight barite supply, strong domestic drilling activity and the search for deep natural gas should result in a growing demand for barite-based drilling fluids in the 1980's. Average mud cost per well was about $25,500 in 1981. Mud cost for deep wells, below 15,000 feet, averaged $479,000. The domestic drilling market amounts to about $1.7 billion per year, and growth of 10% to 15% is foreseen through the mid-1980's.

New grinding plants were completed by Coastal and Western Minerals at Knippa, Concentrated Mud Chemicals Co. at Corpus Christi, Conmon Port at Brownsville, the Halliburton Co. Imco Services Div. at Brownsville, and Uni Minerals Corp. at Houston. Chromalloy-American Corp. at Houston and Dresser Industries, Inc., Minerals Div. at Galveston expanded their grinding operations. Newpark Resources, Inc., purchased Drilling Materials, Inc., and Mud Products, Inc., both of Kingsville, and Concentrated Mud Chemicals of Corpus Christi. Newpark has a substantial interest in barite deposits in Nevada.

Cement.—Total cement shipments increased 7.5% in 1981, compared with the 1.5% gain in 1980. Portland cement output rose 7.8%, whereas masonry cement fell 5.0%. High interest rates throughout 1981 adversely affected housing and other sectors of the construction industry. However, commercial, industrial, and energy-related construction continued firm and maintained their rising demand for cement; prices, however, weakened. Following 2 years of

double-digit percentage price increases, the price of portland cement eased to $55.29 per ton, masonry cement fell to $68.55, and the average price for total cement output was off to $55.58. Portland cement comprised 98% of total cement output. Because of persistently high interest rates, operators kept a close watch on their inventories; total cement stocks were up only 9% at yearend.

Thirteen companies operated twenty-two cement plants in Texas. Ready-mix companies took about 60% of the cement, off 2% from that of 1980. Other markets were highway contractors, 4%, and other contractors, 18%, both about the same as those of 1980; concrete product manufacturers, 7%, down slightly; building material dealers, 6%, up slightly from that of 1980; Government agencies, 1%, unchanged; and miscellaneous customers, 5%, up substantially in 1981. Trucking continued to be the main mode of transport for finished portland cement; 1.9% was moved by rail, and 1.2% was shipped by barge or other means.

In December 1980, General Portland, Inc., began producing cement at its new 925,000-ton coal-fired Balcones plant near New Braunfels and officially dedicated the $93.5 million facility in January 1981. The highly computerized, low-labor plant incorporates the latest in preheater-precalciner technology. An indirect coal-firing system, using washed coal, affords better burning and improved fuel efficiency. The company has a long-term contract for purchasing high-quality limestone from a nearby quarry and contracts out the mining and hauling of company-owned clay to the cement plant. The facility is well situated to serve the Houston, San Antonio, and south Texas markets.

Texas Industries, Inc., dedicated its new 550,000-ton plant in Hunter. The facility will increase Texas Industries cement capacity by 33% and will serve the Houston and south Texas markets. Texas Cement Co., a subsidiary of Centex Corp., will double the capacity of its Buda plant to 6 million barrels in an 18-month expansion program. The 3-million-barrel facility first produced cement in 1978. Centex Corp., a Dallas-based holding company with interests in cement, oil, and gas production—as well as home building, real estate development, and general construction—will act as its own general contractor during the expansion. Alamo Cement Co. announced plans to construct a new $50 million cement plant in northeast Bexar County, outside the San Antonio metropolitan area.

Ideal Basic Industries, Inc., planned to close its two Houston cement plants early in 1982. Combined gray and white cement capacity of the two plants was 675,000 tons per year. Rising costs of materials, energy, and labor effected the planned closure of the facilities that have recorded output as far back as 1938. Ideal Basic will continue to operate a cement-distribution terminal in Houston; the terminal is to be modified and updated at a cost of $1.6 million. Ideal Basic will ship cement to Houston from its new 1.5-million-ton Cris Dobbins plant near Mobile, Ala., the largest cement plant ever built in one stage in the United States.

Table 4.—Texas: Portland cement salient statistics

(Short tons)

	1980	1981
Number of active plants	19	20
Production	9,151,423	9,951,936
Shipments from mills:		
Quantity	9,516,949	10,261,852
Value	$535,690,104	$567,390,926
Stocks at mills, Dec. 31	503,980	551,199

Table 5.—Texas: Masonry cement salient statistics

(Short tons)

	1980	1981
Number of active plants	13	13
Production	219,834	229,298
Shipments from mills:		
Quantity	241,364	229,346
Value	$18,309,793	$15,698,648
Stocks at mills, Dec. 31	23,105	21,746

Clays.—Up about 11% and about equal to the recent peak recorded in 1978, total clay output reversed a 2-year moderate downtrend. This upturn was attributed to the 12% rise in common clay production that usually represents more than nine-tenths of Texas clay output. Ball and fire clay output fell sharply, bentonite and fuller's earth production increased moderately, and kaolin output approached the 12% rise of common clay. Total value for all clay was up 7.8%. Largely used in the oil and gas drilling industry, bentonite increased 10% in price per ton. Fuller's earth also rose in unit price, and common clay—by far the largest tonnage clay—moved up a moderate 3.1% per ton. Ball clay and kaolin prices were down, and the average price of fire

clay was off 53%.

Thirty-nine companies produced clay at 88 mines in 39 counties in Texas during 1981. The four leading producers mined about one-half of the clay valued at one-third of the statewide total from 34 mines. One-half of the operating mines (44) yielded 76% of the clay for 44% of the value. Ten companies mined more than 100,000 tons each, 7 produced 50,000 to 100,000 tons, and 18 turned out 10,000 to 50,000 tons each. Mines per company ranged up to 14.

English China Clay, Ltd., acquired Southern Clay Products, Inc., of Gonzales in Gonzales County. Southern Clay produced bentonite for oil-drilling muds, and ball clay and talc for the ceramics industry. Southern Clay's clay operations are in the central and eastern parts of the State.

Graphite.—Southwestern Graphite Co. produced no natural graphite from its mine near Burnet in Burnet County in 1981; however, the company initiated exploration for new deposits and reexamined old properties.

Table 6.—Texas: Clays sold or used by producers, by kind

(Thousand short tons and thousand dollars)

Year	Ball clay, fuller's earth, and kaolin		Bentonite		Fire clay		Common clay and shale		Total[1]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1977	129	4,808	40	974	56	278	3,586	10,213	3,810	16,272
1978	128	4,944	56	1,101	50	273	3,955	13,500	4,189	19,818
1979	137	6,019	66	3,242	58	725	3,610	11,548	3,871	21,533
1980	123	5,953	109	7,061	57	743	3,475	13,265	3,763	27,022
1981	112	5,251	116	8,265	42	259	3,902	15,359	4,172	29,135

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

Gypsum.—Demand for gypsum continued sluggish in 1981 as output rose moderately. However, this increase represented a recovery of about one-half of the 12% decline in production in 1980 that interrupted an uptrend begun in 1976. Average price per ton of crude gypsum eased 0.5%, from $8.40 in 1980 to $8.36 in 1981. (In 1980, gypsum price had moved up a sharp 40% from the $6.00 plateau that prevailed in the late 1970's.) Calcined gypsum tonnage was up 1.6%; but its price continued to slide, falling another 14% in 1981, following the precipitous 32% decline in 1980.

Texas again led the Nation in crude gypsum mined and continued as second in calcined gypsum production. Texas gypsum output was 15.5% of the Nation's total, up from 13.6% in 1980. Seven companies mined gypsum in six Texas counties, and five companies calcined gypsum in four counties, unchanged from that of 1980.

Helium.—Separation and recovery of crude helium from natural gas continued to decline sharply. Off more than one-third in 1980, recovery was off another one-half in 1981. Both figures parallel the 44% decline in 1980 and 59% fall in 1981 in national totals from the three producing States—Kansas, Oklahoma, and Texas. Production of high-purity helium continued its moderate rise; up 7.3% nationwide in 1980, it rose another 5.5% in 1981. Texas output of high-purity helium increased substantially in 1981, to 238 million cubic feet from 35 million cubic feet.

The Bureau of Mines Helium Field Operations headquarters are located in Amarillo, Tex. High-purity helium and liquid helium are produced at the Exell helium plant at Masterson, Tex. By law, the Bureau is responsible for supplying helium to Federal agencies, which constitutes about 30% of the total U.S. helium demand. Gaseous helium in high-pressure cylinders and highway semitrailers is distributed from the Amarillo helium plant. About 40 billion cubic feet of Federal and private crude helium is in Government storage at the Cliffside Storage Reservoir, 10 miles northwest of Amarillo. The volume in storage is essentially the same as it was in 1980.

Lime.—Although lime production declined in 1981 from that of 1980, average unit value continued its uptrend of recent years, increasing from $44.27 per ton in 1980 to $48.21 in 1981. Demand for lime moderated in energy-related areas, and weak demand and pricing were evident in some construction sectors and in the aluminum industry.

Austin White Lime Co. completed expansion of its quicklime and hydrated lime

operation at McNeill. A new 500-ton-per-day kiln and a hydrator about doubled plant capacity. Chemical Lime Inc., of Fort Worth, expanded its Clifton operation with the addition of a new 600-ton-per-day kiln. Chemical Lime marketed its Clifton pebble lime product in Texas and in all bordering States. United States Gypsum Co. added a new 600-ton-per-day rotary kiln at its New Braunfels plant and installed a pressure hydrator for producing dolomitic Type S lime. The New Braunfels plant was the only operation in Texas to produce both high-calcium and dolomitic lime. United States Gypsum had the State's largest lime-producing capacity.

Table 7.—Texas: Lime sold or used by producers, by use

Use	1980		1981	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Road stabilization	427,139	$19,079	313,659	$14,871
Steel, electric	76,455	2,493	209,092	9,670
Paper and pulp	174,292	7,936	156,424	7,728
Soil stabilization	W	W	154,554	7,827
Aluminum and bauxite	134,229	7,671	126,804	7,001
Water purification	124,116	5,548	126,171	6,346
Steel, open-hearth	143,070	5,743	W	W
Sewage treatment	107,203	3,964	62,773	2,881
Oil well drilling	21,601	1,151	17,090	904
Mason's lime	13,218	578	13,084	647
Food, animal and human	W	W	3,194	148
Other[1]	293,956	12,912	209,889	9,135
Total	1,515,279	67,075	1,392,734	67,158

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes acid mine water; chrome (1980); glass; magnesium; manganese (1981); oil and grease (1981); other chemical and industrial uses; other construction lime; other metallurgy; paint (1980); petroleum refining; sugar refining (1981); steel, basic oxygen furnace (1981); tanning (1980); wire drawing; and uses indicated by symbol W.

Perlite (Expanded).—Although Texas perlite mines have been inactive for a decade, seven companies operating plants in Bexar, Comal, Dallas, Harris, and Nolan Counties continued to process imported perlite. Ranked fourth, Texas was one of 32 States that produced expanded perlite and turned out 8.3% of the Nation's total, up from 7.3% in 1980. Average price per short ton was $181 in Texas in 1981, up from $160 in 1980. National figures were $139 in 1981, compared with $129 in 1980.

Salt.—Seven companies continued to produce salt in brine from wells pumping from salt deposits at nine plants; two companies also produced rock salt from underground mines. Texas ranked second in salt output among 16 producing States, the same as in 1980, yielding 22% of the Nation's 38.9 million tons in 1981. Texas output fell about one-sixth, and the national total decreased slightly as demand slackened and the tight supplies of recent years came into balance with demands. Average price per ton was firm, rising to $10.03 in 1981, up from $9.36 in 1980. Because of tight supplies in 1980, the average price per ton of salt had risen from $5.99 in 1979 to $9.36 in 1980.

Sand and Gravel.—To reduce reporting burdens and costs, the Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but contains complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Total sand and gravel output declined for the second consecutive year because of the continued sluggish pace of most sectors in the construction industry. Production was off 2.7%, compared with the 12% fall in 1980. Output was lower than that of any year since 1975. Construction sand and gravel mined was down slightly; however, average price per ton moved up from $3.13 in 1980 to $3.28. Industrial sand output was up 9.2%, and its price rose 6.9% from $15.43 in 1980 to $16.50. Eight companies produced industrial sand from 10 operations in 8 counties, down from the 11 companies, 15

operations, and 10 counties in 1980.

Texas ranked fourth nationally in industrial sand production, third in estimated construction sand and gravel, and third in total sand and gravel. In 1980, the State ranked fifth in industrial sand and second in construction and total sand and gravel.

Texas Mining Co., a subsidiary of Oglebay Norton Co., began a $7.3 million expansion program at its Voca operation to increase its annual proppant sand capacity from 1.5 million to more than 4 million tons. Proppant sand is pumped into the opening created when a well is fractured to stimulate flow and increase hydrocarbon recovery. Texas Mining had been a major producer of the sand for the oil and gas industry for 23 years; strong demand for proppant sand in recent years and anticipated demand in the near future stimulated this major capital investment.

Ottawa Silica Co., of Ottawa, Ill., acquired the industrial sand- and kaolin-producing facilities of Dresser Industries, Inc., at Kosse. The facilities, to be known as Texas Industrial Minerals Co., will be operated as a subsidiary of Ottawa Silica. The Kosse operation produced high-grade silica sand for local consumption by the glass container industry. It also produced pulverized sand for cement manufacture, ceramics, cleansers, fillers, and oil and gas drilling.

Table 8.—Texas: Sand and gravel sold or used by producers, by use

Use	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	25,680	$74,003	$2.88	NA	NA	NA
Gravel	18,971	65,889	3.47	NA	NA	NA
Total or average	44,651	139,892	3.13	P43,200	P$141,500	P$3.28
Industrial: Sand	2,054	31,684	15.43	2,242	36,992	16.50
Grand total or average[1]	46,704	171,576	3.67	P45,442	P178,492	P3.93

PPreliminary. NA Not available.
[1]Data may not add to totals shown because of independent rounding.

Stone.—Crushed and total stone production declined 5.3% in 1981. Representing 0.06% of Texas' total stone output, dimension stone rose 14% following a doubling of tonnage in 1980; both increases indicated strong commercial building in the construction industry. Average price of crushed stone rose 4.9% to $3.02, whereas dimension stone fell 31% to $131.98. Average value of total stone output was up 4.4% to $3.10.

Texas continued to lead the Nation in crushed and total stone output in 1981 and ranked 8th in dimension stone, up from 11th place in 1980. Stone was recovered from 156 sites (155 quarries and 1 shell operation) in 65 counties. Ten quarries cut dimension stone. Bexar County, with 11.5 million tons of stone output, was the leading producer, closely followed by Williamson County, with 10.3 million tons, and by Wise County, with 10.2 million tons. Fifteen counties produced 1 million tons or more, comprising 75% of Texas stone output. Twelve quarries, each producing more than 1 million tons, cumulatively yielded 41% of Texas' stone production. Quarries with 100,000 to 1 million tons of output accounted for 57%; quarries yielding less than 100,000 tons made up the remaining 2%. About 85% of the stone was shipped by truck; 12%, by rail; 1%, by water; and 2%, by other means.

Crushed limestone comprised about 97% of all the State's crushed stone output. Crushed sandstone represented more than 1%, and the remaining 2% of crushed stone included, in order of decreasing tonnage, shell, marl, marble, and traprock.

Dimension stone consisted of the following approximate distribution: granite 42%, limestone 38%, and marble 20%. Average value per ton of crushed stone was marble $23.84, shell $6.16, sandstone $3.99, traprock $3.88, limestone $2.96, and marl $1.56. Average value per ton of dimension stone was granite $217.46, limestone $78.68, and marble $57.62.

Table 9.—Texas: Crushed stone[1] sold or used by producer, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	299	639	407	1,554
Poultry grit and mineral food	153	1,299	W	W
Concrete aggregate	12,284	45,322	10,521	39,400
Bituminous aggregate	4,806	24,578	4,459	24,470
Dense-graded road base stone	31,227	68,315	28,744	71,124
Surface-treatment aggregate	3,325	13,064	2,192	8,786
Other construction aggregate and road stone	6,219	16,122	7,038	18,045
Riprap and jetty stone	231	1,008	238	1,064
Railroad ballast	872	2,870	825	2,822
Filter stone	734	1,769	922	2,498
Manufactured fine aggregate (stone sand)	1,579	4,753	1,929	5,725
Terrazzo and exposed aggregate	210	3,359	135	2,085
Cement manufacture	10,334	19,678	11,128	22,803
Lime manufacture	2,446	7,792	1,979	6,782
Flux stone	364	1,039	635	2,105
Whiting or whiting substitute	62	--	--	--
Other fillers or extenders	356	5,174	294	5,837
Glass manufacture	--	--	38	W
Roofing granules	60	240	69	277
Other[2]	923	3,244	903	3,710
Total[3]	76,483	220,265	72,454	219,086

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

[1]Includes limestone, granite (1980), marble, marl, sandstone, shell, and traprock.

[2]Includes stone used in macadam aggregate, chemical stone used for alkali works, abrasives (1981), asphalt filler, waste material (1980), sulfur removal from stack gases, and other uses not specified.

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

Sulfur.—As in 1980, four companies at seven operations in five counties—Culberson, Fort Bend, Liberty, Pecos, and Wharton—produced Frasch sulfur. Production eased slightly in 1981, quantity sold or used fell by about one-fourth, and yearend stocks rose about one-eighth. Total value of sulfur shipments declined 4.5%; however, on a unit basis, the price of sulfur increased 25%.

Recovered sulfur was extracted from natural gas and crude oil at 60 operations in 33 counties. Production was up 3.0% from 1,110,947 metric tons in 1980 to 1,144,041 metric tons. Quantity sold or used also rose 3.0%, from 1,103,731 to 1,136,367 metric tons. Yearend stocks increased 18% from 40,185 to 47,564 metric tons. Total value of recovered sulfur sold or used increased from $88.0 million in 1980 to $115.3 million in 1981. On a unit basis, the price rose sharply from $79.72 in 1980 to $101.42 in 1981.

Table 10.—Texas: Sulfur produced and shipped from Frasch mines

(Thousand metric tons and thousand dollars)

Year	Production	Shipments	
		Quantity	Value
1977	3,454	3,536	W
1978	3,720	3,752	W
1979	3,897	4,649	W
1980	4,081	4,810	W
1981	3,908	3,674	W

W Withheld to avoid disclosing individual company proprietary data.

Talc and Soapstone.—In Hudspeth County, five producers quarried 282,000 tons of talc worth $4.1 million or about $14.63 per ton. Output was off 30% from that of 1980; however, value per ton rose about 36%, slightly less than the 43% increase in 1980. Ceramics continued as the major market for talc. Lesser amounts were used in cosmetics, paints, paper, plastics, roofing, rubber, and miscellaneous markets. Texas ranked second in national output of talc, representing about one-fourth of the tonnage and one-eighth of the value.

Vermiculite (Exfoliated).—Texas' last

producing vermiculite mine, in Llano County, closed in 1979 and remained inoperative in 1981. However, W. R. Grace & Co. operated two exfoliation plants in Bexar and Dallas Counties, and Vermiculite Products, Inc., ran a plant in Harris County, all using imported crude vermiculite. These three Texas plants produced about 10% of total U.S. output, up slightly from that of 1980. Production was essentially unchanged in 1981, but value per ton rose about 16% to bring the price of exfoliated vermiculite in Texas closer to the national average price of $214 per ton. About 45% of the exfoliated vermiculite was used in concrete aggregate. Other uses were fireproofing, 30%; insulation, 15%; and plaster aggregate and agriculture, 5% each.

METALS

Aluminum.—Texas ranked fourth nationally in primary aluminum production, recovered from alumina in bauxite. In 1980, Texas ranked second. Seventeen States again recorded aluminum production. U.S. output eased about 3.6%; however, Gulf Coast States recorded relatively sharp declines in aluminum production because of their widespread use of increasingly costly natural gas for energy. Texas' production of aluminum fell more than 25%. States that used low-cost hydropower generally maintained their production levels. Posted prices for aluminum recorded a continuation of the uninterrupted annual price increase that began in 1973 and an indicated increase of about 6% in 1981; however, market prices for aluminum were weak throughout the year, and sales substantially below list price were commonplace. The production uptrend that began in 1975 terminated in 1981.

The year was marked by curtailed aluminum production because of reduced demand, selling off of aluminum stocks, and weakening market prices. High-cost operations were the most seriously affected by the falling aluminum price and the strengthening price for natural gas. Reynolds Metals Co., for example, in May shut down a 57,000-ton-per-year potline, its last operating unit, which idled its 114,000-ton-per-year San Patricio primary aluminum smelter. Reynolds blamed increased natural gas costs for the closure.

Using 1972 as a base year, the Aluminum Association announced that a 13% reduction in energy needed to produce a pound of aluminum had been accomplished by the end of 1980. Most of the energy saving was attributed to the industry's recycling efforts, which were expected to result in an annual 20% reduction of energy requirements by 1985. Additional energy conservation efforts included installing new furnaces in melting and processing operations, waste-heat recovery systems, aluminum sheet production directly from molten metal, and improved control equipment on production processes aimed at energy savings.

Copper.—Domestic and imported ores and concentrates were processed at the ASARCO Incorporated smelter in El Paso. Copper was refined at Asarco's operation in Amarillo and at the Phelps Dodge plant in El Paso. Production runs returned to normal during most of the year following strike-induced losses in the last half of 1980; however, by yearend, output had once again ebbed owing to curtailment of domestic copper mining, as automotive and construction markets were depressed by high interest rates and an economic recession.

Gold.—Traces of gold and silver mineralization reportedly were found in the Lower Cretaceous marine sediments of the Comanchean Series in north-central Texas. Southern Erath County, about 70 miles southwest of Fort Worth, apparently was the area of primary interest with additional discoveries reportedly found in Comanche County to the southwest. Another discovery was reported southeast of Fort Worth in Tarrant County, located near the U.S. Army Corps of Engineers Lakeview dam and reservoir site, adjacent to the Dallas County line.

Iron Ore.—As demand for steel products weakened in 1981, iron ore output in Texas fell about 31%. Value per long ton, however, was up about 26%. Texas ranked eighth among the 13 iron ore producing States in 1981, the same position as in 1980 when 12 States produced iron ore. Limonite and siderite ores recovered from open pit mines in Cass and Morris Counties were used mostly to produce pig iron; minor quantities were used for cement manufacture and for miscellaneous products.

Lone Star Steel Co., a subsidiary of Northwest Industries, Inc., completed a $3 million investment in the company's iron ore sintering plant. The investment comprised a series of multicone cyclonic dust collectors, a high-velocity wet-dust collection, and a slurry disposal system to eliminate air pollution. Lone Star was conducting a unique experiment: On a 10-acre plot of

reclaimed land, it planted Virginia pine seedlings that will be marketed in a few years as Christmas trees. Survival of the seedlings in their first year has been good on land that had been mined for limonite and siderite iron ore. Iron ore mining in northeast Texas tends to be land intensive because of the thin-bedded and discontinuous mineralization.

At its integrated operation in Lone Star, Morris County, Lone Star Steel Co. continued as one of the Nation's leading manufacturers of oil-related tubular goods and specialty tubing products. Limonite and siderite ores mined in southern Morris and southwestern Cass Counties were processed at the company's 600-acre plant. The company owned or controlled more than 50,000 acres of iron-bearing land in northeast Texas, mostly within a 30-mile radius of the plant. Reserves were sufficient to support the current rate of output for about a century.

Ores are beneficiated by crushing, washing, and screening, with additional logwasher removal of clay and sand as rotary blade mills reduce the ore to 3/8-inch maximum diameter. The ore is then sintered for more efficient reduction in the plant blast furnace. Limestone quarried in central Texas and coal reduced to coke are combined with the ore and fed to the blast furnace. Air preheated to about 1,850° F and natural gas are introduced to the furnace, and the molten iron is drawn from the furnace eight or nine times daily and fed to the onsite open hearth to refine the iron. Ingots from the open hearth are moved by rail to rolling mills for processing and manufacture to meet specific market needs. Lone Star Steel employed over 5,000 people in northeast Texas.

United States Steel Corp. temporarily closed its large-diameter pipe mill at Baytown and furloughed 300 production workers owing to a lack of orders. Raw steel and plate production also was curtailed. About 2,000 persons were normally employed at the Baytown steel facility.

Lead.—Asarco's smelter on El Paso's west side remained in the environmental spotlight when the community objected to the company's plan for converting a natural gas-fired furnace to coal. Since 1967, Asarco invested $100 million in pollution control equipment at the plant; however, added antipollution gear was not planned for the coal conversion. To attain Federal limits on lead pollution, El Paso was faced with an Environmental Protection Agency mandate to reduce lead levels to 1.5 micrograms per cubic meter of air by late 1982.

Magnesium.—Production of magnesium compounds in Texas declined about 6% in 1981; however, value per short ton rose about 10%. Magnesium chloride for metal products was down about one-sixth from that of 1980, but value per ton increased about one-fifth.

American Magnesium Co., which produced magnesium metal and chlorine gas at its plant west of Snyder, did not operate in 1981 because of loss of feedstock. The company developed a proprietary technology intended to reduce energy costs significantly below current standards for magnesium recovery. Norsk Hydro AS of Oslo expressed interest in purchasing the Snyder facility; however, by yearend, neither party announced results of the negotiations. American Magnesium emerged from 9 months of bankruptcy reorganization proceedings in September, and company representatives reported that funds were available to maintain the Snyder plant in caretaker status until yearend with no plans to reopen the facility.

The Dow Chemical USA Freeport operation closed down about 25% of its magnesium production capacity. The shutdown in October was planned for a 6- to 12-month period owing to a drop in demand. Dow also placed on hold a planned rehabilitation of an earlier idled facility and modifications of electrolytic cells that would increase plant capacity. Dow continued efforts to reduce energy used in magnesium production.

Silver.—Early in 1981, silver was priced at about $15.50 an ounce and ended the year at about $8.25. Because of the 1981 downtrend and widespread expectations that price weakness would continue, recent silver exploration and development in west Texas were curtailed.

Tantalum.—Solid tantalum capacitors will be manufactured in a new plant Sprague Electric Co. will build in San Antonio; Sprague is a unit of GK Technologies, Inc., a Penn Central Corp. subsidiary. The 80,000-square-foot, $9 million plant will employ 550 workers. Sister plants are in Brownsville, Tex.; Matamoras, Mexico; Sanford, Maine; and Concord, N.H. Tantalum capacitors from the San Antonio plant will be used in automotive electronics, electronic data processing, and industrial electronics equipment. Commonly associated with columbium, tantalum is imported mainly

from Brazil and Canada.

Titanium.—D-H Titanium Co., a joint venture of Dow Chemical Co. and Howmet Turbine Components Corp., operated a semicommercial titanium plant in Freeport, Brazoria County. High-purity titanium was produced by an improved electrolytic process, requiring about one-half the energy the older Kroll process uses.

Tungsten.—The Anschutz Corp. ammonium paratungstate (APT) plant at Laredo, formerly NL Industries' facility, originally scheduled to come onstream in late 1981, was delayed owing to design problems in the plant and to an anticipated oversupply of APT. The facility will process wolframite from company mines in Bolivia to produce the APT power used for producing tool steels and carbides. The Laredo plant is to produce 200,000-short-ton APT units annually.

Zinc.—Asarco invested $42 million to modernize its Corpus Christi zinc refinery. Operating at 40% of rated capacity since July 1980 because of strike-interrupted raw material shipments from its El Paso plant, Asarco increased production in March at the Corpus Christi facility when the El Paso shipments resumed. El Paso provided about one-half the feedstock at Corpus Christi as zinc oxide recovered from lead-smelter slag. The cutback in operations affected 116 of 480 hourly workers, all recalled by March.

[1]State Liaison Officer, Bureau of Mines, Denver, Colo.

Table 11.—Texas: Primary smelters, refineries, and reduction plants

Product, company, and plant	Location (county)	Material treated
Aluminum:		
Aluminum Company of America:		
Point Comfort (alumina)	Calhoun	Bauxite.
Point Comfort (reduction)	do	Alumina.
Rockdale (reduction)	Milam	Do.
Anderson County (reduction)	Anderson	Do.
Reynolds Metals Co.:		
San Patricio (reduction)	San Patricio	Do.
Sherwin plant (alumina)	do	Bauxite.
Antimony:		
ASARCO Incorporated:		
El Paso smelter	El Paso	Ore.
Anzon American, Inc.:		
Laredo smelter	Webb	Do.
Cadmium:		
ASARCO Incorporated:		
Electrolytic	Nueces	Do.
Copper:		
ASARCO Incorporated:		
Amarillo refinery	Potter	Blister and anode.
El Paso smelter	El Paso	Ores and concentrates.
Phelps Dodge Refining Corp.:		
Nichols refinery	do	Blister and anode.
Iron:		
Armco, Inc.:		
Houston plant	Harris	Ore and scrap.
Lone Star Steel Co.:		
Daingerfield plant	Morris	Do.
United States Steel Corp.:		
Baytown plant	Chambers	Do.
Lead:		
ASARCO Incorporated:		
El Paso smelter	El Paso	Ores and concentrates.
Magnesium:		
Dow Chemical U.S.A.:		
Freeport plants, electrolytic	Brazoria	Seawater.
Manganese:		
Tenn-Tex Alloy Corp.	Harris	Ore.
Sodium:		
Ethyl Corp.	do	Salt.
Tin:		
Gulf Chemical & Metallurgical Corp.:		
Texas City smelter	Galveston	Ore, slag, residues.
Zinc:		
ASARCO Incorporated:		
Corpus Christi electrolytic	Nueces	Ores and concentrates.
El Paso fuming plant	El Paso	Dusts and residues.

Table 12.—Texas: Secondary metal recovery plants

County and company	Material	Product
Austin:		
Schindler Bros. Steel Co	Steel scrap	Reinforced steel bars.
Bexar:		
Newell Salvage Co. of San Antonio	Scrap metal	Smelter and refined scrap metals.
Brazoria:		
Texas Reduction Corp	Aluminum scrap	Alloyed aluminum ingot.
Collin:		
Electro Extraction, Inc	Aluminum and copper scrap	Aluminum ingots, copper bars.
GNB Batteries, Inc	Lead scrap	Battery lead oxide, pig lead.
Dallas:		
ABASCO, Inc	Aluminum scrap	Aluminum ingots, dioxidizing bars and shot.
Dixie Metals Co	Lead scrap	Lead pigs, alloys, chemicals.
Laclede Steel Corp	Steel scrap	Reinforcing steel.
Murdock Lead Co., a division of RSR Corp.	Lead scrap	Lead shot, solders, lead pipe.
El Paso:		
Border Steel Mills, Inc	Steel scrap	Reinforcing bars, bar shapes, steel grinding balls.
Proler International Corp	do	Precipitation iron.
SEC Corp	Nickel-copper waste solution	Nickel.
Ellis:		
Chaparral Steel Co.	Steel scrap	Steel reinforcing bars and shapes.
Industrial Metals Co	Scrap metal	Metal shapes and ingots.
Galveston:		
Gulf Chemical & Metallurgical Corp.	Various metal scrap	Tin, tungsten, nickel.
Gregg:		
Marathon-LeTourneau Co	Steel scrap	Steel castings and shapes.
Southwest Steel Castings Co	do	Steel castings.
Guadalupe:		
Structural Metals Inc	do	Structural steel reinforcing bars.
Harris:		
A & B Metal Manufacturing Co., Inc.	Scrap metal	Tungsten carbide.
Federated Metals Corp	Various metals	Lead ingot, solder, copper tubing, bearing metals, sheet lead, lead pipe.
Gulf Reduction Corp	Aluminum, zinc scrap	Aluminum, zinc ingots and alloys.
Houston Lead Co	Lead scrap	Lead pigs, ingots, alloys.
Lead Products Co., Inc	do	Do.
Newell Metals, Inc	Zinc scrap	Zinc dust.
Proler International Corp	Various metals	Zinc slab, aluminum alloys, precipitation iron.
Redgate, Virgil, Co	do	Recovery of gold, silver, platinum, rhodium, copper, nickel, cadmium, aluminum.
Jefferson:		
Georgetown Texas Steel Corp	Steel scrap	Steel rods and shapes.
Laclede Steel Corp	do	Reinforcing steel.
Leon:		
Nucor Steel Co	do	Steel rods and shapes.
San Antonio:		
Standard Industries	Lead scrap, soft lead and drosses	Battery metals, grids and oxides.
Smith:		
Bloch Metals, Inc	Aluminum scrap	Aluminum ingots.
Tyler Pipe Industries, Inc	Steel scrap	Pipe and pipe fittings.
Tarrant:		
Texas Steel Co	do	Carbon and alloy steel bars and shapes, reinforcing bars.

Table 13.—Principal producers

Commodity and company	Address	Type of activity	County
Asphalt (native):			
Uvalde Rock Asphalt Co	Box 531 San Antonio, TX 78206	Quarry and plant	Uvalde.
White's Mines, Inc	Box 499 San Antonio, TX 78206	do	Do.
Barite:			
Dresser Industries, Inc	Box 6504 Houston, TX 77002	Grinding plant	Cameron and Galveston.
Milwhite Co., Inc	Box 15038 Houston, TX 77020	do	Cameron and Harris.
NL Industries, Inc	Box 1675 Houston, TX 77001	do	Nueces.

Table 13.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Cement:			
Alamo Cement Co	Box 6925 San Antonio, TX 78209	Quarry and plant	Bexar.
Capitol Aggregates, Inc	Route 13, Box 412 San Antonio, TX 78209	do	Do.
Centex Cement Corp	4600 Republic National Bank Tower Dallas, TX 75201	do	Hays and Nueces.
General Portland, Inc	12700 Park Central Place Dallas, TX 75251	do	Dallas and Tarrant.
Gifford-Hill & Co., Inc	Box 520 Midlothian, TX 76055	do	Ellis.
Gulf Coast Portland Cement Co.	Box 262 Houston, TX 77001	do	Harris.
Ideal Cement Co., a division of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, CO 80202	do	Do.
Longhorn Cement Div., Kaiser Cement Corp.	Kaiser Center 300 Lakeside Dr. Oakland, CA 94612	do	Bexar.
Lone Star Industries, Inc	Box 47327 Dallas, TX 75247	do	Harris and Nolan.
River Cement Co	180 Weidman Rd. Manchester, MO 63011	do	Orange.
Southwestern Portland Cement Co.	Box 392 El Paso, TX 79943	do	Ector, El Paso, Potter.
Texas Industries, Inc	8100 Carpenter Freeway Dallas, TX 75247	do	Ellis.
Clay and shale:			
Acme Brick Co., a division of Justin Industries, Inc.	Box 425 Fort Worth, TX 76101	Pit and plant	Denton, Guadalupe, Nacogdoches, Parker, Van Zandt, Wise.
Balcones Minerals Corp	Box B Flatonia, TX 78941	do	Fayette.
Elgin-Butler Brick Co	Box 1947 Austin, TX 78767	do	Bastrop.
Featherlite Corp	Box 141 Ranger, TX 76470	do	Eastland.
General Portland, Inc	3333 Fort Worth Ave. Dallas, TX 75211	do	Dallas and Limestone.
General Refractories Co	600 Grant St. Room 3000 Pittsburgh, PA 15219	do	Cherokee.
Gulf Coast Portland Cement Co., a division of McDonough Co.	Box 262 Houston, TX 77001	Pit	Chambers.
Henderson Clay Products Co	Box 490 Lindale, TX 75771	Pit and plant	Rusk.
Lone Star Industries, Inc	Box 12449 Dallas, TX 75225	Pit	Fisher and Harris.
Milwhite Co., Inc	Box 15038 Houston, TX 77020	Pit and plant	Fayette and Walker.
Southern Clay Products, Inc	Box 44 Gonzales, TX 78629	do	Angelina, Cherokee, Gonzales.
Texas Clay Industries, Inc	Box 469 Malakoff, TX 75148	do	Henderson.
Texas Industries, Inc	8100 Carpenter Freeway Dallas, TX 75247	do	Comanche, Dallas, Ellis, Fort Bend, Henderson, Marion, Van Zandt.
Fluorspar:			
D & F Minerals Co	Box 75 Terlingua, TX 79852	Mine	Brewster.
Graphite:			
Southwestern Graphite Co	Burnet, TX 78611	Mill	Burnet.
Gypsum:			
Genstar Bldg. Products Co	480 Central Ave. Rutherford, NJ 07073	Quarry and calcining plant.	Nolan.
Georgia Pacific Corp	900 SW. 5th Ave. Portland, OR 97204	do	Hardeman.
National Gypsum Co	325 Delaware Ave. Buffalo, NY 14202	do	Stonewall.
United States Gypsum Co	101 South Wacker Dr. Chicago, IL 60606	do	Nolan.
Do	do	Plant	Harris.

Table 13.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Iron ore:			
Lone Star Steel Co	Box 12226 Dallas, TX 75225	Mine	Cass and Morris.
Lime:			
Aluminum Co. of America	1501 Alcoa Bldg. Pittsburgh, PA 15219	Plant	Calhoun.
Armco Inc	Box 96120 Houston, TX 77015	do	Harris.
Austin White Lime Co	Box 9556 Austin, TX 78766	do	Travis.
Champion International Corp	Box 872 Pasadena, TX 77501	do	Harris.
Chemical Lime Inc	Box 427 Clifton, TX 76634	do	Bosque.
Holly Sugar Corp	Drawer 1778 Hereford, TX 79045	do	Deaf Smith.
McDonough Bros., Inc	Route 2, Box 222 San Antonio, TX 78229	do	Bexar.
Round Rock Lime Co	Box 38 Blum, TX 76627	do	Hill.
Texas Lime Co	Box 851 Cleburne, TX 70631	do	Johnson.
United States Gypsum Co	101 South Wacker Dr. Chicago, IL 60606	do	Comal.
Salt:			
Diamond Shamrock Corp	717 North Harwood Dallas, TX 75201	do	Chambers.
The Dow Chemical Co	2020 Dow Center Midland, MI 48640	Brine	Brazoria.
Morton Salt Co	110 North Wacker Dr. Chicago, IL 60606	Underground mine and brine.	Van Zandt.
Texas Brine Corp	2000 West Loop South Houston, TX 77027	Brine	Harris, Jefferson, Matagorda.
Sand and gravel:			
Capitol Aggregates, Inc	Drawer 33240 San Antonio, TX 78233	Stationary plant	Guadalupe, Val Verde, Travis.
Dresser Industries, Inc	Kosse, TX 76653	do	Limestone.
The Fordyce Co	Box 1981 San Antonio, TX 78297	do	Hidalgo and Victoria.
Fort Worth Sand & Gravel Co	Box 400 Arlington, TX 76010	do	Dallas, Denton, Tarrant.
Gifford-Hill & Co., Inc	Box 47127 Dallas, TX 75247	do	Brazos, Clay, Dallas, McLennan, Tarrant.
R. E. Janes Gravel Co	Box 2155 Austin, TX 78767	do	Borden, Crosby, Lubbock, Taylor.
Lone Star Industries, Inc	Box 47327 Dallas, TX 75247	do	Colorado and Denton.
Parker Bros. & Co., Inc	Box 107 Houston, TX 77001	Stationary plant and dredge.	Colorado, Harris, Victoria.
Thorstenberg Materials Corp	1333 West Loop South Suite 1028 Houston, TX 77002	do	Colorado and Fayette.
Shell:			
Parker Bros. & Co., Inc	5303 Navigation Bldg. Box 107 Houston, TX 77001	Dredge	Calhoun.
Sodium (metallic):			
Ethyl Corp	Box 472 Pasadena, TX 77502	Plant	Harris.
Sodium sulfate (natural):			
Ozark-Mahoning Co	1870 South Boulder Tulsa, OK 74119	do	Gaines and Terry.
Stone:			
General Portland, Inc	2800 Republic National Bank Tower Dallas, TX 75201	Quarry	Dallas, Tarrant, Wise.
Gifford-Hill & Co., Inc	Box 47127 Dallas, TX 75247	do	Comal, Ellis, Wise.
Lone Star Industries, Inc	Box 47327 Dallas, TX 75247	do	Burnet, Nolan, Wise.
McDonough Bros., Inc	Route 2, Box 222 San Antonio, TX 78229	do	Bexar.
Parker Bros. & Co., Inc	Box 107 Houston, TX 77001	do	Comal.
Texas Crushed Stone Co	Box 9345 Austin, TX 78717	do	Llano and Williamson.
Texas Industries, Inc	Box 146 Midlothian, TX 76065	do	Ellis and Wise.
White's Mines, Inc	Box 499 San Antonio, TX 78206	do	Brown, Taylor, Uvalde.

Table 13.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sulfur (byproduct):			
Amoco Production Co	Box 591 Tulsa, OK 74102	Secondary recovery	Andrews, Ector, Hockley, Van Zandt, Wood.
Cities Service Oil Co	Box 300 Tulsa, OK 74102	do	Cochran, Dawson, Gaines, Van Zandt.
Getty Oil Co	Box 8 Scroggins, TX 75480	do	Franklin and Freestone.
Gulf Oil Co	Box 701 Port Arthur, TX 77640	do	Jefferson.
Phillips Petroleum Co	Bartlesville, OK 74003	do	Brazoria, Crane, Ector, Hutchinson.
Shell Oil Co	Box 2099 Houston, TX 77001	do	Cass, Harris, Karnes.
Warren Petroleum Corp	Box 1589 Tulsa, OK 74101	do	Crane, Hopkins, Karnes.
Sulfur (native):			
Duval Corp	1906 First City National Bank Houston, TX 77002	Frasch mine	Culberson.
Farmland Industries, Inc	Box 850 Fort Stockton, TX 79735	do	Pecos.
Jefferson Lake Sulfur Co	Box 1185 Houston, TX 77001	do	Fort Bend.
Texasgulf, Inc	200 Park Ave. New York, NY 10017	do	Fort Bend, Jefferson, Liberty, Pecos, Wharton.
Talc:			
Amoco Minerals Co. (Cyprus)	7000 Yosemite St. Box 3299 Englewood, CO 80155	Mine and plant	Hudspeth.
Pioneer Talc Co., Inc	Chatsworth, GA 30705	do	Do.
Southern Clay Products, Inc	Box 44 Gonzales, TX 78629	Mine	Do.
Texas Talc Co	Box 866 Van Horn, TX 79855	do	Do.
Westex Talc Co	Box 15038 Houston, TX 77020	Mine and plant	Culberson and Hudspeth.
Vermiculite:			
W. R. Grace & Co	2651 Manila Rd. Dallas, TX 75200	Exfoliating plant	Bexar and Dallas.
Vermiculite Products, Inc	Box 7327 Houston, TX 77008	do	Harris.

The Mineral Industry of Utah

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Utah Geological and Mineral Survey, for collecting information on all nonfuel minerals.

By Lorraine B. Burgin[1]

The value of nonfuel mineral production in Utah reached a record $783 million in 1981, a 2.6% increase over the $763.6 million achieved in 1980. The State's leading commodities continued to be copper, gold, molybdenum, potash, portland cement, silver, and salt.

Metal production comprised more than three-fourths of the total value of Utah's nonfuel mineral output; copper, the most important commodity, accounted for nearly two-thirds of the value of metal recovered and more than one-half of the total value of nonfuel mineral production. Utah Copper Div. of Kennecott Minerals Co. was the principal producer of copper and the by-product metals, gold, molybdenum, and silver.

Settlement of the 1980 labor strike at the Utah Copper Div. Bingham Canyon Mine

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

Mineral	1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
Clays thousand short tons	365	$1,517	290	$2,296
Copper (recoverable content of ores, etc.) metric tons	157,775	356,251	211,276	396,471
Gem stones	NA	70	NA	80
Gold (recoverable content of ores, etc.) troy ounces	179,538	109,978	227,706	104,663
Gypsum thousand short tons	287	2,612	300	2,705
Iron ore (usable) thousand long tons, gross weight	1,307	18,540	691	W
Lead (recoverable content of ores, etc.) metric tons	rW	rW	1,662	1,338
Lime thousand short tons	259	13,293	333	16,679
Perlite do.	(2)	2	(2)	4
Pumice do.	(3)	(3)	--	--
Salt do.	1,157	19,373	1,072	21,775
Sand and gravel do.	[4]8,906	[4]17,234	pp9,122	pp18,186
Silver (recoverable content of ores, etc.) thousand troy ounces	r2,203	r45,476	2,883	30,321
Stone:				
Crushed thousand short tons	r2,954	r12,123	2,840	12,157
Dimension do.	3	272	3	280
Zinc (recoverable content of ores, etc.) metric tons	rW	rW	1,576	1,548
Combined value of asphalt (native), beryllium concentrate, carbon dioxide (natural), cement, magnesium compounds, molybdenum, phosphate rock, potassium salts, sand and gravel (industrial, 1980), sodium sulfate, tungsten, vanadium, and values indicated by symbol W	XX	r166,883	XX	174,729
Total	XX	r763,624	XX	783,232

pPreliminary. rRevised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Less than 1/2 unit.

[3]Revised to zero.

[4]Excludes industrial sand; value included with "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Beaver	$92	$82	Sand and gravel.
Box Elder	1,260	W	Stone, sand and gravel, salt.
Cache	978	3,166	Sand and gravel, stone.
Carbon	W	W	Sand and gravel, carbon dioxide.
Daggett	20	--	
Davis	W	2,663	Sand and gravel, stone.
Duchesne	439	355	Sand and gravel.
Emery	W	W	Vanadium, stone.
Garfield	W	W	Stone, vanadium.
Grand	10,861	16,479	Potassium salts, salt, vanadium, sand and gravel.
Iron	W	W	Iron ore, sand and gravel, stone.
Juab	W	W	Gypsum.
Kane	350	W	Sand and gravel.
Millard	W	W	Lime, stone, gypsum, sand and gravel, beryllium, perlite.
Morgan	W	W	Cement, stone, sand and gravel.
Rich	--	(2)	Stone.
Salt Lake	589,016	562,264	Copper, gold, molybdenum, silver, cement, salt, sand and gravel, lime, stone, clays.
San Juan	W	W	Vanadium, sand and gravel.
Sanpete	1,466	1,035	Sand and gravel, gypsum, salt, clays.
Sevier	W	W	Gypsum, clays, salt.
Summit	W	W	Silver, zinc, lead, clays, stone.
Tooele	18,187	36,581	Copper, lime, salt, potassium salts, gold, stone, silver, magnesium compounds, sand and gravel, clays, magnesium chloride, tungsten.
Uintah	W	W	Asphalt, phosphate rock, sand and gravel, stone.
Utah	12,140	19,275	Silver, gold, stone, sand and gravel, copper, clays.
Wasatch	1,301	528	Sand and gravel, stone.
Washington	W	429	Do.
Wayne	40	--	
Weber	34,787	27,248	Potassium salts, salt, asphalt, sodium sulfate, magnesium compounds, sand and gravel, clays, stone.
Undistributed[3]	78,344	93,519	
Total	[4]749,282	763,624	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Piute County is not listed because no nonfuel mineral production was reported.
[2]Less than 1/2 unit.
[3]Includes sand and gravel, stone (1979), vanadium (1980), and gem stones that cannot be assigned to specific counties and values indicated by symbol W.
[4]Data do not add to total shown because of independent rounding.

was the chief factor in the return to almost normal levels of copper and byproduct metals output in 1981. The value of copper production reached a record high; however, the fall in the prices for gold, molybdenum, and silver led to a severe drop in the dollar yield of the byproduct metals.

During the year, the State's iron and steel industry was affected by the depressed automotive and construction industries and by foreign steel imports. The reduction in value of molybdenum output was also directly related to a nationwide oversupply and consequent fall in price.

Total value of output in the nonmetals group increased in 1981. The leading commodities, in terms of value, were potash, cement, salt, sand and gravel, native asphalt (gilsonite), lime, phosphate rock, and stone. Potash and sodium sulfate were the only commodities in the nonmetals group that declined in value during the year.

Nationally, Utah ranked 1st in value of production of gilsonite and beryllium hydroxide; 2d in copper, potash, and vanadium; 3d in gold and molybdenum; 5th in phosphate rock; 6th in silver; and 10th in the value of all nonfuel minerals output.

Trends and Developments.—Utah metal production in 1981 began a slow return to normal from the low level reached the preceding year. In 1980, the quantity of copper produced in the State had fallen to its lowest point since 1959, gold had fallen to its lowest point since 1946, and silver had fallen to its lowest point since records were first kept starting in 1877. Lead and zinc production increased slightly from the 1979 record low. The most recent decline in Utah's metal production began in 1959 for copper and silver, the early 1970's for lead and zinc, and 1974 for gold.

The copper strike of 1980 was the major factor in the lower output of copper, gold, and silver that year. The declines noted in precious- and base-metals production in the 1970's were partly attributed to the shutdown of major underground operations in the Park City and Tintic mining districts,

Table 3.—Indicators of Utah business activity

	1980	1981[p]	Change, percent
Employment and labor force, annual average:			
Total civilian labor force ---- thousands	613.2	634.2	+3.4
Unemployment ---- do	39.6	46.6	+17.7
Employment (nonagricultural):			
Mining[1] ---- do	18.5	20.2	+9.2
Manufacturing ---- do	87.7	89.5	+2.0
Contract construction ---- do	31.5	28.3	-10.2
Transportation and public utilities ---- do	34.1	34.5	+1.2
Wholesale and retail trade ---- do	128.7	130.2	+1.2
Finance, insurance, real estate ---- do	25.8	26.3	+1.9
Services ---- do	99.4	103.8	+4.4
Government ---- do	125.0	125.0	--
Total nonagricultural employment[1] ---- do	[2]550.8	557.8	+1.3
Personal income:			
Total ---- millions	$11,249	$12,610	+12.1
Per capita	$7,681	$8,307	+8.2
Construction activity:			
Number of private and public residential units authorized	10,539	7,145	-32.2
Value of nonresidential construction ---- millions	$271.9	$260.0	-4.4
Value of State road contract awards ---- do	$51.0	$65.0	+27.4
Shipments of portland and masonry cement to and within the State, thousand short tons	801	701	-12.5
Nonfuel mineral production value:			
Total crude mineral value ---- millions	$763.6	$783.2	+2.6
Value per capita, resident population	$519	$536	+3.3
Value per square mile	$8,937	$9,224	+3.2

[p]Preliminary.
[1]Includes bituminous coal and oil and gas extraction.
[2]Data do not add to total shown because of independent rounding.

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

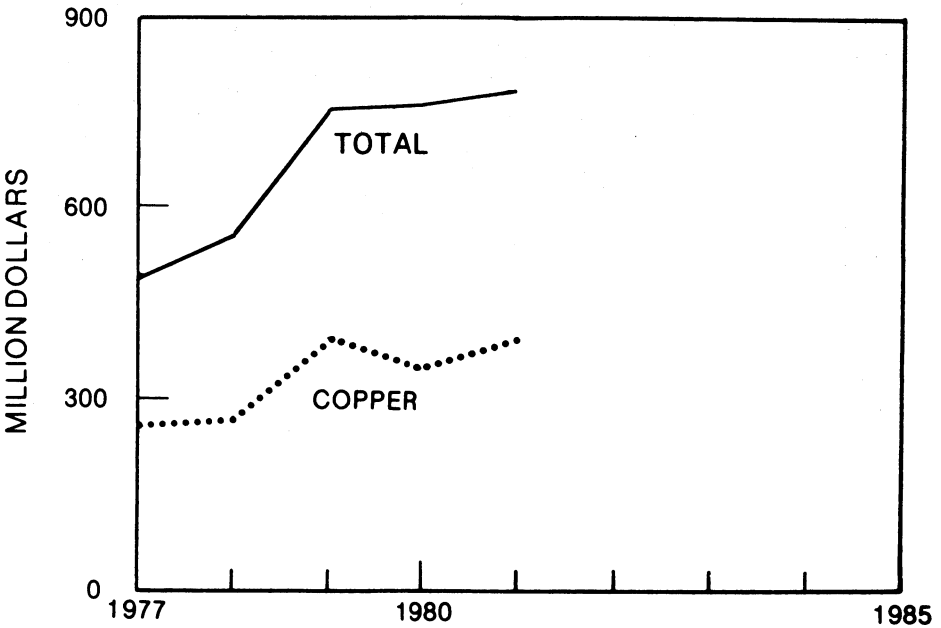

Figure 1.—Value of mine production of copper and total value of nonfuel mineral production in Utah.

when high costs, difficult mining conditions, and low prices for metals prevailed. Higher prices of gold and silver in 1980 and 1981 held the potential for making some precious- and base-metal operations profitable, leading to new exploration projects and the reopening of several mines in the major mining districts in 1981. Prospecting was also noted in other mining districts throughout the State.

In the Eureka area, Sunshine Mining Co. reported spending $3.3 million on exploration and development plans for the Burgin Mine in the East Tintic mining district, Utah County. Four of five drill holes indicated high grades of mineralization and identified three major ore bodies: the Main Burgin, Eureka Standard, and Middle Fault. A new headframe was constructed, and 1,000 feet of the Apex No. 2 shaft was rehabilitated for access to the western section of the mine. ASARCO Incorporated erected a steel headframe on the Chief Consolidated Mining Co. property it leased in the Tintic mining district, Juab County. The Chief No. 2 shaft and some workings on the 1,450-foot level were rehabilitated in preparation for underground exploration and development drilling. At its Trixie operation in the East Tintic mining district, Kennecott Corp. spent $1.4 million on underground and surface drilling and discovered a new ore body in the southern area of the mine; Atlantic Richfield Co. leased the North Lily, also in the East Tintic area, to treat and process tailings, waste dumps, etc.

In other developments, Bullion Monarch Co. acquired silver and lead properties in the Rush Valley mining district, Tooele County, for evaluation and possible exploration. American Gold Minerals Corp. drilled a hydrothermal alteration area on Keg Mountain, Juab County. Horn Silver Mines, Inc., completed access roads and drilling sites at its Horn Silver Mine in southern Utah.

In the Park City mining district, a Dutch investment company, Stiching Mayflower Mountain Fronds, planned a multimillion-dollar resort on the property of the old Mayflower Mine of New Park Resources, Inc., Wasatch County, adjacent to the new Deer Valley Resort. A portion of the resort would adjoin the proposed Jordanelle Reservoir.

The U.S. Bureau of Reclamation continued a three-phase study of the Jordanelle Dam site, 8 miles north of Heber City, and adjacent to the Park City mining district. Mine owners were concerned about possible flooding in the mining area.

Legislation and Government Programs.—Utah's Department of Natural Resources and the Utah Energy Office were reorganized into a new Department of Natural Resources and Energy. Temporarily consolidated for a 2-year study, the new department was expected to improve State functions relating to energy, minerals, and other natural resources, as well as to promote the management, development, and conservation of those resources.

Governor Scott M. Matheson signed into law several bills establishing authority and procedures for disposing of nuclear and hazardous wastes. Placement of high-level nuclear waste in the State would require the Governor's authorization after consultation with local authorities and with the concurrence of the legislature. Two acts authorized the creation of a hazardous-waste authority and provided for adoption of guidelines for locating hazardous-waste treatment, storage, and disposal facilities in the State. State and Federal agencies continued to study removal of radioactive tailings from the old Vitro Chemical Co.'s uranium-vanadium plantsite. Also, the disposal of high-level radioactive wastes in salt domes and other formations was under investigation.

Subject to the Office of Management and Budget approval, in mid-December, the U.S. Department of the Interior issued new rules regulating mining as well as oil and gas drilling in the Glen Canyon National Recreation Area in Utah and Arizona. Drilling or mining companies would have to submit plans to the National Park Service, and the Park Service would consider lease applications on an individual basis.

A guidebook entitled "Permit Requirements for the Development of Energy and Other Selected Natural Resources for the State of Utah" was prepared for the Four Corners Regional Commission and the U.S. Geological Survey in August 1981.

The U.S. Bureau of Mines awarded contracts and grants totaling an estimated $1.5 million to organizations in the State of Utah during fiscal year 1981.

REVIEW BY NONFUEL MINERAL COMMODITIES

METALS

Beryllium.—The quantity and value of beryllium concentrate output was relatively stable in 1981. According to the Brush Wellman, Inc., 1981 annual report, 490,000 pounds of beryllium contained in ore concentrate was recovered from 121,000 tons of ore milled during the year compared with 487,000 pounds recovered from 112,000 tons in 1980. The company estimated ore reserves as of yearend at 3.95 million tons of bertrandite ore with an average grade of 0.23% beryllium.

Bertrandite ores, open pit mined at Spor Mountain, Juab County, were trucked to Brush Wellman's extraction plant at Delta, Millard County. During December 1981, 3.2 million cubic yards of overburden that was removed from the pit exposed ore to be mined in 1982. The company began a program to stimulate beryl ore purchases in the United States and overseas. In December, Brush Wellman announced plans for the $2.5 million modification of its Delta facilities to process beryl ores containing as little as 7% beryllium oxide.[2] The bertrandite ore will remain the chief source of beryllium for the industry.

Beryllium hydroxide concentrate was shipped to Brush Wellman's Elmore, Ohio, refinery for conversion to beryllium alloys, beryllia ceramic, and metallic beryllium.

Copper.—Surpassing the record high set in 1979, the value of copper production increased 11%; output, which rose 34% over that of 1980, reaching its highest point since 1973, reflected the resumption of normal operations after the 1980 copper strike. Declining copper prices, from an average $1.02 per pound in 1980 to an average $0.85 per pound in 1981, prevented a larger increase in value of copper production.

On June 4, 1981, at a cost of $1.77 billion, Utah's principal copper producer, Kennecott Corp., was acquired by Standard Oil Co., an Ohio corporation (Sohio). Sohio was 50% owned by British Petroleum Co. In Utah, Kennecott Minerals, a subsidiary of Kennecott Corp., operated the Utah Copper Div. The facilities included the world's largest open pit copper mine and precipitation plant at Bingham, 25 miles southwest of Salt Lake City; and 16 miles to the north, the Bonneville concentrator and Arthur and Magna flotation concentrators capable of treating 108,000 tons per day of ore, a smelter with an annual production capacity of 280,000 tons of copper anode, and a refinery with an annual capacity of 192,000 tons of copper cathode. On February 11, 1981, a world record was set at the Bingham Mine for hard-rock mining when 638,649 tons of ore and waste was mined in 24 hours. The previous mining record at Bingham was 544,808 tons of material mined in the 24 hours ending November 4, 1978.

According to the Sohio 1981 10K annual report to the Securities and Exchange Commission, the Utah Copper Div. mined and processed 39,024,000 tons of ore to yield 223,123 tons of copper in 1981. In the strike-ridden previous year, 31,578,000 tons of mined and treated ore yielded 200,053 tons of copper. The average grade of ore mined increased from 0.575% copper in 1980 to 0.582% copper in 1981.

At its high-grade North Ore Shoot copper deposit adjacent to the Bingham Canyon open pit mine, the company commenced work on a development project that included sinking a 20-foot-diameter, 4,200-foot shaft, and 3 miles of drift to delineate further the copper, gold, molybdenum, and silver mineralization. At the earliest, production would begin in 1985; when completed, the mine was expected to yield 72,000 tons of copper per year.

Reserves at the Bingham pit were estimated to be over 1 billion tons of ore of 0.63% copper, 0.46% MoS_2, 0.011 ounce of gold, and 0.083 ounce of silver; at the North Ore Shoot, 105 million tons of ore of 2% copper; and at the Bingham underground mine, 615 million tons of ore of 0.75% copper.[3]

During the year, Kennecott Minerals continued a detailed engineering study for modernizing its Utah Copper Div. properties. The proposed project included a new concentrator to replace the three older facilities and in-pit crushing and conveyors to eliminate the present rail-haulage system. Construction was expected to begin in 1983 with completion scheduled by 1986.

In pollution-control matters, Salt Lake County commissioners gave preliminary approval to a Kennecott Corp. request for a $7.2 million issue of tax-free industrial revenue bonds for pollution-control equipment at the Magna smelter. The State also investigated the metal content of water in drainage from the Kennecott Minerals properties into Butterfield Canyon and into Great Salt Lake.

Table 4.—Utah: Mine production (recoverable) of gold, silver, copper, lead, and zinc, by county

County	Lode mines producing	Material sold or treated (metric tons)	Gold		Silver	
			Troy ounces	Value	Troy ounces	Value
1979 total	7	34,412,486	260,916	$80,231,672	2,454,136	$27,216,367
1980 total	r4	r29,384,411	179,538	109,977,798	r2,203,289	r45,475,885
1981:						
Summit	1	33,160	244	112,152	87,900	924,564
Tooele	1	1,276,962	17,712	8,141,144	220,011	2,314,157
Undistributed[1]	7	35,548,237	209,750	96,409,490	2,574,760	27,082,278
Total	9	36,858,359	227,706	104,662,786	2,882,671	30,320,999

County	Copper		Lead		Zinc		Total value
	Metric tons	Value	Metric tons	Value	Metric tons	Value	
1979 total	193,082	$396,002,869	W	W	W	W	$503,465,541
1980 total	157,775	356,251,322	rW	rW	rW	rW	r514,022,502
1981:							
Summit	35	64,849	1,660	$1,337,125	1,575	$1,547,428	3,986,118
Tooele	13,859	26,006,260	--	--	--	--	36,461,561
Undistributed[1]	197,383	370,400,365	1	1,016	(2)	380	493,893,529
Total[3]	211,276	396,471,474	1,662	1,338,141	1,576	1,547,808	534,341,208

rRevised. W Withheld to avoid disclosing company proprietary data.
[1]Box Elder, Juab, Salt Lake, and Utah Counties combined to avoid disclosing company proprietary data.
[2]Less than 500 tons.
[3]Data may not add to totals shown because of independent rounding.

Table 5.—Utah: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1981, by class of ore or other source material

Source	Number of mines[1]	Material sold or treated (metric tons)	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode ore:							
Gold, gold-silver, silver[2]	6	60,533	W	W	[3]605	W	W
Copper	2	36,678,496	[4]227,706	[4]2,882,671	189,049	--	--
Lead-zinc	1	33,160	W	W	W	[5]1,662	[5]1,576
Total	9	36,772,189	[6]227,706	[6]2,882,671	[6]189,654	1,662	1,576
Other lode material:							
Gold tailings	--	57,611	W	W	W	--	--
Copper precipitates	1	28,559	--	--	21,623	--	--
Grand total	9	36,858,359	227,706	2,882,671	[7]211,276	1,662	1,576

W Withheld to avoid disclosing company proprietary data.
[1]Detail will not add to total because some mines produce more than one class of material. An operation from which gold, silver, and copper were recovered from tailings is not counted as a producing mine.
[2]Includes material that was leached.
[3]Includes recovery from lead-zinc ore and from gold tailings.
[4]Includes recovery from gold, gold-silver, and silver ores and from gold tailings.
[5]Includes recovery from gold and silver ores.
[6]Includes recovery from gold tailings.
[7]Data do not add to total shown because of independent rounding.

Anaconda Minerals Co. (formerly the Anaconda Copper Co.), a subsidiary of Atlantic Richfield Co., operated its Carr Fork underground copper mine adjacent to the Bingham Canyon open pit mine of Kennecott Minerals. Two shafts, surface facilities, and a 10,000-ton-per-day concentrator are in Pine Canyon, Tooele County; a third shaft is located in Carr Fork of Bingham Canyon. Concentrates are shipped to Japan for processing. Scheduled to produce 55,000 tons per year of copper when production commenced in 1979, the company reported the Carr Fork Mine yielded 16,100 tons of copper in 1981.

Table 6.—Utah: Mine production (recoverable) of gold, silver, copper, lead, and zinc in 1981, by type of material processed and method of recovery

Type of material processed and method of recovery	Gold (troy ounces)	Silver (troy ounces)	Copper (metric tons)	Lead (metric tons)	Zinc (metric tons)
Lode:					
Cyanidation	--	1,000	--	--	--
Smelting of concentrates	218,462	2,483,786	189,083	1,662	1,576
Direct smelting of:					
Ore and tailings[1]	9,244	397,885	570	--	--
Precipitates	--	--	21,623	--	--
Total	227,706	2,882,671	211,276	1,662	1,576

[1]Combined to avoid disclosing company proprietary data.

Anaconda temporarily suspended production at its Carr Fork Mine on November 18, 1981, citing low market demand and depressed copper prices coupled with the need to complete underground development; up to that point, the mine had operated at about 40% of capacity. Development work and additional engineering studies were planned to prepare the mine for full production when the price of copper improved. About 800 of the 900 employed were retained for mine development work.

Other operations producing copper in the State included Sharon Steel Corp.'s recycling of tailings from the Midvale mill in Salt Lake County; the Noranda Mining Inc.'s Ontario project in the Park City mining district, Summit County; Kennecott Minerals' Iron Blossom Mine in the Tintic mining district, Juab County; and two small operations, one in Salt Lake County and one in Utah County.

Gold.—Output of gold increased over that of 1980 but did not attain its 1979 level; the value of production, however, dropped below the 1980 record high because of the lower metal price. The average price for gold dropped from $612.56 per ounce in 1980 to $459.64 per ounce in 1981.

Utah ranked third in the Nation's gold production; the principal gold producer was Kennecott Minerals, Utah Copper Div., where the metal was recovered as a byproduct of copper output. Other producers included the Carr Fork Mine of Anaconda; the recycled tailings of the Midvale mill of Sharon Steel; the Trixie Mine of Kennecott Minerals; the Ontario project of Noranda Mining; the Iron Blossom Mine of Kennecott Minerals; and one small mine in Salt Lake County.

On July 22, Getty Oil Co. announced that its subsidiary, Getty Mineral Resources Co., would proceed with the development phase of the Mercur Canyon Project, a planned gold mining and milling operation, approximately 40 miles southwest of Salt Lake City. Road construction and site preparation began in September with the open pit mine and 3,000-ton-per-day mill, expected to be operational the second half of 1983. The U.S. Bureau of Mines Metallurgy Research Center in Salt Lake City developed the new process that will be used to recover the micron-sized gold.

The Getty Oil 1981 annual report stated that the Getty Mineral subsidiary was committed to fund 100% of the project, with a former joint-venture participant, Gold Standard, Inc., to receive 15% of the project's net after Getty Mineral recovers its costs. Estimates projected over 10 million tons of ore in place with an average grade of 0.089 ounce of gold per ton.

During the year, Johnson Matthey Investments, Inc., was securing the necessary permits and funding for constructing a $10 million gold and silver refinery in West Valley City, Salt Lake County. The 60,000-square-foot installation was to have an initial capacity of 1 million ounces of gold and 4 million ounces of silver. Small mining operations were to be the feed source of the refinery operated by Johnson Matthey Refining, Inc., the holding company for the London-based company.

Iron Ore.—Shipments of iron ore declined 47% during the year; value dropped 46% as the steel industry adjusted to severe cutbacks in the domestic automotive and construction industries, as well as the influx of foreign steel on the market. The leading iron ore producer in the State, United States Steel Corp., direct shipped iron ore from its Desert Mound Mine in the Iron Springs mining district, west of Cedar City, Iron County, to its Geneva Works steel mill near Orem, Utah County. Another producer in the Iron Springs area was Utah International, Inc., a subsidiary of General Electric Co. The company shipped stockpiled concentrates from its Iron Springs Mine

to the Geneva Works, and, under contract to CF&I Steel Corp., direct shipped iron ore from the Comstock Mine to CF&I's steel plant at Pueblo, Colo.

Layoffs of workers at the Geneva Works of United States Steel began in October, and by early December, about 680 employees had been cut back. Normal employment in 1981 was reported to be 4,900 workers. By mid-November only 4 of the 10 open-hearth furnaces and 2 blast furnaces were operating.

Late in the year, however, United States Steel announced plans to modify its 132-inch mill at the Geneva Works to increase the size of slabs that could be rolled in the mill and to produce a larger, heavier coil with more uniform metallurgical properties through its length. Engineering on the $12 million to $15 million project began in 1981 with construction scheduled for the fourth quarter of 1982 and completion by mid-1983.

In Box Elder County, Nucor Steel Co., a division of Nucor Corp., completed its 400,000-ton-per-year steel mill near Plymouth at midyear. Using scrap, the company reprocessed steel into various products including rebar for markets in Los Angeles and the Pacific Northwest. In addition, in the third quarter, Nucor Corp.'s Vulcraft Div. brought into operation a 40,000-ton-per-year steel joist plant at Brigham City; and in late 1981, the Nucor Grinding Balls Div. at Brigham City started producing steel grinding balls for the mining industry.

Lead.—Utah's lead production increased in quantity and value; Noranda Mining Inc., a subsidiary of Noranda Mines, Ltd., of Canada, shipped lead-zinc ore from its Summit County Ontario project, under lease from United Park City Mines Co. On May 29, 1981, however, Noranda Mining suspended mining operations because of problems with productivity and grade of ore, and because of low metal prices. The company continued a limited exploration and development program on the United Park properties and on the adjacent Park City Consolidated Mines Co. properties in Summit County. Two small precious- and base-metal operations, one in Salt Lake County and the other in Utah County, produced lead. Lead prices in 1981 averaged $0.3653 per pound compared with $0.3743 in 1980.

Magnesium.—AMAX Specialty Metals Corp., Magnesium Div., a subsidiary of AMAX Inc., produced magnesium metal and byproduct chlorine at the Rowley plant, Tooele County. Purchased from NL Industries, Inc., in 1980, the plant was operated at full capacity of 25,000 metric tons per year; however, the planned $60 million expansion program to increase the operating capacity to 47,000 metric tons per year was held in abeyance until the demand for magnesium improved. Approximately 40% of the magnesium the company sold was exported.

In other developments, 500 of the 750 workers employed at the plant went on strike in the second quarter of 1981. After 1 week, the employees accepted a 10% wage increase offer and returned to work.

Molybdenum.—Utah ranked third in the Nation in molybdenum production in 1981. Utah Copper Div., the only producer, continued shipping molybdenum concentrates recovered as a byproduct of copper production. As a result of resumption of operations at its Bingham Mine after the 1980 labor strike, molybdenum output increased; however, the value of production dropped nearly one-fourth because of declining molybdenum prices. The average producer's price per pound of molybdenum contained in technical-grade molybdic oxide dropped from $9.70 in 1980 to $6.85 in 1981.

In 1981, Pine Grove Associates, in a joint-venture project with Phelps Dodge Corp. and Getty Oil, continued evaluating the Pine Grove molybdenum deposit in the Wah Wah Mountains, western Beaver County. Getty Oil was granted an option to purchase the Phelps Dodge interest in the deposit in 1981; the option expires December 15, 1982.

Selenium.—Utah Copper Div. continued producing selenium recovered as a byproduct from copper refining. Resumption of operations after the labor strike in 1980 increased copper throughput at the refinery, and selenium production rose.

Silver.—Nationally, Utah ranked sixth in silver production. The amount of silver from the State's mines increased over the strike-induced decline of 1980 and surpassed 1979 production. The value of silver production in 1981, however, fell from the alltime high reached in 1980, when the average price of silver was $20.63 per ounce. In 1981, the price of silver dropped to $10.52 per ounce.

The Bingham Canyon Mine of the Kennecott Minerals Utah Copper Div. continued to be the major silver source in the State. Other leading operations with silver output included Kennecott Minerals' Trixie Mine, Anaconda Minerals' Carr Fork Mine, Sharon Steel's Midvale tailings project, and Noranda Mining's Ontario project. Five small mines in Box Elder, Juab, and Utah Counties recovered silver from their base-

and precious-metal operations.

Ranchers Exploration and Development Corp., on October 16, announced that the first silver bullion was poured at its Escalante operation about 3 miles west of Beryl Junction, Iron County, and 7 miles north of Enterprise, Washington County.

The mill and refining facility were begun in 1980, completed on August 20, 1981, and by yearend, achieved production of about 125,000 ounces of silver per month. The basic facilities included crushing and grinding equipment and leaching tanks to produce precipitates and bullion.

About a year's supply of feed for the mill, 130,000 tons of ore, was stockpiled underground and on the surface. Throughout the year, development work continued on constructing a 4,700-foot decline to be used for access. The new vertical-retreat mining method was reported working well, and the mine made slightly less water than expected.

As of October, the company estimated reserves at more than 2.6 million tons of ore with an average grade of 12.5 ounces of silver per ton, or more than 33 million ounces of contained silver.

Tungsten.—Production of tungsten increased in value and quantity in 1981. Scheelite mined and milled by the Abracadabra Exploration Corp. at its Fraction Lode near Gold Hill, Tooele County, was shipped to Kennametal Corp.

Vanadium.—Vanadium was recovered from uranium-vanadium ores mined in Emery, Garfield, Grand, and San Juan Counties. Ores and concentrates from these areas were shipped to the Atlas Corp. mill at Moab, Grand County; to the Energy Fuels Nuclear, Inc., mill at Blanding, San Juan County; or to the Union Carbide Corp. mill at Uravan, Colo. Vanadium production increased in value and quantity in 1981, with Utah ranking second out of the six States producing vanadium in the Nation.

In the Colorado Plateau area, development was curtailed at Hecla Mining Co.'s Lisbon Valley uranium-vanadium mine, although Union Carbide, partner in the joint venture, continued to operate the mine on a single-shift basis; production was expected in 1983. In its annual report, Atlas Corp. stated that its Minerals Div. sold approximately 2.3 million pounds of vanadium pentoxide in the fiscal year ending June 30, 1981.

Zinc.—Zinc output increased in quantity and value over that of the previous year; the principal producer was the Ontario project of Noranda Mining Inc., in the Park City mining district. Two small operations, one in Salt Lake County and the other in Utah County, also shipped zinc ores to the smelter. Zinc prices in 1981 averaged $0.4455 per pound compared with $0.3743 per pound in 1980.

NONMETALS

Native Asphalt and Other Bitumens.—Utah is the only producer of asphaltite, also called gilsonite or uintahite, a solidified hydrocarbon. During the year, gilsonite was mined by American Gilsonite Co. from nearly vertical veins at Bonanza, Uintah County, about 52 miles southeast of Vernal; and by Ziegler Chemical & Minerals Corp. from veins at Little Bonanza, about 5 miles northwest of Bonanza. American Gilsonite processed the material through its newly completed 120,000-ton-per-day plant and bagged or trucked the product in bulk to the railhead at Craig, Colo., for shipment to market.

Marketed as a dry product, gilsonite was used in automobile bodysealer products, cement for the oil industry, asphaltic building products, protective coverings, paints, rotogravure printing ink, explosives, and in the nuclear industry.[4]

In January 1981, Standard Oil Co. of California (Socal) became the sole owner of American Gilsonite with payment of $22 million to Barber Oil Corp. The two companies had been equal owners of American Gilsonite since 1946.

Cement.—Production of cement increased slightly in amount, and with higher prices for most types of gray portland cement, the product rose almost 15% in value. According to its 1981 annual report, Ideal Basic Industries, Inc., shipped finished portland and masonry cement from its 350,000-ton-per-year wet-process plant at Devils Slide, Morgan County. Limestone quarries in Parley's Canyon, Salt Lake County, and Grantsville, Tooele County, continued to supply the Portland Cement Co. of Utah, a division of Lone Star Industries, Inc., wet-process cement plant in Salt Lake County. Recently expanded, the plant had a rated capacity of 350,000 tons of cement annually.[5]

On November 14, 1981, the new $85 million, 650,000-ton-per-year Leamington plant of Martin Marietta Corp.'s Mountain Div. came online. The dry-process operation, constructed in a record-breaking 17 months and 9 days, is about 100 miles south of Salt Lake City. Part of the project is the new distribution terminal located at Murray,

Salt Lake County. Cement will be distributed to markets in Utah; western Colorado; and sections of Idaho, Nevada, and Wyoming.[6]

Clays.—Although output of clay and shale decreased during the year, value rose over 51%. Common clay and shale was mined by Utelite Corp., Summit County, for use in concrete block and structural concrete; and by Interpace Corp. in Sevier, Utah, and Weber Counties, for use in making face brick. Mountain Fuel Supply Co. continued to mine clay and shale for plastics at its Cottonwood Mine in Salt Lake County; and for face brick at its Henefer Mine, Summit County; Five Mile Mine, Tooele County; and Jim Gay Mine, Utah County. Redmond Clay and Salt Co. mined swelling bentonite in Sanpete County for waterproofing and sealing. Western Clay Co. obtained swelling bentonite at its Redmond pit, Sevier County, for use in fertilizers. The company also mined fuller's earth at the Aurora Mine, Sevier County, for use in catalytic oil refining and in pesticides and related products. R. D. Wadley Clay Co. mined fire clay at the Wadley Mine in Utah County.

The average unit value of clay in 1981 was $7.92 compared with $4.16 in 1980.

Graphite (Synthetic).—Production of synthetic graphite in Utah continued to increase in quantity and value in 1981. A high-modulus synthetic graphite fiber was produced by Hercules, Inc., at Bacchus, Salt Lake County, and by Fiber Technology Corp. at Provo, Utah County.

Gypsum.—United States Gypsum Co. and Georgia-Pacific Corp., leading producers in the State, mined and calcined gypsum at installations near Sigurd, Sevier County. Used principally in manufacturing wallboard and plaster, crude gypsum production increased in quantity and value in 1981; calcined gypsum, however, rose in output but declined substantially in value. Cox Enterprises, Inc., Sanpete County; Thomas J. Peck & Sons, Inc., Juab County; and White Mountain Gypsum Co., Millard County, all continued to mine crude gypsum.

Lime.—Utah Marblehead Lime Co., a division of General Dynamics Corp., was the leading producer of dead-burned dolomite made from dolomitic limestone mined in the Lakeside Mountains, Tooele County. The product was shipped by rail and truck to steel plants in British Columbia, Canada, California, Utah, and Washington. Continental Lime Co., a subsidiary of Steel Bros. Canada, Ltd., manufactured lime from a high-calcium limestone quarry in the Cricket Mountains, approximately 6 miles west of its 500-ton-per-day plant, about 35 miles south of Delta, Millard County. The lime is used for pH control by the copper, gold, and uranium industries.[7] Kennecott Minerals' Utah Copper Div., Salt Lake County, produced lime for use in its copper operations; and Genstar Cement and Lime Co., a subsidiary of Genstar Corp., of Toronto, Canada, produced lime for finishing lime, electric steel production, and copper ore concentration.

Magnesium Compounds.—Great Salt Lake Minerals & Chemicals Corp., a division of Gulf Resources & Chemical Corp., recovered magnesium chloride and other mineral products from the brines of Great Salt Lake, west of Ogden. Using a process of solar evaporation, selective crystallization and deposition of salts, the magnesium chloride is contained in the concentrated final brine solutions (bitterns) in the solar-evaporation ponds. The product was used as a dust suppressant for roads and industrial areas and in the sugar beet processing industry. Production of the commodity almost doubled in quantity and more than doubled in value.

Perlite.—Production of expanded perlite from crude perlite obtained out of State increased substantially in quantity and value in 1981. The Pax Co., at its plant in Salt Lake City, and Georgia-Pacific, at its plant in Sigurd, continued to produce expanded perlite for use as a plaster aggregate in the construction industry. The product was also sold for use in horticultural aggregates, in formed products, and as an insulation material. Mountain Maid, Inc., continued to mine a small amount of crude perlite near Fillmore, Millard County.

Phosphate Rock.—Production of phosphate rock increased slightly in quantity and substantially in value in 1981. Of the seven States producing phosphate, Utah ranked fifth, all output coming from the open pit mine 12 miles north of Vernal, Uintah County. At yearend 1980, Socal acquired the Stauffer Chemical Co. phosphate mining reserves and processing plant near Vernal; the railroad terminal at Phoston, Wasatch County; and the fertilizer manufacturing installation at Garfield, Salt Lake County. Early in 1981, Chevron Resources Co., a subsidiary of Socal, assumed operation of the Stauffer facilities near Vernal; and Chevron Chemical Co., another subsidiary, took over management of the

fertilizer plant at Garfield. Socal revealed plans to build a new fertilizer plant near Rock Springs, Wyo. Chevron Chemical plans to manufacture wet phosphoric acid and phosphates fertilizer using byproduct sulfur from sour gas wells in Wyoming. The low-cost sulfur for making the sulfuric acid will be recovered from natural sour gas produced from Chevron U.S.A., Inc.'s wells in the Carter Creek area in southwestern Wyoming. Ammonia could be produced from the natural gas and reacted phosphoric acid to produce diammonium phosphate. The fertilizer would be marketed in the Midwest and Western United States.

Potash.—Three companies produced potassium salts in the State: Great Salt Lake Minerals & Chemicals, Kaiser Aluminum & Chemical Corp., and Texasgulf, Inc. The quantity and value of sales decreased because of the fall in demand for fertilizer attributed to declining crop prices and high interest rates.

Great Salt Lake Minerals & Chemicals used solar evaporation and selective crystallization to extract potassium sulfate and byproduct salt, sodium sulfate, and magnesium chloride from concentrated brines of Great Salt Lake. Salts were harvested from 17,000 acres of solar ponds and processed through plants located west of Ogden at Little Mountain, Weber County. Underway was the first phase of a $10 million expansion project to increase the size of the solar ponds to 34,000 acres; the project was to be completed in 4 years. The company extracted brines from the north arm of the lake where potassium is 50% more concentrated than in the south arm.[8] Used as a specialty fertilizer, potassium sulfate is marketed worldwide.

Kaiser recovered potassium salts from brines at its plant, near Wendover, Tooele County. Salts were marketed as standard and coarse potassium chloride (muriate of potash) and manure salts (a mixture of the muriates of potassium and sodium). Brines, extracted from aquifers in the salt sediments of the Bonneville Salt Flats, were collected in solar evaporation ponds and then processed through a flotation concentrator to separate halite (muriate of sodium) and sylvite (muriate of potash).

Texasgulf of Société Nationale Elf Aquitaine (a French Government-controlled oil firm), recovered potassium salts at its Cane Creek operation near Moab, Grand County. Products marketed included standard, coarse, and granular muriate of potash. Potassium, recovered by solution mining Pennsylvanian evaporites at a depth of 2,789 feet, was processed by solar concentration and froth flotation to recover the potassium salts.

Salt.—Producers of solar salt in 1981, listed in alphabetical order, were American Salt Co., Solar Div., Tooele County; Great Salt Lake Minerals & Chemicals, Weber County; Lake Crystal Salt Co., Box Elder County; Lakepoint Salt Co., Tooele County; Morton Salt Co. of Morton-Norwich, Inc., Salt Lake County; and Texasgulf, Grand County. Redmond Clay and Salt produced rock salt and brine in Sevier County, and Moab Brine (LaSal Oil Co.) recovered salt from brine in Grand County. Redmond Clay and Salt acquired the Albert Poulson Salt Co. brine operation in Sanpete County. Salt production declined in amount but increased in value over that of the previous year.

Sand and Gravel.—This chapter contains only preliminary estimates for construction sand and gravel production but contains complete data on industrial sand and gravel. To reduce reporting burdens and costs, the Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Preliminary estimates indicated total sand and gravel production increased slightly in both quantity and value. Industrial sand and gravel, however, declined in quantity but increased in value. Salt Lake Valley Sand & Gravel Co. was the sole producer of industrial sand during the year with the product used for sandblasting and as a mold and core foundry sand.

Table 7.—Utah: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	3,203	$6,994	$2.18	NA	NA	NA
Gravel	5,702	10,240	1.80	NA	NA	NA
Total or average	[1]8,906	17,234	1.94	[p]9,100	[p]$17,900	[p]$1.97
Industrial sand	W	W	--	22	286	13.00
Grand total or average	W	W	W	[p]9,122	[p]18,186	[p]1.99

[p]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Data do not add to total shown because of independent rounding.

Sodium Sulfate.—Great Salt Lake Minerals & Chemicals recovered sodium sulfate from the brines of Great Salt Lake at its operation west of Ogden. Production in 1981 declined when abnormally warm temperatures during the winter of 1980-81 reduced the deposition of salts from which the sodium sulfate was produced. The commodity was used in the ceramic, detergent, glass, and paper industries.

Stone.—The quantity and value of stone production remained relatively stable during 1981, although the tonnage of crushed stone dipped because of the decline in construction, which particularly affected the steel and cement industries.

Listed in descending order of output, the following quarried limestone: United States Steel, Utah County, for use as flux, surface-treatment aggregate, railroad ballast, or dusting material at its various operations; Ideal, Morgan County, for cement; the Southern Pacific Transportation Co., Box Elder County, for riprap and jetty stone; Lone Star, Salt Lake County, for cement; Continental Lime, Millard County, for lime manufacture; Peter Kiewitt & Sons Co., Salt Lake County, for ballast; LeGrand Johnson Construction Co., Cache County, for agricultural limestone; McFarland and Hullinger and Genstar Cement and Lime, Tooele County, for lime manufacture; Mountain Div. of Martin Marietta, Juab County, for cement; and Cedarstrom Calcite Co., Utah County, for poultry grit. Marblehead Lime Co. quarried a dolomitic limestone in Tooele County for dead-burned dolomite and a refractory stone for metallurgical purposes. Sandstone was quarried by Ideal and Martin Marietta for cement manufacture and by the Cache County Road Department for dense-graded road base stone. Star Stone, Inc., quarried dimension stone in Box Elder County.

Crushed stone was produced at 14 quarries in 8 counties in 1981.

Table 8.—Utah: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	178	1,228	127	945
Concrete aggregate	[r]8	[r]23	--	--
Dense-graded road base stone	--	--	174	267
Filter stone	--	--	70	W
Other construction aggregate and road stone	50	156	--	--
Manufactured fine aggregate (stone sand)	(2)	4	--	--
Terrazzo and exposed aggregate	[r]28	[r]347	--	--
Cement manufacture	1,081	3,569	833	3,442
Lime manufacture	W	W	338	1,518
Other[3]	1,608	6,796	1,298	5,984
Total[4]	[r]2,954	[r]12,123	2,840	12,157

[r]Revised to include volcanic cinder and scoria. W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, granite (1980), marble (1980), sandstone, traprock (1980), and volcanic cinder and scoria.
[2]Less than 1/2 unit.
[3]Includes stone used in poultry grit and mineral food, surface treatment aggregate, riprap and jetty stone, railroad ballast, dead-burned dolomite, flux stone, refractory stone, mine dusting, and items indicated by symbol W.
[4]Data may not add to totals shown because of independent rounding.

Sulfuric Acid.—Utah ranked third in the Nation in output of byproduct sulfuric acid, which was recovered at the Kennecott Minerals' smelter operation, Salt Lake County.

Vermiculite.—Vermiculite Intermountain, Inc., continued to produce exfoliated vermiculite from the crude commodity shipped into the State. The product was used mainly in the construction industry for block and loose-fill insulation, fireproofing, concrete and plaster aggregate, and pipe covering. In agriculture, vermiculite was used as a soil conditioner.

[1]State Liaison Officer, Bureau of Mines, Denver, Colo.
[2]Brush Wellman, Inc. News. Brush Wellman Develops Process for Utilizing Lower Grade Beryl Ores. Dec. 2, 1981, 1 p.
[3]Argall, G. O. Takeovers Shake USA Mining Companies. World Min., v. 34, No. 5, May 1981, p. 59.
[4]Jackson, D. (editor). American Gilsonite: Mining Solid Hydrocarbon. Eng. & Min. J., v. 180, No. 7, July 1981, pp. 88-91.
[5]Lone Star Industries, Inc. 1981 Annual Report. P. 20.
[6]Herod, S. Martin Marietta's New Utah Plant on Line in Record Time. Pit & Quarry, v. 74, No. 13, July 1982, pp. 52-60.
[7]Robertson, J. L. Convenient Raw Material Leads to Lime Plant Opening. Rock Prod., v. 84, No. 10, October 1981, pp. 54-58.
[8]Gulf Resources and Chemical Corp. 10K Annual Report, 1981, pp. 15-16.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
Asphalt:			
American Gilsonite Co., a subsidiary of Standard Oil Co. of California.	Suite 1150, Kennecott Bldg. Salt Lake City, UT 84133	Underground mines and plant	Uintah.
Beryllium:			
Brush Wellman, Inc	67 West 2950 South Salt Lake City, UT 84115	Open pit mines and plant	Juab and Millard.
Cement:			
Ideal Basic Industries, Inc., Cement Div.[1]	Star Route Morgan, UT 84050	do	Morgan.
Martin Marietta Cement, Mountain Div., a subsidiary of Martin Marietta Corp.	4885 South 900, East Salt Lake City, UT 84117	Quarries and plant	Millard.
Portland Cement Co. of Utah, a division of Lone Star Industries, Inc.[1]	615 West 800 South Box 1469 Salt Lake City, UT 84110	do	Salt Lake and Tooele.
Clays:			
Interpace Corp., Structural Div.	736 West Harrisville Rd. Box 447 Ogden, UT 84402	Open pit mines and plant	Sevier, Utah, Weber.
Interstate Brick Co., a subsidiary of Mountain Fuel Supply Co.	9210 South 5200 West West Jordan, UT 84084	do	Piute, Salt Lake, Toole, Utah.
Utelite Corp	Box 387 Coalville, UT 84017	Open pit mine and plant	Summit.
Western Clay Co	Box 1067 Aurora, UT 84620	Open pit mines	Sevier.
Copper:			
Anaconda Minerals Co., a subsidiary of Atlantic Richfield Co., Carr Fork Operations.[2]	R.F.D. 1, Box 79 Tooele, UT 84074	Underground mine and mill	Tooele.
Kennecott Minerals Co., a subsidiary of Kennecott Corp., Utah Copper Div.[3]	1129 East 3900 South Box 6500 Salt Lake City, UT 84106	Open pit mine, mills, smelter, refinery.	Salt Lake and Utah.
Gypsum:			
Georgia-Pacific Corp	Sigurd, UT 84657	Open pit mine and plant	Sevier.
United States Gypsum Co	Box 128 Sigurd, UT 84657	Quarry and plant	Do.
Iron ore:			
United States Steel Corp., Utah Ore Operations.	Box 859 Cedar City, UT 84720	Open pit mines	Iron.
Utah International, Inc	Box 649 Cedar City, UT 84720	Open pit mines and plants	Do.
Lead:			
Noranda Mining Inc., a subsidiary of Noranda Mines, Ltd., Ontario Project.[4]	Box 1450 Park City, UT 84060	Underground mine and mill	Summit.
Lime:			
Continental Lime Co., a subsidiary of Steel Bros. Canada, Ltd.	268 West 400 South Suite 201 Salt Lake City, UT 84101	Quarry and plant	Millard.
Genstar Cement and Lime Co., a division of Genstar Corp.	Box 357 Grantsville, UT 84029	Open pit mine and plant	Tooele.
Utah Marblehead Lime Co., a subsidiary of General Dynamics Corp.	Box 596 Grantsville, UT 84029	do	Do.

See footnotes at end of table.

Table 9.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Magnesium:			
AMAX Specialty Metals Corp., Magnesium Div., a subsidiary of AMAX Inc.	238 North 2200 West Salt Lake City, UT 84116	Plant	Tooele.
Phosphate rock:			
Chevron Resources Co., a division of Chevron Industries, Inc., a subsidiary of Standard Oil Co. of California.	Manila Star Route Vernal, UT 84078	Underground mine and plant	Uintah.
Potassium salts:			
Great Salt Lake Minerals & Chemicals Corp., a division of Gulf Resources & Chemical Corp.[5]	765 North 10500 West Little Mountain Box 1190 Ogden, UT 84402	Solar evaporation, concentrator, plant.	Weber.
Kaiser Aluminum & Chemical Corp., Bonneville, Ltd., Div.[6]	Box 580 Wendover, UT 84083	____do	Tooele.
Texasgulf, Inc., a subsidiary of Société Nationale Elf Aquitaine.	Box 1208 Moab, UT 84532	Solution mine, solar evaporation, concentrator, plant.	Grand.
Salt:			
American Salt Co	Box 477 Grantsville, UT 84029	Plant	Tooele.
Morton Salt Co., a division of Morton-Norwich, Inc.	A.M.F. Box 22054 Salt Lake City, UT 84122	____do	Salt Lake.
Sand and gravel:			
Concrete Products Co., a division of Gibbons & Reed Co.	41 West Central Ave. Box 7356 Murray, UT 84107	Pits and plant	Davis and Salt Lake.
LeGrand Johnson Construction Co.[1]	1000 South Main Box 248 Logan, UT 84321	____do	Cache and Rich.
Monroc, Inc	1730 North Beck St. Box 537 Salt Lake City, UT 84110	____do	Salt Lake.
Salt Lake Valley Sand & Gravel Co.	800 North 1550 West Orem, UT 84057	Pit	Do.
Stone:			
McFarland and Hullinger	915 North Main Tooele, UT 84704	Quarry	Tooele.
Southern Pacific Transportation Co.	One Market Plaza San Francisco, CA 94105	____do	Box Elder.
Star Stone, Inc	Box 218 Oakley, ID 83346	____do	Do.
United States Steel Corp., Western Stone Operations.	Box 857 Santaquin, UT 84655	____do	Utah.
Uranium-vanadium:			
Atlas Minerals Div. of Atlas Corp.	Box 1207 Moab, UT 84532	Underground mines and plant	Emery, Grand, San Juan.
Energy Fuels Nuclear, Inc	Box 787 Blanding, UT 84511	Underground mines, ore-buying station, mill.	Emery, Garfield, San Juan.
Union Carbide Corp., Metals Div.	Box 1029 Grand Junction, CO 81501	Underground mines	Grand and San Juan.

[1]Also stone.
[2]Also gold and silver.
[3]Also gold, lime, molybdenum, rhenium, selenium, silver, and stone.
[4]Also copper, gold, silver, and zinc.
[5]Also magnesium compounds, salt, and sodium sulfate.
[6]Also magnesium compounds.

The Mineral Industry of Vermont

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Office of the State Geologist, Agency of Environmental Conservation, for collecting information on all nonfuel minerals.

By L. J. Prosser, Jr.,[1] and Charles A. Ratté[2]

The value of nonfuel mineral production in Vermont in 1981 was $51 million, $8.4 million more than that of 1980. About $7 million of the increase was attributed to the value of dimension stone output. Nationally, Vermont ranked first in dimension stone sales, accounting for about one-fifth of the U.S. total. The State was also a leading domestic producer of asbestos and talc, ranking second and third, respectively. Sand and gravel and crushed stone also contributed to the State's mineral value.

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

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Sand and gravel	thousand short tons	1,900	$4,171	[p]1,900	[p]$4,200
Stone:					
Crushed	do.	1,320	4,787	1,319	5,144
Dimension	do.	169	23,649	207	30,756
Talc	do.	318	2,753	W	W
Combined value of other nonmetals and value indicated by symbol W		XX	7,277	XX	10,919
Total		XX	42,637	XX	51,019

[p]Preliminary. W Withheld to avoid disclosing company proprietary data ; value included in "Combined value" figure.
XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

Table 2.—Value of nonfuel mineral production in Vermont, by county

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Addison	W	W	Sand and gravel, stone.
Bennington	$1,453	$942	Do.
Caledonia	1,094	W	Sand and gravel.
Chittenden	W	W	Stone, sand and gravel.
Essex	W	W	Sand and gravel.
Franklin	W	W	Stone, sand and gravel.
Grand Isle	W	6	Stone.
Lamoille	W	W	Asbestos, talc, sand and gravel, stone.
Orange	1,093	W	Stone, sand and gravel.
Orleans	W	494	Sand and gravel, stone.
Rutland	W	W	Stone, sand and gravel.
Washington	W	W	Do.
Windham	W	—	
Windsor	W	W	Talc, stone, sand and gravel.
Undistributed[1]	50,494	41,194	
Total[2]	54,136	42,637	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Includes gem stones and values indicated by symbol W.
[2]Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Vermont business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	248.9	256.7	+3.1
Unemployment	do	15.5	15.4	-.6
Employment (nonagricultural):				
Mining	do	.7	.6	-14.3
Manufacturing	do	50.9	50.8	-.2
Contract construction	do	10.1	10.7	+5.9
Transportation and public utilities	do	8.7	8.6	-1.2
Wholesale and retail trade	do	40.8	42.1	+3.2
Finance, insurance, real estate	do	8.0	8.2	+2.5
Services	do	43.9	44.5	+1.4
Government	do	37.0	36.6	-1.1
Total nonagricultural employment	do	200.1	202.1	+1.0
Personal income:				
Total	millions	$4,004	$4,462	+11.4
Per capita		$7,810	$8,654	+10.8
Construction activity:				
Number of private and public residential units authorized		3,038	3,962	+30.4
Value of nonresidential construction	millions	$10.5	$32.6	+210.5
Value of State road contract awards	do	$62.4	$32.5	-47.9
Shipments of portland and masonry cement to and within the State	thousand short tons	129	130	+.8
Nonfuel mineral production value:				
Total crude mineral value	millions	$42.6	$51.0	+19.7
Value per capita, resident population		$83	$100	+20.5
Value per square mile		$4,437	$5,310	+19.7

[p]Preliminary.

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

Trends and Developments.—In the past several years, Vermont's dimension stone industry has continued to increase in importance. In 1981, dimension stone value accounted for about 60% of the State's total mineral value, a 22% increase over that of 1975. Output increased to the current level of about 15% of the Nation's dimension stone production. Vermont output has increased from about 120,000 tons in 1975 to more than 200,000 tons in 1981; U.S. production has averaged about 1.3 million tons during the same period.

In May, granite industry workers in the Barre area of central Vermont accepted a 3-year contract ending a 2-week strike. The stoppage, the first in a decade to shut down the area's granite operations, temporarily

idled about 1,200 workers. Also during the year, Vermont Minerals, Ltd., Montpelier, continued work on a flotation system designed to recover silicon carbide from granite sludge. Full-scale operations were expected to be underway in 1982 with recovery capacity estimated at 25 to 50 tons per day.

After nearly a year, Middlebury planning and zoning officials severely restricted new marble mining operations in the area by adopting a "buffer zone" requirement. The zoning ordinance stipulates that a new quarry must be located 2,000 feet from all existing structures. Current operations were not affected by the revised zoning ordinance.

In other developments, Hinesburg Sand & Gravel Co., Chittenden County, devised a computerized process control system for its sand classification plant. The system was designed to control classification and reblending of sand into several product grades.[3]

In western Vermont, a Massachusetts firm was reportedly investigating the kaolinitic clay belt. Kaolin was last mined in Bennington County in the 1930's for use by the paper, pottery, fire clay, and brick industries.[4] Common clay was last produced in Vermont in 1970 at Essex Junction, Chittenden County.

Legislation and Government Programs.—Because of the renewed interest in oil, gas, and mineral potential in western Vermont, the State Geologist was assisting the Vermont Natural Gas and Oil Resources Board in developing oil and gas legislation.

During the year, the U.S. Bureau of Mines completed two Mineral Land Assessment Reports: One on the mineral resources of the Lye Brook Wilderness in Bennington and Windham Counties,[5] and the other on the Bristol Cliffs Wilderness Areas in Addison County.[6]

The Bureau also continued work on development of asbestos substitutes through a contract with the University of California at Los Angeles (UCLA). Among the raw materials used in the research were quantities of Vermont marble and slate. According to a UCLA report, glass fibers from mixtures of Vermont slate and marble were found to have better alkali resistance than commercially available glass fibers. The report also indicated that the slate glass fibers appeared to be comparable with chrysotile asbestos in alkali-resistant properties.[7]

The Vermont Division of Geology and Earth Resources (DGER), Agency of Environmental Conservation continued a cooperative topographic mapping program with the U.S. Geological Survey (USGS). The USGS also conducted petrographic, mineralogic, and chemical studies at the inactive Elizabeth Mine in Vermont's copper belt.

The DGER also received a U.S. Department of Energy (DOE) grant to provide an overview of DOE geologic and environmental literature studies on the State's potential for disposal of nuclear waste. Other activities by the DGER in 1981 included preparation of informational pamphlets on gold, gas, and oil, sand and gravel operators, and the State's mineral industry.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Asbestos.—Vermont again ranked second nationally in asbestos production. U.S. shipments in 1981 totaled 83,354 short tons; California and Arizona, ranking first and third, respectively, were the only other producing States.

The Vermont Asbestos Group, Inc. (VAG), the State's sole producer, was intermittently shut down a total of 12 weeks during the year. Production and sales declined in 1981 compared with 1980 levels primarily because of a weakened demand from the depressed construction and automobile industries.

Since 1978, sales of asbestos fibers by VAG have declined about 33%. In an attempt to strengthen the firm's financial situation, VAG leased its subsidiary, Vermont Industrial Products, to Masonite, Inc. Masonite was given the option to purchase the subsidiary, a manufacturer of fire-resistant wallboard, in the third year of the agreement. VAG also sold about 15% of its stock to Connell Brothers, which has acted as a broker for the firm in Far East sales. Connell Brothers is a subsidiary of Wilbur Ellis Co., which has a 46% interest in the Copperopolis Mine in Calaveras County, Calif.[8] The Copperopolis Mine was the Nation's leading asbestos-producing operation in 1981.

Also during the year, VAG proposed us-

ing part of its Lowell Mine for an asbestos waste dump. The proposal specified that the only material to be disposed at the site would be that from firms that purchased asbestos mined by VAG. However, Lowell residents, many of whom work at the mine, protested the disposal proposal, and an ordinance was adopted banning the waste dump.

In April, a strike by the 175 workers of VAG was averted 1 day before a scheduled walkout. A new 2-year contract was signed that extended through March 1983.

Sand and Gravel.—The U.S. Bureau of Mines, to reduce reporting burdens and costs, implemented new sand and gravel canvassing procedures for the survey of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel operators will be conducted for even-numbered years only. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Based on the preliminary data, production of sand and gravel remained the same in 1981 compared with that of 1980. Historically, leading counties in terms of output have been Bennington, Addison, and Chittenden. During the past few years, most of the sand and gravel mined was used for concrete aggregate, road base, and fill.

Table 4.—Vermont: Construction sand and gravel sold or used by producers

	1980			1981[p]		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Sand	842	$1,860	$2.21	NA	NA	NA
Gravel	1,058	2,311	2.19	NA	NA	NA
Total or average	1,900	4,171	2.20	1,900	$4,200	$2.21

[p]Preliminary. NA Not available.

Stone.—Nationally, Vermont again ranked first in the value of dimension stone production. About 207,000 tons (2.2 million cubic feet) was produced in the State and along with Georgia's output of 268,000 tons, accounted for about 35% of the U.S. total.

Vermont's dimension stone industry consisted of 25 operations: 16 were in Rutland; 4, in Washington; 2, in Windsor; and 1 each, in Bennington, Orange, and Orleans Counties. Types of dimension stone mined, in descending order of output, were slate, granite, and marble.

During the year, a granite workers strike in Barre, Washington County, shut down three of the State's seven quarries. After 2 weeks, a new contract was signed, and the area's 1,200 granite fabricators and quarriers returned to work.

Rock of Ages Corp., the State's leading dimension granite producer, announced plans to convert heating units at its monument manufacturing plants from fuel oil to bituminous coal. The project was expected to help the firm remain competitive with southern granite manufacturers with lower heating costs.

Buttura & Sons, Inc., at Barre, a granite monument manufacturing firm, received a $44,000 low-interest loan from the Vermont Industrial Development Authority. The funds were used to purchase a diamond saw and an automatic polisher, and for modernizing other machinery.

Vermont's crushed stone production remained the same compared with that of 1980. Crushed stone was produced at 11 quarries; 9 mined limestone; 1, granite; and 1, serpentine (a byproduct of the VAG asbestos mining operation). Leading counties in output were Chittenden, Franklin, and Washington. The stone was used primarily by the road construction industry.

Table 5.—Vermont: Dimension stone[1] sold or used by producers, by use

Use	1980			1981		
	Short tons	Thousand cubic feet	Value (thousands)	Short tons	Thousand cubic feet	Value (thousands)
Rough stone:						
Irregular-shaped stone	3,704	41	$123	3,374	40	$122
Monumental	90,419	905	11,029	87,778	881	12,653
Flagging	82	1	4	83	1	5
Dressed stone:						
House stone veneer	1,411	16	346	1,391	16	370
Monumental	2,162	24	1,203	2,232	26	1,343
Flagging	24,752	272	995	49,400	543	1,857
Roofing slate (standard)	2,543	28	1,104	2,295	25	1,112
Roofing slate (architectural)	140	2	60	99	1	47
Flooring slate	27,027	297	5,063	44,323	488	9,185
Other[2]	17,036	195	3,721	15,844	187	4,063
Total[3]	169,276	1,782	23,649	206,819	2,209	30,756

[1]Includes granite, marble, and slate.
[2]Includes stone used in rough blocks, sawed stone, structural and sanitary, and other uses not specified.
[3]Data may not add to totals shown because of independent rounding.

Table 6.—Vermont: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	W	W	147	1,013
Concrete aggregate	85	332	W	W
Bituminous aggregate	219	712	153	618
Other construction aggregate and road stone	265	839	188	641
Riprap and jetty stone	18	60	20	62
Other fillers or extenders	W	W	156	W
Other[2]	733	2,844	655	2,809
Total	1,320	4,787	1,319	[3]5,144

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, granite, and other stone.
[2]Includes stone used in agricultural limestone, dense-graded road base stone, surface-treatment aggregate, railroad ballast, filter stone, manufactured fine aggregate (stone sand), terrazzo and exposed aggregate, and items indicated by symbol W.
[3]Data do not add to total shown because of independent rounding.

Talc.—Vermont ranked third in U.S. production of talc in 1981. Total U.S. output was 1.3 million tons, an increase of 10% from that of 1980. The combined tonnages of talc mined in Montana, Texas, Vermont, and New York accounted for about 90% of the Nation's production. Quantity and value data for the State's talc industry are proprietary.

In 1981, Windsor Minerals, Inc., operated three mines in Windsor County; OMYA, Inc., one mine in Windham County; and Eastern Magnesia Talc Co., one mine in Lamoille County. The talc was ground and sold for use in cosmetics, insecticides, paint, paper, and plastics.

[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.

[2]State geologist, Agency of Environmental Conservation, Montpelier, Vt.
[3]Rock Products. Computer System Controls Sand and Gravel Production. November 1981, pp. 45-49.
[4]Ratté, C. A. Mineral Resource Provinces of Vermont. Agency of Environmental Conservation Open File Rept. No. 1982-1, February 1982, pp. 13-14.
[5]Harrison, D. K. Mineral Resources of the Lye Brook Wilderness, Bennington and Windham Counties, Vermont. BuMines MLA 17-81, 1981, 21 pp.; available for consultation at the Bureau of Mines library in Pittsburgh, Pa.; at the Division of Mineral Land Assessment, Washington, D.C.; and at the National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C.
[6]Mory, P. C. Mineral Resources of the Bristol Cliffs Wilderness Areas, Addison County, Vt. BuMines MLA 18-81, 1981, 15 pp.; available for consultation at the Bureau of Mines library in Pittsburgh, Pa.; at the Division of Mineral Land Assessment, Washington, D.C.; and at the National Library of Natural Resources, U.S. Department of the Interior, Washington, D.C.
[7]Bortz, S. A., and R. S. DeCesare (comp. by). Accomplishments in Waste Utilization. BuMines IC 8884, 1982, pp. 20-21.
[8]Minerals Week. Wilbur Ellis Unit Buys Interest in Vermont Asbestos Group. Apr. 10, 1981, p. 119.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
Asbestos:			
Vermont Asbestos Group, Inc	Box 70 Hyde Park, VT 05655	Pit	Orleans.
Sand and gravel:			
Burgess Bros., Inc	Burgess Rd. Bennington, VT 05201	Pit	Bennington.
Calkins Sand & Gravel Co	Lyndonville, VT 05851	Pit	Orleans.
J. P. Carrara & Sons	Box 1043 Middlebury, VT 05753	Pit	Addison.
Lawrence Sand & Gravel Co., Inc	138 Portland St. St. Johnsbury, VT 05819	Pit	Essex.
Stone:			
L. F. Carter, Inc	Box 224 Pittsford, VT 05763	Quarry	Rutland.
Cooley Asphalt Paving Corp	Box 542 Barre, VT 05641	do	Washington.
OMYA, Inc	Proctor, VT 05765	Quarries	Addison, Rutland, Windsor.
Pike Industries, Inc	U.S. Route #3 Tilton, NH 03276	do	Addison.
Rock of Ages Corp	Box 482 Barre, VT 05641	do	Orange, Washington, Windsor.
Shelburne Limestone Corp	Bishop Rd. Shelburne, VT 05482	do	Chittenden and Franklin.
Frank W. Whitcomb Construction Corp	Box 429 Bellows Falls, VT 05101	Quarry	Chittenden.
White Pigment Corp	Proctor, VT 05765	Quarries	Addison and Rutland.
Talc:			
Eastern Magnesia Talc Co	Menlo Park, NJ 00817	Mine and mill	Lamoille.
OMYA, Inc	Chester, VT 05143	do	Windham.
Windsor Minerals, Inc	Windsor, VT 05089	Mines and mills.	Windsor.

The Mineral Industry of Virginia

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

By Doss H. White, Jr.,[1] and Palmer C. Sweet[2]

Virginia's nonfuel mineral production in 1981 was valued at $282.5 million, a decrease of $22.8 million from that reported in 1980, the second consecutive year that nonfuel mineral value declined. Production and sales of crushed stone, the State's leading nonfuel mineral commodity, fell significantly compared with output and sales of other mineral commodities as construction activity in Virginia continued to decline.

Despite the state of the economy, Virginia continued to lead the Nation in kyanite production and was one of three States that produced vermiculite. Developments during 1981 included a mining permit application for the State's first gold mine since the 1940's and development work on two new mineral operations, an industrial sand and an absorbant clay producer. At yearend, the oldest continuously active metal mine in the United States closed.

Trends and Developments.—A significant portion of Virginia's mineral output is used by the construction industry, and the depressed economic conditions that extended from the previous year had a crippling effect on mineral output and sales. The effects of the failing economy, classified as a recession in July by the National Bureau of Economic Research, were felt in most sec-

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

Mineral	1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Clays thousand short tons	762	$3,172	502	$2,016
Gem stones	NA	15	NA	20
Lead (recoverable content of ores, etc.) metric tons	1,563	1,463	1,607	1,294
Lime thousand short tons	824	33,872	804	35,984
Sand and gravel[2] do.	8,264	29,508	[p]7,400	[p]27,700
Stone:				
Crushed do.	44,615	167,839	37,071	152,630
Dimension do.	27	2,287	4	1,130
Zinc (recoverable content of ores, etc.) metric tons	[r]12,038	9,934	9,731	9,558
Combined value of aplite, cement, gypsum, iron oxide pigments (crude), kyanite, sand and gravel (industrial), silver (1981), talc (soapstone), and vermiculite	XX	57,216	XX	52,201
Total	XX	305,306	XX	282,533

[p]Preliminary. [r]Revised. NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes industrial sand; value included in "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Accomack	$299	$209	Sand and gravel.
Albemarle	W	W	Stone, sand and gravel.
Amelia	--	W	Clays.
Amherst	W	W	Stone.
Appomattox	W	W	Do.
Augusta	W	W	Stone, sand and gravel.
Bath	W	611	Stone.
Bedford	W	W	Do.
Bland	W	W	Do.
Botetourt	W	W	Cement, stone, clays.
Brunswick	W	W	Stone, clays.
Buckingham	W	W	Kyanite, stone.
Campbell	4,023	W	Stone, sand and gravel.
Caroline	1,336	780	Sand and gravel.
Carroll	--	72	Stone.
Charles City	W	W	Sand and gravel.
Chesapeake (city)	811	571	Do.
Chesterfield	W	W	Sand and gravel, stone, clays.
Clarke	W	W	Stone.
Craig	175	W	Sand and gravel.
Culpeper	W	1,920	Stone.
Dinwiddie	W	W	Do.
Essex	W	--	
Fairfax	W	W	Stone, sand and gravel.
Fauquier	W	W	Stone.
Floyd	16	15	Do.
Franklin	W	13	Do.
Frederick	W	W	Stone, lime.
Giles	W	W	Lime, stone.
Gloucester	187	W	Sand and gravel.
Goochland	8,705	10,427	Stone.
Grayson	W	W	Stone, sand and gravel.
Greensville	W	W	Stone, clays.
Halifax	W	W	Stone, sand and gravel.
Hanover	W	W	Stone, aplite, sand and gravel.
Henrico	14,212	13,475	Sand and gravel, stone.
Henry	W	W	Stone, sand and gravel.
Isle of Wight	W	W	Sand and gravel.
James City	W	W	Do.
King and Queen	W	W	Do.
King George	W	W	Do.
King William	30	28	Do.
Lancaster	W	W	Do.
Lee	1,973	2,340	Stone.
Loudoun	14,721	15,464	Do.
Louisa	W	W	Vermiculite.
Middlesex	8	8	Sand and gravel.
Montgomery	W	W	Stone, clays.
Nansemond	W	--	
Nelson	W	W	Aplite, talc.
New Kent	W	W	Sand and gravel.
Newport News (city)	W	--	
Northampton	13	7	Sand and gravel.
Northumberland	32	W	Do.
Nottoway	W	W	Stone.
Orange	W	W	Clays.
Page	W	--	
Patrick	W	--	
Pittsylvania	W	W	Stone.
Prince George	1,886	W	Sand and gravel.
Prince William	W	W	Stone, clays.
Pulaski	W	2,075	Crude iron oxide pigments, stone.
Rappahannock	W	W	Stone.
Richmond (city)	W	W	Stone, clays.
Roanoke	5,437	4,409	Do.
Rockbridge	W	W	Do.
Rockingham	W	W	Stone, sand and gravel.
Russell	7,068	5,633	Stone.
Scott	1,692	1,435	Do.
Shenandoah	W	W	Lime, stone.
Smyth	W	W	Lime, stone, clays, sand and gravel.
Southampton	175	W	Sand and gravel.
Spotsylvania	W	W	Stone, sand and gravel.
Stafford	W	W	Do.
Suffolk (city)	W	--	
Surry	W	W	Sand and gravel.
Tazewell	W	W	Stone, clays.
Virginia Beach (city)	1,745	1,017	Sand and gravel.
Warren	W	W	Cement, stone, lime, sand and gravel.
Washington	W	W	Stone, gypsum.

See footnotes at end of table.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Westmoreland	$92	W	Sand and gravel.
Wise	1,557	$2,503	Stone.
Wythe	16,864	15,837	Zinc, stone, lead, crude iron oxide pigments.
York	W	W	Sand and gravel.
Undistributed[2]	226,725	226,459	
Total[3]	309,789	305,306	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]The following cities and counties are not listed because no production was reported: Alexandria (city), Alleghany, Arlington, Bedford (city), Bristol (city), Buchanan, Buena Vista (city), Charlotte, Charlottesville (city), Clifton Forge (city), Colonial Heights (city), Covington (city), Cumberland, Danville (city), Dickenson, Emporia (city), Fairfax (city), Falls Church (city), Fluvanna, Franklin (city), Fredericksburg (city), Galax (city), Greene, Hampton (city), Harrisonburg (city), Highlands, Hopewell (city), Lexington (city), Lunenburg, Lynchburg (city), Madison, Martinsville (city), Mathews, Mecklenburg, Norfolk (city), Norton (city), Petersburg (city), Portsmouth (city), Powhatan, Prince Edward, Radford (city), Richmond, Roanoke (city), Salem (city), South Boston (city), Staunton (city), Sussex, Waynesboro (city), Williamsburg (city), and Winchester (city).

[2]Includes gem stones and values indicated by symbol W.

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

Table 3.—Indicators of Virginia business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	2,541.0	2,592.8	+2.0
Unemployment	do	127.4	173.1	+35.9
Employment (nonagricultural):				
Mining[1]	do	22.7	21.4	-5.7
Manufacturing	do	413.8	411.9	-.5
Contract construction	do	128.3	115.7	-9.8
Transportation and public utilities	do	115.8	116.6	+.7
Wholesale and retail trade	do	451.2	462.8	+2.6
Finance, insurance, real estate	do	105.9	106.2	+.3
Services	do	408.3	415.8	+1.8
Government	do	511.2	509.6	-.3
Total nonagricultural employment[1]	do	2,157.2	[2]2,160.1	+.1
Personal income:				
Total	millions	$50,404	$56,711	+12.5
Per capita		$9,406	$10,445	+11.0
Construction activity:				
Number of private and public residential units authorized		38,708	30,928	-20.1
Value of nonresidential construction	millions	$903.8	$1,037.5	+14.8
Value of State road contract awards	do	$196.3	$198.0	+.9
Shipments of portland and masonry cement to and within the State	thousand short tons	1,935	1,661	-14.2
Nonfuel mineral production value:				
Total crude mineral value	millions	$305.3	$282.5	-7.5
Value per capita, resident population		$57	$53	-7.0
Value per square mile		$7,480	$6,922	-7.5

[p]Preliminary.

[1]Includes bituminous coal, oil, and gas extraction.

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

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

tors of Virginia's mineral industry. Production fell below the previous year's levels for 10 of the 12 primary mineral commodities produced in-State. Output of crushed stone, the backbone of the residential-commercial and highway construction industries, fell 7.5 million tons. Residential construction permits were 7,600 below the 1980 level.

In spite of the recession and depressed state of the economy, several companies announced plans for new operations to develop and market the State's mineral resources.

Walnut Creek Mining, Inc., investigated a quartz vein about 33 miles northeast of Rhoadesville in Orange County; pyrite is present along with varying amounts of gold, cobalt, and titanium. The company applied for a mining permit and the County Board of Supervisors was expected to make a decision in January 1982. The company also plans a commercial gold panning operation

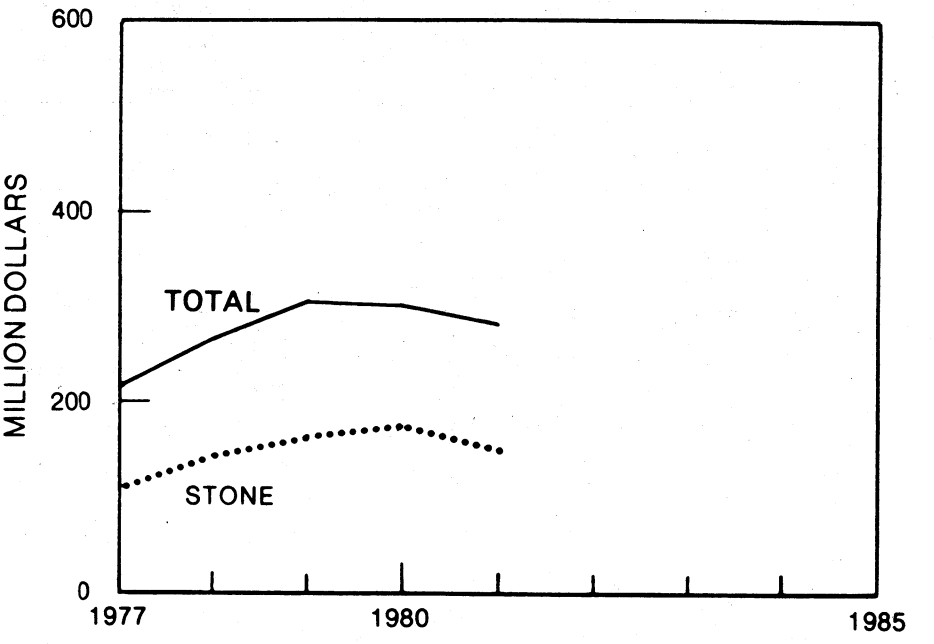

Figure 1.—Value of stone and total value of all nonfuel mineral production in Virginia.

for tourists near the community of Wilderness, west of Fredericksburg. The last reported gold production in Virginia was as a byproduct of zinc-lead mining in 1947 from the Valzinco Mine in Spotsylvania County, southwest of Fredericksburg.

Bennett Minerals Co. was nearing completion of its clay processing plant near Walkerton, King and Queen County; approximately 60 people will be employed at full production. Diatomaceous sediments, including appreciable amounts of montmorillonite clay, will be mined, ground, and dried in a wood-waste-fueled rotary kiln. The clay will then be screened, bagged, and marketed as an industrial absorbent.

Marline Uranium Corp. has leased approximately 40,000 acres in Pittsylvania County and 600 acres in the Ridgeway area of Henry County, in southern Virginia, for potential uranium development. Leases are also held on 15,000 acres in Culpeper, Fauquier, Madison, and Orange Counties in north-central Virginia. Approximately 250 exploratory holes have been drilled in the Dry Fork area of Pittsylvania County. As a result, the Virginia Coal and Energy Commission Uranium Subcommittee has been formed to evaluate the environmental impact of uranium exploration, mining, and milling in Virginia and to determine State regulations to adequately supervise uranium operations. The 23-member commission was to supply recommendations to the General Assembly by yearend.

The New Jersey Zinc Co., Austinville, Wythe County, in southwestern Virginia, terminated operations at the company's underground zinc-lead mine on December 31, 1981. Gulf + Western Industries, Inc., the parent company, plans to sell the property to a company that will continue to produce agricultural lime for the southern Piedmont area of Virginia. About 500,000 tons of agricultural lime was produced annually as a byproduct from the zinc-lead mine.

During 1981, United Rockwool, Inc., constructed a pilot plant in the Woodbridge area of Prince William County. The operation, scheduled to use granite and limestone in the manufacture of mineral wool, is tentatively scheduled to begin production in the spring of 1982. Increased interest in mineral wool and its insulation applications has been expressed over the last several years due primarily to high energy costs.

Luck Quarrys, Inc., applied for a permit for a quarry near Ruckersville in Greene County. A public hearing on amending the

zoning laws to allow a special use permit was scheduled for February 1982. The Ruckersville Civic Association is protesting the proposed quarry on the basis of possible water and air pollution and excessive noise and resulting decrease in property values.

Several companies continued basic reconnaissance of base-metal sulfide mineralization, including drilling of coreholes in the Virginia Piedmont province along the old Gold-Pyrite Belt. Another company geared activity toward precious metals exclusively. Exploration continued northeast of the Gossan lead area in Grayson and Carroll Counties. Significant activity was reported around the Toncrae Mine area of Floyd County and surrounding areas. More than 600,000 pounds of copper was produced from the Toncrae Mine in 1938, 1944-45, and 1947.[3]

Metallurgical grade flux material is produced in the southwest Virginia area, and occurrences of similar raw material in the central Piedmont were investigated during the year. One company, Saltville Silica Inc., began work on a quarry and plant near Saltville, Smyth County, during the latter part of 1981 to produce a glass grade material, furnace, and foundry sand. The silica sand will be used in a glass plant in Kingsport, Tenn.

Legislation and Government Programs.—Legislation was passed to establish a Board of Geology and regulate the practice of geology and the registration of geologists in Virginia. A Virginia Geothermal Resource Conservation Act, regulating the use of geothermal resources and defining terms and penalties, was also established.

The Virginia Division of Mineral Resources, responsible for identifying the State's mineral resource potential, continued a number of studies on mineral occurrences and basic geologic mapping. These studies resulted in the publication of a report on the high-silica resources of Augusta, Bath, Highland, and Rockbridge Counties;[4] and the completion of a Directory of the Mineral Industry listing 281 mineral-producing companies, excluding coal mine operators. In addition, geologic maps and reports for 10 quadrangles were completed; 5 field trip guidebooks were prepared.

Cooperative studies completed included (1) coastal plain stratigraphy (U.S. Geological Survey) and (2) geologic factors affecting roof falls (Appalachian Regional Commission). Other cooperative studies in progress included (1) a seismic and aeroradioactivity survey of the Culpeper Triassic Basin (Virginia Polytechnic Institute and State University-U.S. Geological Survey), (2) aeroradioactivity of crystalline rocks, (3) geology of Buchanan County, and (4) U.S. Interstate 64 detailed gravity and seismic surveys (U.S. Geological Survey).

The Virginia Division of Mineral Resources received a grant from the Department of Energy to conduct a test drilling program to determine coalbed methane potential in Montgomery County. A similar grant was obtained by Merrill Natural Resources, Inc., to determine coalbed methane potential in the Richmond Triassic Basin.

Under a cooperative agreement between the Virginia Division of Mineral Resources and the U.S. Bureau of Mines, the Tuscaloosa Research Center tested a number of clay samples from Virginia to evaluate potential use.

The Department of Conservation and Economic Development, Division of Mined Land Reclamation, Minerals Other Than Coal, was responsible for the State's orphaned land program established to reclaim abandoned mining sites with monies received from the reclamation fund.

Actual reclamation under the orphaned land program began in early 1981. At year-end, three projects were completed or nearing completion; less than $45,000 had been spent in correcting environmental problems at the three sites.

Personnel of the U.S. Bureau of Mines Eastern Field Operations Center, Pittsburgh, Pa., worked on the report compilation phase for four Virginia RARE II-Wilderness Area studies. Mineral potential evaluation continued on the Dolly Anne, Southern Massanutten, and Devils Fork RARE II, further planning area studies, and the James River Face Wilderness area.

During 1982, the U.S. Geological Survey conducted a number of investigations of mineral occurrences in the State. Included were (1) titanium resource in the Roseland district in central Virginia, (2) the structural setting of the Great Gossan lead sulfide deposit in southern Virginia, (3) lead-zinc resources in the State's Timberville district, (4) Virginia silica resources, and (5) Tazewell and Russell Counties on fuel minerals.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Aplite.—The State was the sole producer of "Virginia Aplite, " used in the manufacture of glass.

One company, The Feldspar Corp., near Montpelier in Hanover County, mined and processed the feldspar-like mineral marketed under the trade name of "Virginia Aplite." During the year, plans were finalized to convert the facility's magnetic separation unit from dry to wet process, which will result in a significant energy savings. Despite the recession, demand was strong as much of the material is used in the manufacture of beer bottles.

Two additional operations in Amherst and Nelson Counties marketed a lower grade "Virginia Aplite" for aggregate. Demand slumped as construction fell below the previous year's level.

"Virginia Aplite" varies in chemical composition from true aplite and, in future U.S. Bureau of Mines publications, the commodity in Virginia will be discussed under the heading of Feldspar.

Cement.—Virginia's cement industry, located in Warren and Botetourt Counties and the City of Chesapeake, reported declining sales as high interest rates continued to plague the construction industry.

Riverton Corp., Warren County, produced masonry cement and Lone Star Cement, Inc., Botetourt County, produced portland and masonry cements. Lone Star LaFarge, Inc., City of Chesapeake, used domestic and imported clinker to produce low-alumina calcium aluminate cement, or Cement Fondu. Quicklime for producing high-alumina calcium aluminate cement is purchased from Chemstone Corp. The alumina continues to be acquired from various sources. Total sales were below those of 1980.

Clays.—As with other construction mineral commodities, clay output fell as demand for clay products continued to decline. Clay production, from six counties in southwestern Virginia, five counties in eastern Virginia, and in the City of Richmond, dropped 260,000 tons below the 1980 level, and 557,000 tons below that produced in 1979, the record year. Sales were $1.2 million below those of the previous year.

Bennett Minerals Co. began construction on an absorbent-clay facility in King and Queen County in eastern Virginia. Scheduled for production in 1982, the company will produce an absorbent for animal and industrial waste.

Table 4.—Virginia: Clays sold or used by producers

(Thousand short tons and thousand dollars)

Year	Quantity	Value
1977	890	1,294
1978	1,043	3,266
1979	1,059	3,512
1980	762	3,172
1981	502	2,016

Gypsum.—United States Gypsum Co. mined gypsum in western Virginia and imported gypsum from Nova Scotia for wallboard manufacture. Gypsum was mined by underground methods in Smyth County and trucked to a wallboard plant at Saltville in adjacent Washington County. The company plant at Norfolk received Canadian gypsum by ship for wallboard fabrication. A small tonnage of anhydrite was imported and sold to cement companies for portland cement maufacture.

Kyanite.—The State's kyanite industry is centered in Buckingham County in central Virginia. Kyanite Mining Corp. operates two surface mines and processing plants at East Ridge and Willis Mountain. Flotation and magnetic separation are used to produce a product sold to the ceramic and refractories industries.

Kyanite Mining Corp. produces approximately 90,000 tons of kyanite per year, 45% of the world's output.[5] Approximately 40% is shipped through the Port of Hampton Roads to worldwide users.

Lime.—Sales of lime continued a 2-year decline as the steel and paper industries, the largest lime users, reduced production as traditional customers faced lagging sales. The lime industry in Virginia, situated in Frederick, Giles, Shenandoah, Smyth, and Warren Counties, operated five surface mines and two underground room-and-pillar mines.

Table 5.—Virginia: Lime sold or used by producers, by use

Use	1980		1981	
	Quantity (short tons)	Value (thousands)	Quantity (short tons)	Value (thousands)
Steel, basic oxygen furnace	186,479	$7,745	228,194	$10,191
Paper and pulp	129,831	5,354	211,203	9,883
Water purification	60,559	2,663	85,598	3,985
Acid mine water	64,071	2,682	66,064	2,887
Steel, electric	36,285	1,518	51,261	2,449
Steel, open-hearth	48,178	1,988	W	W
Sewage treatment	W	W	32,899	1,530
Mason's lime	W	W	31,941	955
Metallurgical, other	W	W	9,844	442
Agriculture	5,249	224	9,678	256
Other[1]	293,015	11,698	77,284	3,406
Total	823,667	33,872	803,966	35,984

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes calcium carbide (1981), chrome (1981), fertilizer (1981), animal and human food (1981), glass (1981), other chemical and industrial uses, other construction uses, other metallurgical uses (1981), road stabilization, soil stabilization (1981), sugar refining (1981), tanning (1981), wire drawing (1980), and uses indicated by symbol W.

Mica.—Asheville Mica Co. and an affiliate, Mica Co. of Canada, Inc., processed mica at facilities in Newport News on the coast. Crude mica was purchased through New York brokerages, mainly from Brazil and India. The operations produced mica paper and a variety of mica shapes.

Perlite.—Crude perlite, imported by rail from New Mexico, was expanded by Manville Products Corp., Woodstock, Shenandoah County, for the manufacture of roofing insulation board.

Sand and Gravel.—The U.S. Bureau of Mines, to reduce reporting burden and costs, implemented new sand and gravel canvassing procedures for the survey of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel operators will be conducted for even years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production. The preliminary estimates for production of construction sand and gravel for odd years will be revised and finalized the following year.

Preliminary industry data indicated that the State's construction sand and gravel industry produced 7.4 million tons valued at $27.7 million, a decrease of 900,000 tons and $1.8 million from the 1980 levels. The Virginia Division of Mineral Resources identified 135 construction sand and gravel producers active in the State in 1981.[6]

Two companies, Unimin Corp., Frederick County, and J. C. Jones, Virginia Beach, produced an industrial-grade sand for glass, traction, and foundry uses. At yearend, construction was underway on the plant and mine of a third industrial sand producer, Saltville Silica Inc., at Saltville in the southwestern part of the State.

Output and value of industrial sand declined as the recession affected construction and automobile sales, two key industries for the flat glass market. The closing of a Maryland glass plant adversely affected sales of glass-grade silica from northwestern Virginia.

Table 6.—Virginia: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	5,697	$17,745	$3.11	NA	NA	NA
Gravel	2,567	11,763	4.58	NA	NA	NA
Total or average	8,264	29,508	3.57	P7,400	P$27,700	P$3.74
Industrial sand	W	W	8.00	W	W	7.50
Grand total or average	W	W	3.58	W	W	P3.75

PPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.

Table 7.—Virginia: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	1,678	9,421	1,581	10,244
Agricultural marl and other soil conditioners	5	10	5	12
Concrete aggregate	5,302	20,770	5,081	22,141
Bituminous aggregate	5,092	21,383	4,644	20,598
Macadam aggregate	532	1,933	470	1,652
Dense-graded road base stone	15,602	56,969	11,665	46,970
Surface treatment aggregate	1,494	5,652	1,400	5,806
Other construction aggregate and road stone	7,995	26,377	5,374	17,709
Riprap and jetty stone	289	1,589	316	1,886
Railroad ballast	659	2,228	932	3,030
Filter stone	180	479	87	347
Manufactured fine aggregate (stone sand)	1,519	6,357	1,523	6,320
Cement manufacture	1,470	2,556	1,365	2,616
Lime manufacture	1,488	3,731	1,475	5,701
Dead-burned dolomite	--	--	1	7
Flux stone	137	346	73	226
Mine dusting	335	1,674	307	1,686
Other fillers or extenders	186	1,302	247	2,409
Glass manufacture	W	W	W	1,126
Other[2]	652	5,064	523	2,146
Total[3]	44,615	167,839	37,071	152,630

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, granite, marl, sandstone, traprock, other stone, and slate.
[2]Includes stone used in poultry grit and mineral food, terrazzo and exposed aggregate (1981), ferrosilicon, asphalt filler (1981), acid neutralization, floor slate, lightweight aggregrate, roofing granules, sulfur removal from stack gases, and other unspecified uses.
[3]Data may not add to totals shown because of independent rounding.

Table 8.—Virginia: Crushed stone statistics, 1981

Stone type	Number of quarries	Unit value	Quantity (million short tons)	Quantity change, 1980-81 (million short tons)
Limestone-dolomite	66	$3.80	16.4	-2.1
Granite-gneiss	26	4.39	14.3	-3.9
Sandstone	9	3.73	1.6	+.4
Traprock	8	4.45	4.4	-1.5
Slate	2	10.65	W	W
Aplite	2	3.83	W	W
Marble	1	7.18	W	W
Marl	1	2.00	.003	(1)

W Withheld to avoid disclosing company proprietary data.
[1]Less than 1/2 unit.

Stone.—As in previous years, stone continued as the leading mineral commodity, valuewise, produced in Virginia. However, production continued a 2-year decline and was 14 million tons below that of the 1979 record year. The market decline translated into a sales loss of $15 million for Virginia's stone industry, compared with 1980 sales.

A variety of stone types were crushed and sold by the industry. Tables 7-8 summarize output by end use and stone type.

Dimension stone operators quarried granite, limestone, quartzite, and slate. Production was reported from four quarries in four counties. Sales of dimension stone decreased from those of the previous year.

Sulfur.—Amoco Oil Co. in York County used the Claus process to recover elemental sulfur from hydrogen sulfide gas from crude oil refining. Byproduct sulfur is sold for use in fertilizers. Production was approximately the same as reported in 1980.

Talc.—A limited tonnage of a talc-chlorite dolomite schist was mined by Blue Ridge Talc Co., Franklin County, in south-central Virginia. Sales of the material, in pulverized and sized form, were to foundries as a release agent in foundry molds. Sales were depressed as output from many of the Nation's foundries dropped.

Vermiculite.—In 1981, Virginia was one of three States with vermiculite production.

Virginia Vermiculite, Ltd., Louisa County, mined and processed vermiculite for horticultural uses. Four different size ranges are produced by flotation and shipped to greenhouses with exfoliation facilities in the Eastern United States. A significant amount of the facility's production was purchased by a lawn and garden fertilizer manufacturer in Ohio.

METALS

Ferrovanadium.—Chemstone Corp., a subsidiary of Englehard Corp., produced ferrovanadium from vanadium pentoxide obtained from out-of-State sources. Production from the facility, located at Strasburg in Shenandoah County, was sold to the steel industry.

Iron Oxide Pigments.—Three companies processed iron oxide pigments in Virginia. Hoover Color Corp. and Virginia Earth Pigments Co. mined crude iron oxide materials for the manufacture of coloring agents, and Blue Ridge Talc ground and bagged iron ore imported from Michigan.

Lead and Zinc.—The oldest active mine in the United States, New Jersey Zinc Co.'s operation at Austinville in southwestern Virginia, closed in December after 225 years of continuous operation. A depressed market, mining and transportation costs, and Federal regulations were cited as reasons for closing the mine and mill.

Lithium.—Foote Mineral Co. produced lithium hydroxide from lithium carbonate transferred from Foote's operation near Kings Mountain, N.C. Lithium carbonate, produced at the Sunbright plant in Scott County, Va., was used in multipurpose grease manufacture.

Magnetite.—Reiss Viking Corp. in Tazewell County and Virginia Lime Co. in Giles County processed magnetite obtained from out-of-State suppliers as a coal preparation media. The material was marketed in the eastern coalfields. Some byproduct magnetite from Kyanite Mining Corp.'s processing plant is marketed to Lone Star Cement's plant in Botetourt County to use in the production of cement.

Manganese.—Union Carbide Corp. operated a grinding plant at Newport News to process manganese ore imported from Gabon. After processing, the ore was shipped to other company facilities for the manufacture of batteries.

[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]Head geologist, Economic Geology Section, Virginia Division of Mineral Resources.
[3]Sweet, P. C. Abandoned Copper Mines and Prospects in the Virginia District, Va. Va. Minerals, v. 22, No. 3, 1976, p. 27.
[4]———.High Silica Resources of Augusta, Bath, Highland, and Rockbridge Counties, Va. Va. Div. of Mineral Res. Pub. 32, 1981.
[5]Dixon, G. B., Jr. Kyanite Mining in Virginia. Va. Minerals, v. 26, No. 1, February 1980.
[6]Sweet, P. C. Directory of Mineral Industry in Virginia—1981. Va. Div. of Mineral Res., 1982, 60 pp.

Table 9.—Principal producers

Commodity and company	Address	Type of activity	County
Aplite (crude):			
The Feldspar Corp	Route 1, Box 23 Montpelier, VA 23192	Quarry and plant	Hanover.
Cement:			
Lone Star Cement, Inc.[1]	Box 27 Cloverdale, VA 24077	____do ____	Botetourt.
Lone Star Lafarge, Inc	Box 5128 Chespeake, VA 23320	Plant	Chesapeake (city).
Riverton Corp.[2]	Riverton, VA 22651	Quarry and plant	Warren.
Clay and shale:			
Brick and Tile Corp	Box 45 Lawrenceville, VA 23868	Pits and plant	Brunswick and Greensville.
General Shale Products Corp	Box 3547 Johnson City, TN 37601	____do ____	Rockbridge, Smyth, Tazewell.
Webster Brick Co., Inc	Box 12887 Roanoke, VA 24029	____do ____	Botetourt and Orange.
Ferroalloys:			
Chemstone Corp.[3]	Box 189 Strasburg, VA 22657	Plant	Shenandoah.
Gypsum:			
United States Gypsum Co	Box 4686 Norfolk, VA 23523	____do ____	Norfolk (city).
Do	Route 1 Saltville, VA 24370	Mine and plant	Washington.
Iron oxide pigments (crude):			
Hoover Color Corp	Box 218 Hiwassee, VA 24347	____do ____	Pulaski.
Kyanite:			
Kyanite Mining Corp	Dillwyn, VA 23936	____do ____	Buckingham and Prince Edward.

See footnotes at end of table.

Table 9.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Lime:			
Chemstone Corp.[4]	Box 71 Strasburg, VA 22657	Plant	Shenandoah.
National Gypsum Co	Star Route 635 Ripplemead, VA 24150	do	Giles.
Virginia Lime Co	Star Route Ripplemead, VA 24150	do	Do.
Perlite, expanded:			
Manville Products Corp	Box 442 Woodstock, VA 22644	do	Shenandoah.
Sand and gravel:			
Lone Star Industries, Inc	977 Norfolk Square Norfolk, VA 23501	Pits and plant	Charles City, Chesterfield, Henrico, Prince George.
Sadler Materials Corp	Box 5607 Virginia Beach, VA 23455	Pits	Henrico and Prince George.
West Sand and Gravel Co., Inc	Box 6008 Richmond, VA 23222	do	Henrico.
Stone:			
Lone Star Industries, Inc	Box 420 Norfolk, VA 23501	Quarries	Brunswick, Chesterfield, Dinwiddie.
Luck Quarrys, Inc	Box 4682 Richmond, VA 23229	do	Albemarle, Augusta, Fairfax, Goochland, Halifax, Mecklenburg, Pittsylvania, Prince William, Rockingham, Washington.
Vulcan Materials Co., Midsouth Div.	Box 7 Knoxville, TN 37901	do	Bristol.
Talc:			
Blue Ridge Talc Co., Inc.[5]	Box 39 Henry, VA 24102	Quarry and plant	Franklin.

[1]Also sand and gravel and stone.
[2]Masonry cement only; also produces limestone and lime.
[3]Also lime.
[4]Also ferroalloys.
[5]Also finished iron oxide pigments.

The Mineral Industry of Washington

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

By George T. Krempasky,[1] Herbert R. Babitzke,[2] and Ellis R. Vonheeder[3]

The value of nonfuel mineral production in Washington was $212 million in 1981. The nonmetals—cement, clays, gem stones, diatomite, gypsum, lime, olivine, peat, sand and gravel, and stone—accounted for 97% of the total output value. The metals—copper, gold, silver, and tungsten—accounted for the remainder. The value of nonfuel mineral production in 1981 was 9% more than the average yearly value for the 5-year period (1977-81).

Exploration and development activities continued strong in 1981, with at least 60 different companies active in the State.

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

Mineral	1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Cement:				
Masonry thousand short tons	W	W	15	$1,284
Portland do	1,546	$89,208	1,560	100,845
Clays[2] do	301	1,571	263	1,524
Gem stones	NA	150	NA	200
Pumice thousand short tons	(3)	(3)	--	--
Sand and gravel do	[4]19,019	[4]46,731	[p]18,404	[p]49,458
Silver thousand troy ounces	W	W	67	709
Stone:				
Crushed thousand short tons	[r]11,085	[r]W	9,516	25,619
Dimension do	6	248	15	2,378
Combined value of clays (fire clay), copper (1981), diatomite, gold, gypsum, lead (1980), lime, olivine, peat, sand and gravel (industrial 1980), tungsten (1981), and values indicated by symbol W	XX	[r]69,454	XX	30,461
Total	XX	207,362	XX	212,478

[p]Preliminary. [r]Revised. NA Not available. W Withheld to avoid disclosing company proprietary data; value included with "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

[2]Excludes fire clay; value included with "Combined value" figure.

[3]Revised to none.

[4]Excludes industrial sand; value included with "Combined value" figure.

Major efforts in nonmetals were related to barite and feldspar. Precious metals were being sought in Chelan, Ferry, Okanogan, Stevens, and Whatcom Counties; placer activities were noted in Kittitas, Okanogan, Stevens, and Whatcom Counties; base metal occurrences were being explored in Chelan, Ferry, Okanogan, and Stevens Counties; strategic metals, especially cobalt and tin, were being sought in northeastern Washington.

Washington was the leading producing State for primary aluminum with its seven aluminum reduction plants producing 24% of the Nation's total. Raw material was all imported, mostly from Australia.

Trends and Developments.—Other mineral-related activities included plans of International Titanium Inc. to construct a titanium sponge plant in the Moses Lake area.

Northwest Alloys Inc., a producer of magnesium, ferroalloys, and ferrosilicon, reduced its magnesium metal production owing to declining demand for magnesium.

AMAX Inc. placed its Mount Tolman molybdenum project on hold owing to adverse market conditions.

Aves Industries West Inc. selected Spokane as the site for its first plant employing a unique process of applying boride coatings on metals to create a hardened surface.

Feldslite Corp. of America disclosed plans to mine and process feldspar near Wenatchee.

The Puget Sound Air Pollution Control Agency granted ASARCO Incorporated a variance until December 31, 1982, on sulfur dioxide emissions from its copper smelter near Tacoma.

Cominco Ltd. of Canada acquired Bethlehem Copper Corp. of Vancouver, British Columbia, Canada, and thus all of the Bethex Corp. (a fully owned subsidiary) properties in the United States, including some Washington properties.

Legislation and Government Programs.—The Mining and Mineral Resources and Research Institute at the University of Washington in Seattle, which was created under Title III of Public Law 95-87, received a total of $173,801 for operations and research efforts from the Office of Surface Mining, U.S. Department of the Interior.

Table 2.—Value of nonfuel mineral production in Washington, by county

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Adams	W	W	Sand and gravel, stone.
Asotin	$288	$267	Stone, sand and gravel.
Benton	W	W	Sand and gravel, stone.
Chelan	W	W	Sand and gravel.
Clallam	W	W	Clays, sand and gravel, stone.
Clark	2,042	2,382	Sand and gravel, stone, clays.
Columbia	188	193	Stone.
Cowlitz	W	W	Stone, sand and gravel.
Douglas	W	W	Do.
Ferry	5,567	W	Gold, silver, stone.
Franklin	W	177	Stone, sand and gravel.
Garfield	293	--	
Grant	7,818	W	Diatomite, sand and gravel, stone.
Grays Harbor	1,520	1,872	Sand and gravel, stone.
Island	329	166	Do.
Jefferson	W	W	Stone, sand and gravel.
King	W	W	Cement, sand and gravel, stone, clays, peat.
Kitsap	W	W	Sand and gravel, stone, peat.
Kittitas	W	W	Sand and gravel, stone, clays.
Klickitat	3,739	W	Sand and gravel, stone.
Lewis	W	W	Stone, sand and gravel.
Lincoln	981	W	Do.
Mason	W	W	Stone.
Okanogan	W	W	Stone, sand and gravel, gypsum.
Pacific	717	637	Stone.
Pend Oreille	13,125	W	Cement, stone, sand and gravel.
Pierce	17,083	17,540	Sand and gravel, lime, stone, clays, silver, lead, gold.
San Juan	W	1,615	Sand and gravel.
Skagit	W	W	Olivine, stone, sand and gravel.
Skamania	613	368	Stone.
Snohomish	W	W	Sand and gravel, stone, clays.
Spokane	W	W	Stone, sand and gravel, clays.
Stevens	11,096	W	Lime, sand and gravel, stone, clays.
Thurston	W	W	Sand and gravel, stone.

See footnotes at end of table.

Table 2.—Value of nonfuel mineral production in Washington, by county —Continued

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Wahkiakum	$14	$25	Stone.
Walla Walla	552	W	Sand and gravel, stone.
Whatcom	W	W	Cement, stone, sand and gravel.
Whitman	1,603	970	Stone.
Yakima	W	W	Sand and gravel, stone.
Undistributed[1]	157,579	181,144	
Total[2]	225,150	207,362	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Includes gem stones, pumice, sand and gravel, stone that cannot be assigned to specific counties, and values indicated by symbol W.
[2]Data may not add to totals shown because of independent rounding.

Table 3.—Indicators of Washington business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	1,901.1	1,928.1	+1.4
Unemployment	do	153.3	214.3	+39.8
Employment (nonagricultural):				
Mining[1]	do	3.2	3.1	-3.1
Manufacturing	do	308.7	301.9	-2.2
Contract construction	do	92.6	88.7	-4.2
Transportation and public utilities	do	91.4	89.3	-2.3
Wholesale and retail trade	do	381.3	382.7	+.4
Finance, insurance, real estate	do	91.8	91.4	-.4
Services	do	308.5	317.0	+2.8
Government	do	330.8	324.2	-2.0
Total nonagricultural employment[1]	do	1,608.3	1,598.3	-.6
Personal income:				
Total	millions	$42,869	$47,511	+10.8
Per capita		$10,355	$11,266	+8.8
Construction activity:				
Number of private and public residential units authorized		33,375	23,852	-28.5
Value of nonresidential construction	millions	$1,049.6	$854.6	-18.6
Value of State road contract awards	do	$248.0	$186.0	-25.0
Shipments of portland and masonry cement to and within the State	thousand short tons	1,382	1,300	-5.9
Nonfuel mineral production value:				
Total crude mineral value	millions	$207.4	$212.5	+2.5
Value per capita, resident population		$50	$51	+2.0
Value per square mile		$3,041	$3,116	+2.5

[p]Preliminary.
[1]Includes bituminous coal extraction.

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

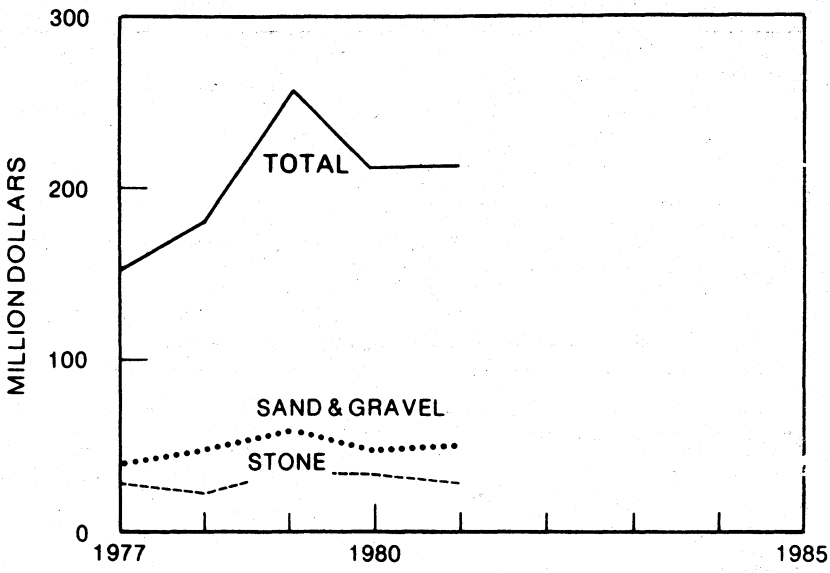

Figure 1.—Value of sand and gravel and stone, and total value of nonfuel mineral production in Washington.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Nonmetal mineral production in Washington during 1981 was 97% of the total value of nonfuel mineral production. Cement led in production value of all commodities produced in the State. Other significant commodities in terms of value were clays, diatomite, lime, olivine, sand and gravel, and stone.

Exploration and development for nonmetals continued. Major efforts were related to barite. C & E Minerals Div. of Combustion Engineering of Athens, Ga., purchased the Flagstaff Mountain deposit and the Calhoun mill at Leadpoint. The company plans to process barite and other high-grade industrial products, such as silica. C & E has also acquired 75% of the Uribe deposit and was negotiating for adjacent properties. The Pease-Loon Lake deposit of barite near Valley and the Madsen deposit of barite were mined, with shipments reported to Montana Barite Co. in Missoula, Mont. Milchem, Inc., of Battle Mountain, Nev., was reported to have drilled the O'Toole Mountain barite deposit.

International Minerals and Chemical Co. acquired Northwest Olivine Co. Interpace Corp., a producer of clay products, sold its Renton plant and clay pits in King and Spokane Counties to North American Refractories Co. Central Pre-Mix Concrete Co. received a permit to operate a gravel mining operation in the Moab area of Spokane County. In a move to increase efficiency in use of raw materials, Central Pre-Mix acquired Inland Asphalt Co.

Calcium Chloride (Synthetic).—Two companies in Pierce County, Hooker Chemical Corp. and Reichold Chemicals, Inc., produced synthetic calcium chloride in 1981.

Cement.—Portland cement was produced by four companies: Columbia Cement Corp., a subsidiary of Filtrol Corp., Bellingham; Ideal Basic Industries, Inc., and Lone Star Industries, Inc., Seattle; and Lehigh Portland Cement Co., Metaline Falls. Masonry cement was produced by three companies: Columbia, Lehigh, and Lone Star. Portland cement was used by ready-mix concrete companies (82%), concrete product manufacturers (8%), building materials dealers (4%), and others, including highway con-

tractors and government agencies. In 1981, portland cement shipments were 4% less than the yearly average for the 5-year period (1977-81), while the value of the product was 14% more than the yearly average value for the same period. Coal and electrical energy was used by all plants. In addition, three plants used natural gas. Raw materials consumed in the manufacture of cement included limestone, sand, quartz, clay, iron ore, gypsum, fly ash, and slag. Approximately 90% of the product was shipped to the consumers by truck.

Clays.—In 1981, clays were produced in six counties: Clallam, King, Kittitas, Pierce, Spokane, and Stevens, compared with production from eight counties in 1980. A total of four companies produced the material from nine minesites. Production quantity was 16% less than the 5-year average (1977-81), while value was 7% more when compared with the same period.

Diatomite.—Mine production and value of diatomite in 1981 were 25% and 60% more, respectively, than the yearly average for the 5-year period (1977-81). Washington ranked third nationally in the value of production of diatomite in 1981. Inorganic Specialties, a division of Witco Chemical Corp., the only reported producer of diatomite, recovered the product from a surface mine near George, in Grant County, and processed the material at its plant near Quincy.

Feldspar.—Feldslite Corp. of America won approval from the U.S. Forest Service to construct two rock processing plants and shipping facilities on National Forest land near Nason Creek. The deposit at Wenatchee Ridge reportedly contains 200 million tons of feldspar and is perhaps the largest deposit in the Nation.

Gypsum.—Agro Minerals, Inc., produced crude gypsum in Okanogan County. Calcined gypsum was produced by Norwest Gypsum, Inc., in King County, and by Domtar Gypsum America, Inc., in Pierce County.

Lime.—Tacoma Lime, a division of Continental Lime, Inc., in Pierce County, and Northwest Alloys, Inc., in Stevens County, produced lime. In 1981, production and value were 20% and 27% more, respectively, than the yearly average for the 5-year period (1977-81).

Olivine.—A small tonnage of olivine was mined and processed in Skagit County. Production quantity and value were 20% and 14% less, respectively, than the 5-year average (1977-81).

Peat.—Three companies reported peat production in 1981, most of which came from Renton in King County. All peat produced in Renton was used for general soil improvement.

Sand and Gravel.—To reduce reporting burden and costs, the Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary statistics for construction sand and gravel production but contains complete data on industrial sand and gravel. The preliminary statistics for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

It was estimated that total production of sand and gravel was 18 million short tons valued at $49 million. This preliminary value suggests that the quantity of sand and gravel produced has decreased from that of previous years and is 14% less than the 5-year average (1977-81); value was only 1% less for the same period.

Table 4.—Washington: Sand and gravel sold or used by producers

Use	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	6,732	$15,775	$2.34	NA	NA	NA
Gravel	12,287	30,956	2.52	NA	NA	NA
Total or average	19,019	46,731	2.46	[p]18,100	[p]$46,100	[p]$2.55
Industrial sand	W	W	12.22	304	3,358	11.05
Grand total or average	W	W	2.56	[p]18,404	[p]49,458	[p]2.69

[p]Preliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.

Stone.—Crushed and dimension stone was produced from 124 quarries in 31 counties. Snohomish was the leading producing county, followed by Yakima, Whatcom, and Grays Harbor. The largest producer was the U.S. Forest Service with 18% of total production. Companies producing in excess of 100,000 tons, 24 in number, accounted for 81% of the production during 1981. Total crushed stone production was down from that reported in 1980, and down 18% and 9% in quantity and value, respectively, from the 5-year average (1977-81).

Table 5.—Washington: Crushed stone[1] sold or used by producers in 1981

(Thousand short tons and thousand dollars)

Use	Quantity	Value
Agricultural limestone	24	363
Concrete aggregate	W	W
Bituminous aggregate	999	1,986
Dense-graded road base stone	1,017	2,649
Surface-treatment aggregate	667	2,109
Other construction aggregate and road stone	4,407	11,335
Riprap and jetty stone	822	3,277
Railroad ballast	206	431
Filter stone	27	105
Terrazzo and exposed aggregate	23	194
Fill	27	27
Other[2]	1,298	3,142
Total[3]	9,516	25,619

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, granite, sandstone, traprock, and volcanic cinder and scoria.
[2]Includes stone used in cement manufacture, dead-burned dolomite, ferrosilicon, chemical stone for alkali works, and items indicated by symbol W.
[3]Data may not add to totals shown because of independent rounding.

Sulfur.—Three companies produced sulfur or sulfur dioxide (SO_2). Atlantic Richfield Co. and Mobil Oil Corp. produced sulfur in Whatcom County. Asarco produced liquid SO_2 in Pierce County.

METALS

Search for precious metals continued to receive considerable emphasis during the year, with numerous companies and individuals active. Those known were Day Mines, Astra Corp., Houston International Minerals (now Tenneco), Rocky Mines, Morse Brothers, Inc., and Jack Evans in Ferry County; Fred Higby, Western Land Resources, Utah Minerals, Ltd., Exxon Minerals Co. U.S.A., Sheel Minerals, and Bryon King in Okanogan County; Madre Mining, Ltd., Gus Girius, and Irving Scott in Stevens County; and Lions Mines and Duval of Vancouver, British Columbia, Canada, in Whatcom County.

Exploration for other metals also accelerated. Copper was being sought in Chelan, Ferry, Okanogan, Skamania, and Stevens Counties. Molybdenum exploration was active in Ferry, Okanogan, and Stevens Counties. Lead and zinc prospects were being evaluated in Chelan, Ferry, Okanogan, and Stevens Counties. The strategic metals potential of northeastern Washington was under investigation, especially for cobalt and tin.

Aluminum.—Washington ranked first in the Nation in quantity and value of primary aluminum production, with 24% of the national total. Although there was a downturn in the economy, production and value in 1981 were slightly higher than those of the previous year. Feed for the seven reduction plants was imported, primarily from Australia.

The Aluminum Company of America reduced production at its Vancouver plant to 40% of capacity, and shut down two 41,300-ton-per-year potlines at its Wenatchee plant. Reynolds Metals Co. shut down a 23,000-ton-per-year potline at its Longview plant.

Kaiser Aluminum & Chemical Corp. laid off approximately 600 employees during the year from its Trentwood rolling mill. Cuts were also anticipated at the Mead reduction plant, but no decision had been reached by yearend. Both the rolling mill and the reduction plant are near Spokane. Kaiser also announced plans for a $600 million plant modernization for its Spokane and Tacoma operations.

Table 6.—Washington: Primary aluminum plant production data

Year	Quantity (thousand short tons)	Percent of national total	Value (thousands)
1977	1,032	23	$1,064,799
1978	1,203	25	1,301,367
1979	1,211	24	1,476,957
1980	1,171	23	1,678,645
1981	e1,209	24	1,837,630

eEstimated.

Gold.—Gold was recovered from three mines in Ferry, King, and Skamania Counties, with most of the production coming from the Knob Hill Mine in Ferry County. Production in 1981 was the lowest it has been in at least the past 4 years. Quantity produced was 27% less than the 5-year average (1977-81); value was 5% more.

Gold and silver exploration and mining received a considerable amount of emphasis during the year. Two heap-leaching operations in Ferry and Okanogan Counties were started.

In the Liberty district of Kittitas County, numerous placer operations were noted. Swauk and Williams Creeks saw a flurry of activity, while Shasser and Peshastin Creeks in the Blewett district had a number of floating suction dredge operations. The Department of Natural Resources issued six placer mining leases in Okanogan County and three in Stevens County. Whatcom County also had some sluicing and dredging activity, plus considerable summer weekend recreational panning.

Silver.—Silver was recovered from three mines in Ferry, King, and Skamania Counties. The Hecla-Day Mines Corp. was the major producer at the Knob Hill Mine near Republic. Total production was 67,390 troy ounces valued at $708,833. Both quantity and value were less than in 1980. Although quantity produced was 23% less than the 5-year average (1977-81), the value was 20% more.

Madre Mining, Ltd., of Calgary and Sacramento, purchased the Deer Trail Mine near Fruitland. A 150-ton-per-day mill was erected in 1981 to process silver from the dumps. A small underground mining operation was also planned.

Tungsten.—Tungsten was produced at three mines in Stevens County, with most of it coming from the Blue Grouse Mine. All mined tungsten was in the form of scheelite.

[1]Formerly State Liaison Officer, currently deputy chief, Western Field Operations Center, Bureau of Mines, Spokane, Wash.
[2]State Liaison Officer, Bureau of Mines, Spokane, Wash.
[3]Lands Division geologist, Department of Natural Resources, Olympia, Wash.

Table 7.—Principal producers

Commodity and company	Address	Type of activity	County
Aluminum:			
Aluminum Company of America	Box 120 Vancouver, WA 98660	Plant	Clark.
Do	Box 221 Wenatchee, WA 98801	do	Chelan.
Kaiser Aluminum & Chemical Corp.	Box 6217 Spokane, WA 99207	do	Spokane.
Do	3400 Taylor Way Tacoma, WA 98400	do	Pierce.
Reynolds Metals Co	Box 999 Longview, WA 98632	do	Cowlitz.
Cement:			
Columbia Cement Corp.,[1] a subsidiary of Filtrol Corp.	Box 37, Marietta Rd. Bellingham, WA 98225	do	Whatcom.
Ideal Basic Industries, Inc.[2]	950 17th St. Denver, CO 80201	do	King.
Lehigh Portland Cement Co.[1]	718 Hamilton Mall Allentown, PA 18105	do	Pend Oreille.
Lone Star Industries, Inc	One Greenwich Plaza Greenwich, CT 06836	do	King.
Clays:			
Mutual Materials Co	Box 2009 Bellevue, WA 98009	Pits and plant	King and Pierce.
North American Refractories Co	3502 Breakwater Ct. Haywood, CA 94545	do	King, Spokane, Stevens.
Diatomite:			
Inorganic Specialties, a division of Witco Chemical Corp.	277 Park Ave. New York, NY 10017	Mine and plant	Grant.
Gold:			
Hecla-Day Mines Corp.[3]	Box 1010 Wallace, ID 83873	Mine and mill	Ferry.

See footnotes at end of table.

Table 7.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Lime:			
Northwest Alloys, Inc.[4 5]	Box 115 Addy, WA 99101	Plant and mines	Stevens.
Tacoma Lime, a division of Continental Lime, Inc.	1220 Alexander Ave. Tacoma, WA 98421	Plant	Pierce.
Peat:			
Maple Valley Humus	18805 SE. 170th St. Renton, WA 98055	Bog	King.
Stone:			
De Atley Corp	Box 648 Lewiston, ID 83501	Quarry and plant	Yakima.
Industrial Rock Products, Inc	3707 California Bank Ctr. Seattle, WA 98164	____do	Snohomish.
U.S. Forest Service, Region 6	319 SW. Pine St., Box 3623 Portland, OR 97208	Quarries	Various.
Woodworth & Co., Inc	1200 East D St. Tacoma, WA 98421	Quarries and plant	Pierce.

[1]Also stone.
[2]Also clays.
[3]Also silver.
[4]Also industrial sand and gravel.
[5]Also magnesium.

The Mineral Industry of West Virginia

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the West Virginia Geological and Economic Survey for collecting information on all nonfuel minerals.

By Donald K. Harrison[1] and Dewey S. Kirstein[2]

The value of West Virginia's nonfuel mineral production in 1981 was $96.4 million, a $9.8 million decrease from that of 1980. Construction mineral commodities (crushed stone and sand and gravel) continued to contribute the largest portion to this value. Other mineral commodities produced included cement, salt, dimension stone, common and fire clays, and lime. In addition to minerals mined or produced in State, the primary metals, chemical, and glass manufacturing industries added considerably to the State's gross product. Other mineral-related industries included synthetic graphite, synthetic iron oxide, and ferroalloy producers. The State has the largest single iron oxide facility in the United States and the world's largest rolling mill devoted exclusively to the production of high-nickel alloys.

Table 1.—Nonfuel mineral production in West Virginia[1]

Mineral		1980		1981	
		Quantity	Value (thousands)	Quantity	Value (thousands)
Clays[2]	thousand short tons	291	$642	220	$502
Sand and gravel[3]	do	2,728	11,454	[p]2,700	[p]11,500
Stone (crushed)	do	9,766	36,305	7,885	28,399
Combined value of cement, fire clay, lime, salt, and sand and gravel (industrial)		XX	57,885	XX	56,046
Total		XX	106,286	XX	96,447

[p]Preliminary. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes fire clay; value included with "Combined value" figure.
[3]Excludes industrial sand; value included with "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Berkeley	$32,126	$30,740	Cement, stone, clays, lime.
Boone	--	W	Stone.
Braxton	(2)	--	
Brooke	W	W	Sand and gravel.
Cabell	7	--	
Fayette	126	W	Stone.
Gilmer	W	--	
Grant	302	414	Stone.
Greenbrier	W	7,316	Do.
Hampshire	W	W	Do.
Hancock	W	W	Clays, sand and gravel.
Harrison	W	123	Stone.
Jefferson	W	1,051	Do.
Kanawha	223	W	Do.
Lincoln	W	W	Clays.
Logan	1,415	1,511	Stone.
Marshall	W	W	Salt.
Mason	94	W	Sand and gravel.
Mercer	1,712	1,391	Stone.
Mineral	W	732	Do.
Monongalia	W	W	Do.
Morgan	W	W	Sand and gravel.
Pendleton	W	W	Stone, lime.
Pocahontas	680	649	Stone.
Preston	W	W	Do.
Raleigh	1,535	2,329	Do.
Randolph	5,645	4,376	Do.
Tucker	W	411	Do.
Tyler	W	W	Salt.
Wetzel	W	W	Sand and gravel.
Wirt	2	W	Stone.
Wood	W	W	Sand and gravel.
Wyoming	W	W	Stone, sand and gravel.
Undistributed	74,726	55,243	
Total	[3]118,595	106,286	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."

[1]Barbour, Calhoun, Clay, Doddridge, Hardy, Jackson, Lewis, McDowell, Marion, Mingo, Monroe, Nicholas, Ohio, Pleasants, Putnam, Ritchie, Roane, Summers, Taylor, Upshur, Wayne, and Webster Counties are not listed because no nonfuel mineral production was reported.

[2]Less than 1/2 unit.

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

Table 3.—Indicators of West Virginia business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	773.7	773.0	-0.1
Unemployment	do	75.9	81.5	+7.4
Employment (nonagricultural):				
Mining[1]	do	65.7	58.0	-11.7
Manufacturing	do	117.2	111.4	-4.9
Contract construction	do	35.8	28.4	-20.7
Transportation and public utilities	do	43.1	41.5	-3.7
Wholesale and retail trade	do	129.4	131.0	+1.2
Finance, insurance, real estate	do	22.0	22.0	--
Services	do	99.5	101.2	+1.7
Government	do	133.1	130.5	-2.0
Total nonagricultural employment[1]	do	[2]645.9	624.0	-3.4
Personal income:				
Total	millions	$15,270	$16,267	+6.5
Per capita		$7,814	$8,334	+6.6
Construction activity:				
Number of private and public residential units authorized		3,374	3,376	+.1
Value of nonresidential construction	millions	$60.3	$76.2	+26.4
Value of State road contract awards	do	$330.0	$220.0	-33.3
Shipments of portland and masonry cement to and within the State	thousand short tons	587	512	-12.8

See footnotes at end of table.

Table 3.—Indicators of West Virginia business activity —Continued

		1980	1981[p]	Change, percent
Nonfuel mineral production value:				
Total crude mineral value	millions	$106.3	$96.4	-9.3
Value per capita, resident population		$55	$49	-10.9
Value per square mile		$4,395	$3,988	-9.0

[p]Preliminary.
[1]Includes bituminous coal and oil and gas extraction.
[2]Data do not add to total shown because of independent rounding.

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

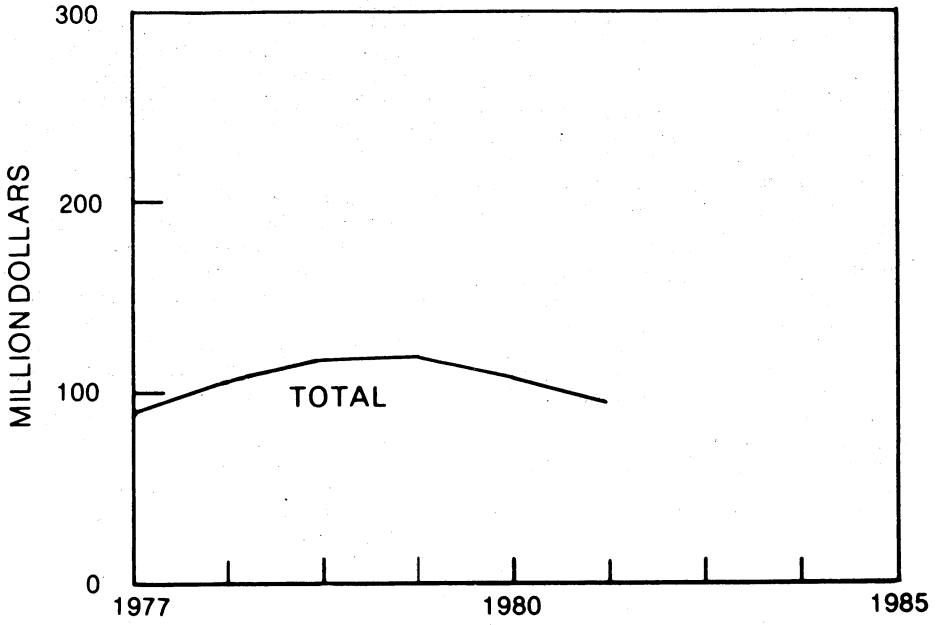

Figure 1.—Total value of nonfuel mineral production in West Virginia.

Trends and Developments.—Output of nonfuel mineral commodities mined or processed declined during the year in West Virginia—as in the rest of the Nation—primarily because of continuing high interest rates and a lower demand by those industries utilizing construction mineral commodities and primary metals. Suppliers of raw construction materials also suffered an additional setback in November when voters rejected a proposed $750 million road bond issue. The defeat is expected to mean a loss of millions of dollars in Federal road money, more job cuts in the Highway Department, and a complete halt in new road and bridge construction.

Kaiser Aluminum & Chemical Corp. shut down all four of its potlines at its Ravenswood Works in Jackson County and was planning cutbacks at its adjacent fabricating plant. The company cited market conditions, labor contract problems, and escalating production costs as the reasons for the closings and layoffs. Also during the year, Union Carbide Corp. sold one of its ferroalloy plants to a foreign concern and began consolidating its graphite operations at Clarksburg. Construction was also underway at the company's new silicone plant in South Charleston. When completed in 1983,

the plant will be among the largest of its kind in the world.

At least two West Virginia firms played an important function in the space shuttle Columbia's successful April mission. The Kaiser Aluminum, Ravenswood Works provided much of the high-strength plate used for the external fuel tank, and Huntington Alloys, Inc., in Huntington developed three heat-resistant alloys used in the space shuttle's engines.

Legislation and Government Programs.—The West Virginia Legislature passed several acts affecting the State's mineral industry.

House bill 1716, passed in April, removed the requirement for a mandatory hearing when proposing to mine within 200 feet of an oil and gas well. In previous years, a hearing was required even if all parties had agreed to the mining operation. House bill 1716 also provides that a surface mine operator must submit to the Department of Mines and the well operator copies of the maps and plans for the area and furnish public liability insurance.

Senate bill 279, passed in April and in effect July 1, continued the Geologic and Economic Survey even though the Geologic and Economic Survey Commission expired on July 1. The Survey was reestablished as a direct executive department, with the Director and State geologist a direct gubernatorial appointee. Overall, the agency's functions in the areas of geology, natural resources, and archeology remained essentially the same.

A new policy was issued on prospecting by the State Division of Reclamation. Generally, the policy states that "unless excavating equipment is used in prospecting, it is not necessary to obtain approval from the Department of Natural Resources (DNR)." This policy clarifies situations involving use of core drilling equipment, which did not include excavating equipment. The policy further states that the 15-day waiting period will begin when the Notice of Intent is given to the local Reclamation Inspector. Previously, this period was not considered to have started until the notice was received in Charleston. If DNR does not reject the notice in 15 days, the operator may begin prospecting.

Federal legislation (H.R. 5161) pertaining to mineral resources was introduced in the House in December for approval. The legislation was the fifth attempt in recent years to preserve the wilderness status of the Cranberry section of Monongahela National Forest, Webster and Pocahontas Counties. The bill would also designate the Laurel Fork North and Laurel Fork South RARE II areas as wilderness and release Seneca Creek and Cheat Mountain from consideration as wilderness until at least 1995.

H.R. 5161 would also provide compensation for the mineral rights beneath the Cranberry Wilderness Study Area. Under the bill, the Chessie System (CSX Corp.), which owns nearly 86% of mineral rights, would transfer the coal rights to the Federal Government through arbitration. The Government would then exchange Cranberry's mineral rights with a minable property of equal value, subject to CSX approval.

The Economic Section of the West Virginia Geological and Economic Survey continued evaluating the State's limestone and clay and shale deposits to determine suitability for various uses. A report on the limestone resources of Harrison County containing detailed stratigraphic, chemical, and physical data was being prepared. Large-scale maps (1:50,000) showing limestone thicknesses and depth of overburden were to be included in the report. The Economic Section was also outlining high-growth areas in the State to determine which nearby construction material resources would be the most economical to develop. A reconnaissance of the geologic, economic, and hydrologic resources of Mason County was also underway during the year. Mineral resources in the county include sand and gravel, limestone, and clay.

During 1981, the DNR issued seven new surface mining permits for nonfuel minerals. Permits were issued for sand and gravel, limestone, sandstone, and clay and shale operations. Of the State's surface mines, 92% are coal operations, 4% are limestone, 3% are sandstone, and the remaining 1% are sand and gravel, clays, or shale.

In fiscal year 1981, the Federal Government allocated approximately $283,802 to the State for activities (timbering, mineral leasing, recreation, user fees, etc.) in Monongahela National Forest.

Mine rescue team training materials developed by West Virginia University were accepted for use by the U.S. Mine Safety and Health Administration (MSHA). The teaching materials were prepared under a contract with the U.S. Bureau of Mines in conjunction with the National Mine Rescue Association. They will be used in an initial

20-hour course consisting of an introduction to mine rescue and use of the self-contained breathing apparatus. Mine rescue team members must then take a 40-hour refresher course each year. Topics covered include surface organization, mine gases, mine ventilation, exploration, fires, firefighting and explosives, rescue of survivors, recovery of bodies, and mine recovery.

A report on the mineral resources of Otter Creek Wilderness, Tucker and Randolph Counties, was published as U.S. Geological Survey (USGS) Miscellaneous Field Studies Maps MF-1267 A-E. The study, jointly conducted by the U.S. Bureau of Mines and USGS, was undertaken in accordance with provisions of the Wilderness Act and Eastern Wilderness Act.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Cement.—Martin Marietta Corp., the only cement producer (portland and masonry) in the State, operated three coal-fired kilns at Martinsburg in Berkeley County in eastern West Virginia. Production was down slightly in 1981 primarily because of the slowdown in construction, which generally accounts for about one-third of cement consumption.

The wet-process plant has an annual grinding capacity of 935,000 tons[3] and uses electric precipitators for pollution control. Raw materials used in the manufacturing process included limestone and shale mined at the plantsite and sand from the nearby Pennsylvania Glass Sand Corp. in Berkeley Springs.

Most of the cement was used by ready-mix and concrete product manufacturers. In addition to in-State consumption, shipments were made to the District of Columbia, Maryland, North Carolina, Pennsylvania, and Virginia. The majority was shipped by truck; the remainder, by rail.

Clays.—In 1981, West Virginia produced both common and fire clays. Common clay was mined by three companies in Berkeley and Lincoln Counties, with Berkeley County accounting for virtually all of the State's production. Fire clay was mined by one company in Hancock County.

Most of the common clay was used in the manufacture of common face brick and cement. A small amount mined in Lincoln County was sold as "dummy clay" used in mine explosives stemming.

Even though there is an abundance of common clay resources in the State, builders serving most of West Virginia import a majority of their brick from other States. Since West Virginia brick is made only in the eastern panhandle in Berkeley and Hancock Counties, the high transportation costs prevent these producers from competing with many nearby out-of-State producers. In an effort to make local brick more available and possibly reduce construction costs in the State, the West Virginia Geological and Economic Survey has been evaluating the clay resources of the State to determine which deposits would be most economical to mine.[4]

Fire clay, mined only in Hancock County, most commonly occurs as underclays beneath coal seams. Since the brick made from this clay has a high fusion or melting point and is able to withstand higher temperatures, most of it is used for firebrick (refractories). Other amounts are used for building block or shipped unprocessed.

Continental Clay Products Co. completed construction of a new grinding facility at its Martinsburg plant, Berkeley County, which greatly increased raw material capacity. The expansion, which cost nearly $1 million, also has a ground storage facility of 3,300 tons that feeds ground material continuously to the brick machine by a basic reclaiming system. Prior to the completion of the new storage facility, the plant could store only about 75 tons of clay.[5]

Graphite (Synthetic).—Union Carbide continued to produce graphite specialties and electrodes at its Clarksburg plant in Harrison County. Basic raw materials used to make the graphite were petroleum coke and coal tar pitch. Production involved five basic steps: (1) forming, (2) baking, (3) pitch impregnation, (4) graphitizing, and (5) machining. At the Clarksburg plant, over 750 sizes and grades of graphite specialties and electrodes were produced. Approximately 85% of the finished stock was shipped by truck; the remainder, by rail.

During the year, the company announced plans to consolidate its graphite specialties operations at Clarksburg as part of a major expansion and modernization program of its coal products manufacturing facilities. The company's graphite operations at Niagara Falls, N.Y., will be transferred to Clarksburg, and some electrode production facilities will be transferred from

Clarksburg to another out-of-State facility. Several million dollars are expected to be invested in expanding and modernizing the existing facilities, while at the same time introducing a new line of products. Consolidation is expected to take 2 years.

Iron Oxide Pigments (Synthetic).—West Virginia ranked fourth nationally in the production of finished iron oxide pigments. Output and value increased 52% and 69%, respectively, over those of 1980. Production originated from the Mobay Chemical Corp. New Martinsville plant. A major expansion was completed in 1980, making the plant the largest single iron oxide facility in the United States. The pigments were used by the construction, paint, and plastics industries.

Iron oxides were also recovered from steel plant wastes by National Steel Corp. at its plant in Weirton. Both production and value of regenerator oxides decreased nearly 20% in 1981, reflecting cutbacks in steel production during the year.

Lime.—Lime production in West Virginia in 1981 remained essentially the same as that of 1980. Value was up slightly, the result of higher unit prices and inflationary factors. Two companies produced lime in the State. Both quicklime and hydrated lime were produced by one company in Pendleton County, while only quicklime was produced by another company in Berkeley County. The lime was used principally in sewage treatment, acid mine water neutralization, sugar refining, and paper and pulp manufacturing.

Combustion tests were conducted at West Virginia University's Coal Research Bureau using high-sulfur coal mixed with varying percentages of quicklime, hydrated lime, and limestone. The process, called sulfurtain, involves intimately mixing the lime or limestone with high-sulfur (5% to 7%) coal prior to combustion. Tests proved the process effective in reducing and, in some cases, eliminating sulfur released to the atmosphere when burned at 1,850° F or higher. The tests further showed that the addition of lime or limestone actually enhanced the combustion of carbon, which can result in higher furnace efficiencies. Slightly improved sulfur removal efficiency occurred with hydrated lime than with limestone.

Salt.—In 1981, three companies produced salt brines from deep well solution mining operations in Marshall and Tyler Counties. Salt sold or used in 1981 remained essentially the same as that of 1980. Most of the salt was used for the manufacture of chlorine, caustic soda, and other chemicals.

During the year, site preparation began at the PPG Industries, Inc., Natrium complex for a new production unit for calcium hypochlorite, used widely for water purification. Scheduled for completion in 1983, the unit was to utilize a new PPG process and increase calcium hypochlorite production to 200,000 pounds per day.

In a program at West Virginia University, researchers have been testing salt brines recovered from a gasfield for suitability in ice and snow control. Under a grant from the West Virginia Department of Highways, the tests were being conducted to determine if the brine can replace or supplement the more costly rock salt being applied to the roads. Currently, oil and gas companies have to pay to dispose of the salt brines, which are considered a waste product.

Sand and Gravel.—To reduce the reporting burdens and costs, the U.S. Bureau of Mines implemented new sand and gravel canvassing procedures for the survey of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel operators will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but contains complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

Based on these preliminary estimates, output of construction sand and gravel remained essentially the same in 1981. The majority of the State's production was recovered by dredge on the State's rivers, and the remainder from surface operations. Main uses were for asphalt and concrete aggregate, road base, and concrete products.

Early in 1981, Dravo Corp. purchased selected assets of the McDonough Co. former Ohio River Sand & Gravel Div. The purchase extended Dravo's Aggregates Div. operations into the Parkersburg, W. Va., area.

Industrial sand was produced by one company, the Pennsylvania Glass Sand Corp., in Morgan County. No production was reported from Brooke County where two de-

Table 4.—West Virginia: Sand and gravel sold or used by producers

	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	1,618	$6,833	$4.22	NA	NA	NA
Gravel	1,110	4,621	4.16	NA	NA	NA
Total or average	2,728	11,454	4.20	p2,700	p$11,500	p$4.26
Industrial sand	W	W	13.87	W	W	15.67
Grand total or average	W	W	7.12	W	W	p7.53

pPreliminary. NA Not available. W Withheld to avoid disclosing company proprietary data.

posits were mined in 1980. Value per ton in 1981 was $15.67 compared with $13.87 in 1980. The sand was used for a variety of purposes including glassware, molding, refractory, blasting, abrasives, and traction and roofing granules.

Stone.—Total output of crushed stone (limestone and sandstone) decreased nearly 19% from that of 1980. The decline was primarily the result of a slowdown in construction activity in the State. Also, because of budget cuts in the State Government, the Department of Highways purchased considerably less crushed stone during 1981 than in the previous years. Because of the cuts, road maintenance work was kept to a minimum during the year.

Table 5.—West Virginia: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	60	368	25	190
Agricultural marl and other soil conditioners	W	W	13	70
Concrete aggregate	964	3,040	1,042	3,730
Bituminous aggregate	231	947	212	968
Macadam aggregate	235	1,017	84	310
Dense-graded road base stone	2,346	9,202	1,556	5,940
Surface-treatment aggregate	434	1,591	282	1,065
Other construction aggregate and road stone	2,881	11,247	2,045	8,583
Riprap and jetty stone	70	303	69	276
Railroad ballast	507	1,060	480	1,341
Filter stone	W	W	106	467
Manufactured fine aggregate (stone sand)	351	1,741	331	1,464
Abrasives	21	91	20	93
Mine dusting	148	1,365	W	W
Fill	25	77	17	W
Roofing granules	--	--	1	W
Other[2]	1,493	4,255	1,603	3,898
Total[3]	9,766	36,305	7,885	28,399

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone and sandstone.
[2]Includes stone used in poultry grit and mineral food (1980), cement manufacture, lime manufacture, refractory stone, asphalt filler, sulfur removal from stack gases (1980), unspecified uses, and uses indicated by symbol W.
[3]Data may not add to totals shown because of independent rounding.

Crushed limestone was produced in 12 counties at 30 mines and quarries. The leading limestone-producing counties, in descending order of output, were Berkeley, Monongalia, Randolph, and Greenbrier. Major uses were for construction aggregate, road base, concrete, riprap, agriculture, and railroad ballast.

Crushed sandstone was produced in 7 counties at 13 quarries. Counties that led in output were Raleigh, Logan, and Tucker. Major uses were for road base and construction aggregate.

Of the total stone produced, 87% was shipped by truck, and the remaining 13%, by rail.

A study undertaken by West Virginia University details the concept of using coal or limestone mines to create power banks. The system would necessitate the installa-

tion of reversible pump turbines near the bottom of the mine. During peak power consumption, water from a river or a lake would be diverted to the bottom of the mine to turn the turbines and produce electricity. Then, during slumps in demand, the water would be pumped out of the mine by power from conventional powerplants.

METALS

Aluminum.—In 1981, Kaiser Aluminum closed all four of its potlines at the 163,000-ton-per-year primary aluminum smelter in Ravenswood. Although the first potline was closed in April when lightning damaged a utility company's distribution center, the remaining three were shut down because of reduced demand for aluminum, high operating costs, and labor concession problems. The Ravenswood plant, the largest employer in the area, has laid off nearly 1,500 workers since April.

The company also restructured the adjacent fabricating plant where ingots are rolled into sheets of varying thicknesses. Additional layoffs were also expected because of dismal performances in the transportation and housing industries. About one-half of the plant's production is consumed by aluminum can manufacturers, which have not made major cuts in their aluminum orders.

Ferroalloys.—In 1981, three companies produced ferroalloys: Union Carbide at its Alloy plant in Fayette County, the Foote Mineral Co. at its Graham plant in Mason County, and Chemetals Corp. subsidiary, SEDEMA S.A., at Kingwood in Preston County.

Ferroalloy shipments in 1981 totaled 126,308 tons, valued at nearly $77 million. Shipments in 1981 were 2% lower than that of 1980 and 27% lower than 1979 production. Cutbacks in domestic auto production and increased foreign competition contributed to the decline in ferroalloy sales. Soft demand by foundry, steel, and aluminum producers also necessitated curtailed production.

Foote Mineral announced that it was curtailing production of ferroalloy products in December at its Graham plant. The plant, which produces ferrosilicon and proprietary silicon products, reduced production to 25% of capacity from a 100% operating rate. The reduction was required to hold inventory levels in balance with reduced demand.

During the year, Union Carbide completed the sale of its ferroalloy plant in Alloy to Elkem AS of Norway. The Alloy plant was one of several plants owned by Union Carbide in the United States and Norway that were sold to Elkem. The plant, which employs more than 800 persons, will be operated by Elkem Metals Co. based in Pittsburgh, Pa. Union Carbide announced that the sale was part of a plan to eliminate businesses that no longer fit into its long-term strategy.

Iron and Steel.—Consumption of pig iron increased about 12% in 1981. Output of both iron and steel slag declined because of the depressed condition of the steel industry.

Weirton Steel Div. of National Steel, and Wheeling-Pittsburgh Steel Corp. are the State's major steel producers. National Steel operated a plant at Weirton, and Wheeling-Pittsburgh operated plants in Benwood, Follansbee, Beech Bottom, and Wheeling. Virtually one-half of the State's primary metals industry production was directly attributable to National Steel's Weirton plant.

In October, National Steel reduced ironmaking operations at its Weirton plant when it shut down the second of four blast furnaces; the first furnace was closed in August 1979. The latest shutdown resulted in the layoff of 600 employees because the cutback in molten iron output also impacted on downstream steelmaking mills.

The State's coke industry also was affected by the reduced steel demand. Of five new coke plants proposed to be built in the State, construction was underway on one coke plant. The four plants dropped or postponed included the Sharon Corp. Fairmont plant, the National Steel and Elk River Resources, Inc., Prichard plant, the Philpott Corp. Beckeley plant, and a coking facility in Morgantown proposed by Alla-Ohio Valley Coals. The only coking plant under construction at yearend was Pennsylvania Coke Technology's facility at Lester, Raleigh County.

Nickel.—Huntington Alloys, a division of Inco Alloy Products Co., continued to produce wrought and high-nickel alloys at its Huntington plant in Cabell County. This plant is the largest integrated rolling mill complex among the market economy countries devoted exclusively to the production of high-nickel alloys. The product line was composed of alloys ranging from general purpose materials for corrosive service to highly specialized alloys for electronic and gas turbine components. They were used by

the chemical, energy, mineral exploration, aerospace, heat-treating, pollution control, and marine industries.

Net sales were again lower in 1981 reflecting the overall poor economic conditions. Weak demand was particularly evident in the aerospace engines markets. However, operating earnings, while lower than in 1980, benefited from improved production processes, inventory reductions, and effective working capital controls.[6]

Zinc.—The Meadowbrook Corp., a wholly owned subsidiary of T. L. Diamond & Co., Inc., operated a zinc plant at Spelter, Harrison County. Zinc drosses, ashes, and other residues were used to produce zinc dust, oxides, and other zinc products.

Zirconium.—Corhart Refractories Co. continued to produce high-density zircon and chromic oxide refractory brick for the metallurgical industry at its Buckhannon plant in Upshur County. The chromic oxide used at the plant is imported from the Republic of South Africa, and the zircon originates in Australia. Tin oxide is also used at the plant to make tin oxide electrodes, used mainly by the glass-melting industry.

[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.
[2]Economic geologist and Head, Economic Section, West Virginia Geological and Economic Survey, Morgantown, W. Va.
[3]Portland Cement Association. U.S. and Canadian Portland Cement Industry: Plant Information Summary. Skokie, Ill., Dec. 31, 1980, p. 26.
[4]Kirstein, D. S. Bricks: Man's Earliest Substitute for Building Stone. Mountain State Geol., W. Va. Geol. and Econ. Survey, December 1981.
[5]Streeter, M. Grinding Plant Raises Clay Prep Capacity. Brick and Clay Record, April 1982.
[6]Inco, Ltd. 1981 Annual Report.

Table 6.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Martin Marietta Corp.[1]	Box 885 Martinsburg, WV 25401	Quarry and plant	Berkeley.
Clays:			
Continental Clay Products Co	Box 1111 Martinsburg, WV 25401	Pit	Do.
Globe Refractories, Inc	Box D Newell, WV 26050	Underground mine	Hancock.
Sanders Dummy Co	Box 146 Midkiff, WV 25504	Pit	Lincoln.
Iron oxide pigments, finished:			
Mobay Chemical Corp	Penn Lincoln Parkway West Pittsburgh, PA 15205	Plant	Wetzel.
National Steel Corp., Weirton Steel Div.	Weirton, WV 26062	do	Hancock.
Lime:			
German Valley Limestone Co	Greer Bldg. Morgantown, WV 26505	Quarry and plant	Pendleton.
Riverton Corp	Riverton, VA 22651	do	Berkeley.
Salt:			
FMC Corp	Box 8127 South Charleston, WV 25303	Brine wells	Tyler.
LCP Chemicals-West Virginia, Inc.	Drawer J Moundsville, WV 26041	Brine wells and plant	Marshall.
PPG Industries, Inc	1 Gateway Center Pittsburgh, PA 15222	do	Do.
Sand and gravel:			
Dravo Corp	1 Oliver Plaza Pittsburgh, PA 15222	Dredge	Hancock.
McDonough Co	Box 538 Parkersburg, WV 26100	do	Tyler and Wetzel.
Pennsylvania Glass Sand Corp	Box 187 Berkeley Springs, WV 25411	Quarry and plant	Morgan.
Shippingport Sand and Gravel Co.	1200 Stambaugh Bldg. Youngstown, OH 44501	Plant	Hancock.
Smelters:			
Kaiser Aluminum & Chemical Corp.	Box 98 Ravenswood, WV 26164	do	Jackson.
Stone:			
Acme Limestone Co	Box 27 Fort Spring, WV 24936	Mine and quarry	Greenbrier.
Beckley Stone Co	Box 1284 Beckley, WV 25801	Quarry	Raleigh.
The H. Frazier Co., Inc	Box 1877 Richmond, VA 23211	do	Greenbrier.
Greer Limestone Co., a division of Greer Steel Co.	Greer Bldg. Morgantown, WV 26505	Mine and quarries	Monongalia and Pendleton.
Marquette Co	Route 3, Box 489 Morgantown, WV 26505	Mine	Monongalia.
Shenandoah Quarry, Inc	Box C Millvale, WV 25432	Quarry	Jefferson.

[1]Also clays and stone.

The Mineral Industry of Wisconsin

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Wisconsin Geological and Natural History Survey for collecting information on all nonfuel minerals.

By James J. Hill[1] and Thomas J. Evans[2]

The value of nonfuel mineral production in Wisconsin was $156.3 million in 1981, a modest increase over that of 1980 but below the record value of $179.7 million set in 1979. As in preceding years, nonmetallic minerals contributed the greatest amount of value to the State's mineral production, with construction aggregates (stone and sand and gravel) contributing the largest sums. Mineral commodities produced in the State were, in decreasing order of value, sand and gravel, stone, iron ore, lime, cement, and peat. Perlite and vermiculite were imported into the State for processing, and sulfur was recovered as a refinery byproduct.

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

Mineral	1980		1981	
	Quantity	Value (thousands)	Quantity	Value (thousands)
Iron ore (usable) thousand long tons, gross weight	679	W	853	W
Lime thousand short tons	357	$17,287	326	$17,548
Peat do	11	535	10	535
Sand and gravel do	22,014	r47,571	p20,400	p52,280
Stone:				
Crushed do	20,603	49,245	15,189	39,962
Dimension do	45	4,501	40	4,259
Combined value of abrasive stone, cement, clays, and values indicated by symbol W	XX	33,151	XX	41,749
Total	XX	r152,290	XX	156,333

pPreliminary. rRevised. W Withheld to avoid disclosing company proprietary data; value included in "Combined value" figure. XX Not applicable.

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Adams	W	--	
Ashland	$65	W	Stone, sand and gravel.
Barron	1,076	$243	Sand and gravel.
Bayfield	W	W	Stone.
Brown	W	W	Lime, stone.
Buffalo	574	463	Stone, sand and gravel.
Burnett	1,109	753	Sand and gravel.
Calumet	W	W	Stone, sand and gravel.
Chippewa	842	557	Sand and gravel.
Clark	664	W	Do.
Columbia	3,234	W	Sand and gravel, stone.
Crawford	W	W	Do.
Dane	W	4,550	Do.
Dodge	W	W	Stone, lime, sand and gravel.
Door	774	688	Sand and gravel, stone.
Douglas	W	13,888	Lime, cement, stone, sand and gravel.
Dunn	W	W	Stone, sand and gravel.
Eau Claire	495	W	Sand and gravel.
Florence	47	18	Do.
Fond du Lac	W	W	Stone, lime, sand and gravel, clays.
Forest	154	229	Sand and gravel.
Grant	1,680	1,643	Stone.
Green	W	W	Stone, sand and gravel.
Green Lake	W	W	Sand and gravel, stone.
Iowa	683	1,010	Stone.
Iron	W	--	
Jackson	W	W	Iron ore, sand and gravel.
Jefferson	637	566	Stone, sand and gravel.
Juneau	W	W	Stone.
Kenosha	3,706	1,737	Sand and gravel.
Kewaunee	774	617	Do.
La Crosse	W	W	Stone, sand and gravel.
Lafayette	W	876	Stone.
Langlade	W	W	Sand and gravel.
Lincoln	365	393	Do.
Manitowoc	10,350	7,878	Stone, lime, sand and gravel, cement.
Marathon	6,868	6,801	Stone, sand and gravel.
Marinette	3,002	W	Do.
Marquette	W	W	Sand and gravel, stone.
Milwaukee	W	W	Stone, cement.
Monroe	1,305	1,935	Stone.
Oconto	978	658	Sand and gravel, stone.
Oneida	844	493	Sand and gravel.
Outagamie	W	2,023	Stone.
Ozaukee	W	623	Sand and gravel, stone.
Pepin	197	56	Stone, sand and gravel.
Pierce	W	1,449	Sand and gravel, stone.
Polk	3,195	2,858	Stone, sand and gravel.
Portage	1,422	1,457	Sand and gravel.
Price	96	101	Do.
Racine	3,590	W	Stone, sand and gravel.
Richland	W	220	Do.
Rock	3,190	2,604	Sand and gravel, stone.
Rusk	702	663	Sand and gravel.
St. Croix	W	W	Stone, sand and gravel.
Sauk	W	W	Stone, sand and gravel, abrasives.
Sawyer	248	106	Sand and gravel.
Shawano	915	W	Sand and gravel, stone.
Sheboygan	1,188	W	Do.
Taylor	1,416	1,369	Sand and gravel.
Trempealeau	W	880	Stone.
Vernon	W	W	Do.
Vilas	728	449	Sand and gravel.
Walworth	1,839	2,009	Sand and gravel, stone.
Washburn	W	W	Sand and gravel.
Washington	W	993	Sand and gravel, stone.
Waukesha	15,849	12,337	Sand and gravel, stone, peat.
Waupaca	W	W	Sand and gravel, stone.
Waushara	W	W	Sand and gravel.
Winnebago	5,252	W	Stone, sand and gravel.
Wood	79	188	Stone.
Undistributed[2]	99,554	75,908	
Total[3]	179,682	152,290	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Menominee County is not listed because no nonfuel mineral production was reported.
[2]Includes some sand and gravel 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 Wisconsin business activity

		1980	1981[P]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	2,394.9	2,427.5	+1.4
Unemployment	do	168.9	220.6	+30.6
Employment (nonagricultural):				
Mining	do	2.6	2.2	-15.4
Manufacturing	do	558.0	543.1	-2.7
Contract construction	do	70.1	60.7	-13.4
Transportation and public utilities	do	92.1	90.8	-1.4
Wholesale and retail trade	do	436.8	432.4	-1.0
Finance, insurance, real estate	do	93.3	95.9	+2.8
Services	do	364.2	375.9	+3.2
Government	do	321.1	319.0	-.6
Total nonagricultural employment[1]	do	1,938.1	1,919.9	-.9
Personal income:				
Total	millions	$44,400	$47,681	+7.4
Per capita		$9,413	$10,056	+6.8
Construction activity:				
Number of private and public residential units authorized		18,510	13,046	-30.0
Value of nonresidential construction	millions	$526.3	$503.6	-4.3
Value of State road contract awards	do	$142.0	$159.2	+12.1
Shipments of portland and masonry cement to and within the State	thousand short tons	1,590	1,372	-13.7
Nonfuel mineral production value:				
Total crude mineral value	millions	$152.3	$156.3	+2.6
Value per capita, resident population		$32	$33	+3.1
Value per square mile		$2,712	$2,784	+2.6

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

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

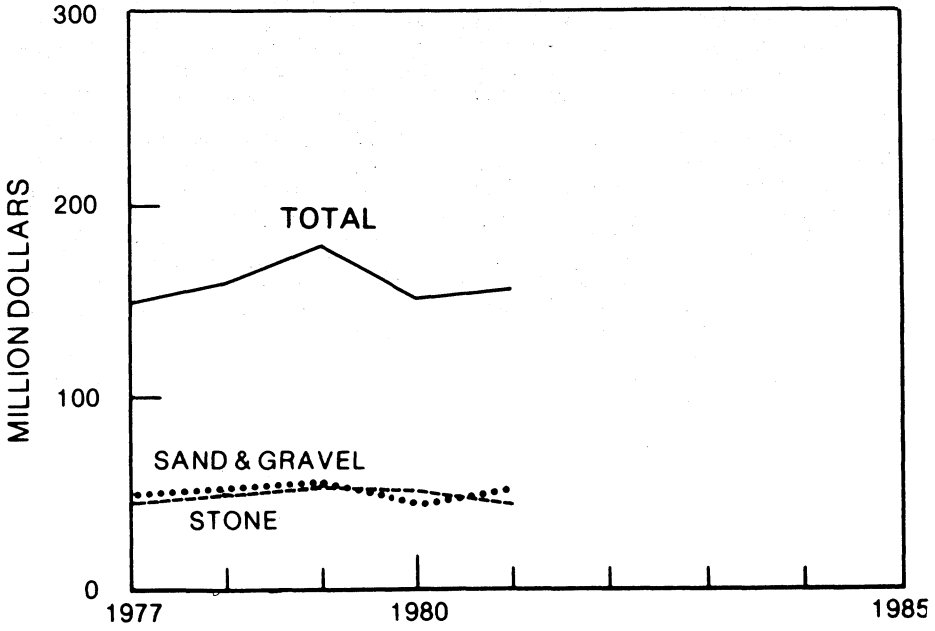

Figure 1.—Value of sand and gravel, and stone, and total value of nonfuel mineral production in Wisconsin.

Trends and Developments.—In retrospect, 1981 was a lackluster year for Wisconsin's mineral industry, and the effects of the nationwide recession were felt throughout the State's economy. For the second year in a row, housing and general construction dropped, affecting a large portion of the State's mineral economy. The State's Department of Industry, Labor, and Human Relations reported a 9% drop below 1980 figures for the number of building plans examined for compliance with the State's commercial building code in areas outside of Milwaukee. The U.S. Department of Commerce reported a 30% drop in the number of units for which permits were issued for residential construction (public and private). Also, the value of private nonresidential construction dropped 4% below 1980 figures. Only 275 new capital investment projects were undertaken in 1981, the fewest since 1964. In addition, 33 plants closed statewide. However, Wisconsin's industrial sector added 4,720 new jobs in 1981, 147 more than in 1980, according to the annual industrial expansion report by the State Department of Development.

Anderson/Roethle & Associates, Inc., in its Wisconsin Acquisition and Merger Report, recorded 31 transactions of Wisconsin companies being acquired by out-of-State firms. This resulted in the loss of more than $4 billion in Wisconsin-based annual sales volume.

In February, Inspiration Mines, Inc., of Phoenix, Ariz., an affiliate of Inspiration Consolidated Copper Co., purchased four inactive zinc-lead mines in southwestern Wisconsin from Eagle-Picher Industries, Inc. The purchase included 151 surface acres and the Shullsburg, Crawhall, Bear Hole, and Elmo No. 3 Mines. In addition, approximately 10,000 acres of mining leases in Wisconsin and Illinois were obtained. With the purchase, Inspiration assumed the responsibility for reclamation of the mines.

In April, Harnischfeger Corp., a Brookfield-based manufacturer of construction, mining, and material-handling equipment, announced it would sell 10% of its stock—1 million shares—to Kobe Steel Ltd., one of Japan's largest steelmakers. Kobe Steel manufactured a variety of P & H-brand construction and mining equipment under license from Harnischfeger for 25 years. Proceeds of the sale, which also included certain Japanese patent rights, were to be used to reduce the firm's short-term debt.

In November, the Jackson County iron mine at Black River Falls shut down for 31 days. The action resulted from a decline in steel orders at the Inland Steel Co., Indiana Harbor Works, East Chicago, Ind., and the decreased need for taconite pellets.

Also during November, a new zinc-copper discovery in Wisconsin was reported by Forbes magazine. The deposit, located on the Mole Lake Indian Reservation just east of the Exxon Minerals Co., U.S.A., Crandon deposit, was discovered by the U.S. Geological Survey (USGS), which explored the reservation in 1979-80 under an interagency agreement with the U.S. Bureau of Indian Affairs. Details on the tonnage and grade of the deposit were not released.[3]

After several years of negotiations between mining company representatives and local and State officials, the State's controversial 1977 mining tax law was amended. A new law that lowered net-proceeds taxes on mining and provided additional tax deductions to mining firms became effective November 28, 1981. The law also strengthened environmental safeguards.

Exploration.—The search for mineral deposits continued at a rapid pace during 1981, with most of the activity occurring in north-central and northeastern Wisconsin. Mining companies concentrated mainly on nonferrous base-metal targets and, to a lesser extent, on uranium. The State Department of Natural Resources (DNR) reported drilling in 10 counties, with the greatest number of holes drilled in Forest, Price, and Florence Counties. Total footage surpassed that drilled in 1980 by about 28,400 feet. Fourteen companies held active metallic mineral exploration licenses during the year; two companies allowed their licenses to expire on July 1, the annual license renewal date. Of the 14 companies holding exploration licenses, 10 drilled holes. Drilling activity during 1981 is summarized in table 4.

Table 4.—Wisconsin: Metallic mineral exploration, 1981

Licensed exploration companies	Number of drill holes	Total footage drilled
AMAX Exploration, Inc	6	2,344
American Copper & Nickel Co., Inc	11	6,853
Amoco Minerals Co	13	12,331
Central Wisconsin Joint Venture	--	--
Duval Corp.[1]	--	--
Exxon Minerals Co., U.S.A.[2]	15	8,940
Inspiration Mines, Inc	--	--
Kerr-McGee Corp	12	5,816
E. K. Lehmann & Associates of Wisconsin, Inc	28	29,282
Minatome Corp	8	1,309
Mineral Sciences Division, UOP, Inc	14	8,310
Noranda Exploration, Inc	2	1,646
St. Joe American Corp	2	1,168
Western Nuclear, Inc.[1]	--	--
Total	111	77,999

[1]Metallic mineral exploration license lapsed July 1, 1981.
[2]Includes 13 holes (8,381 feet) drilled on the Crandon deposit.

Source: Metallic Mineral Exploration Drillhole Abandonment Reports, Wisconsin Department of Natural Resources.

Shipping.—Total waterborne commerce through the Port of Duluth-Superior in 1981 was 36.4 million metric tons, down from the 37.9 million metric tons reported by the Seaway Port Authority of Duluth for 1980. Domestic shipments accounted for most of the port's traffic, with iron ore and concentrates having the greatest tonnage. Shipments of iron ore and concentrates to domestic ports totaled 21.7 million metric tons, down from the 22.0 million metric tons reported in 1980. Exports of these commodities to Canada totaled 2.6 million metric tons, compared with 1.9 million metric tons shipped in 1980. The Burlington Northern, Inc., transshipment terminal on Allouez Bay in Superior handled 10.7 million gross tons of the port's taconite pellets in 1981. Imports of limestone and limestone products from both domestic and Canadian sources dropped 22% from those reported in 1980. A portion of these commodities was used by the CLM Corp. lime plant and the Huron Cement Co. clinker grinding facility in Superior.

In 1981, Fraser Shipyards, Inc., in Superior, began converting three vessels in the United States Steel Co. Great Lakes fleet into self-unloaders. The 767-foot freighters, each with a capacity of 26,500 long tons, will be able to unload their cargoes in 5 hours instead of the previous 17 hours. The modifications were scheduled to be completed in time for the 1982 navigation season.

Total tonnage handled through the Port of Milwaukee, which serves Wisconsin's densely populated southeastern region, fell nearly 25% in 1981. Domestic cargo handled in the port dropped 41%, Canadian cargo was up 58%, and other international cargo was down 29%. The overall decline from that of 1980 was 23%, from 2.04 million to 1.58 million short tons. The drop in cargo handled can in part be attributed to the sluggish economy in 1981, as well as the lack of shipping service into the western Great Lakes. In 1981, the Port of Milwaukee lost the service of the Manchester line, which had handled some of the port's business. Nonmetallic mineral commodities imported in the region, excluding fuels, were cement, salt, sand, limestone, and slag (table 5). All were imported from domestic sources in 1981.

Table 5.—Port of Milwaukee: Nonmetallic mineral commodity imports

(Short tons)

Commodity	1980	1981
Cement	447,306	416,587
Salt	[1]254,725	222,683
Sand	65,965	65,534
Limestone	--	11,687
Slag	--	11,460
Clinker	51,500	--
Total	819,496	727,951

[1]Includes Canadian imports.

Source: Port of Milwaukee, U.S.A.

During the year, Bay Shipbuilding Corp.,

a subsidiary of Manitowoc Co., Inc., completed construction of several vessels at its Sturgeon Bay shipyard. In May, the MV *Columbia Star* was christened and joined the fleet of Oglebay Norton Co. The 1,000-foot ore carrier was designed to carry 61,000 gross tons at maximum draft and unload at 10,000 tons per hour. In July, the MV *American Republic* was christened and joined the American Steamship Co. Great Lakes fleet. The new iron ore carrier will be able to discharge pellets at 6,000 gross tons per hour and carry a cargo of 24,500 gross tons.

Two oceangoing barges were also completed during the year. *Energy Freedom,* a 550-foot coal carrier, was delivered to Universal American Shipping Corp., Greenwich, Conn. The bulk cargo barge was chartered to New England Electric System for carrying coal from eastern ports to power stations in Massachusetts. Also, the new dry bulk cargo barge *Oceanport* was delivered to Ocean Barge Corp. The vessel will be able to transport 34,300 short tons of cargo to ports within the United States and worldwide.

Legislation and Government Programs.—Chapter 86, Laws of 1981, was signed by the Governor and became effective November 28, 1981. Enactment of the legislation brought Wisconsin's mining tax structure back into line with other mining States and is viewed as encouraging for mine development in the State. The statute addressed three major areas affecting metallic mining in Wisconsin: (1) Revision of the net-proceeds tax, (2) revision of Investment and Local Impact Fund disbursement of certain tax revenues and creation of a Badger Fund to manage the remaining tax revenues, and (3) miscellaneous environmental issues.

The net-proceeds tax on metalliferous mining was reduced, and deductions used to determine net-proceeds tax liability from a company's gross proceeds were expanded. Tax rates were lowered to range from 3% to 15% (formerly 6% to 20%). Allowable deductions include extracting, concentrating, smelting, refining, inventorying, and handling costs; sales, income, and property taxes; depreciation on property; interest and royalty payments; and premining and reclamation costs.

Revenues from the net-proceeds tax on metalliferous mining are distributed to local municipalities to address mine-related impacts. Disbursement programs of the Investment and Local Impact Fund Board were modified to include block grants to municipalities containing a known metalliferous mineral ore body. Also, the disbursement program guarantees local governments certain minimal assistance indexed for inflation. Revenues not designated for the Local Impact Fund or the Mining Damages Claim Fund are reserved for the Badger Fund. Interest on Badger Fund monies (36% of the annual net-proceeds tax revenue) is to be divided equally between aid to educational systems and capital improvements to municipal recreational facilities.

Environmental issues addressed included a simplified procedure for settling claims of damage to private water supplies resulting from mining and the transfer of management for mining-derived radioactive materials to DNR.

Chapter 87, Laws of 1981, clarified certain timing provisions in the State's "truth in leasing" statutes. A lessor may cancel the lease if 10 years have elapsed after the lease is recorded and if the lessee has not applied for a prospecting or mining permit. If the lessee applies for a prospecting or mining permit but does not receive it within 10 years following application, the lessor's right to cancel is revived.

Public hearings were held during the year on administrative rules that regulate metallic mine disposal and ground water protection. Formal adoption of the rules was expected in 1982.

Section 107.15 of the Wisconsin statutes, requiring mining firms to file results of exploration activities with the State geologist, was declared unconstitutional by a county circuit court in late 1980. The State filed an appeal to the decision in 1981, and a ruling on the appeal was expected in 1982.

On the Federal level, the U.S. Supreme Court ruled in 1981 that Federal mine safety inspectors do not need search warrants to conduct surprise inspections of mines and quarries. The case involved a Wisconsin quarry operator who refused to allow a mine safety inspector to continue an inspection unless a search warrant was obtained.

Wisconsin's Mining Investment and Local Impact Fund Board approved $203,160 in grants to local governments for use in dealing with the effects of metallic mineral development. The 1981 awards, to be distributed in 1982, will go to 12 communities (cities and/or towns), 8 counties, and 4 Indian tribes. Uses of the funds include (1)

expenses for local and regional impact committees, (2) legal services, (3) planning assistance and planning studies, (4) environmental and technical studies, (5) capital improvements, and (6) fencing and cave-ins.

In 1981, the Wisconsin Geological and Natural History Survey completed its Preliminary Bedrock Geology of Northeastern Wisconsin map (scale 1:250,000). This map represents the first of several new bedrock geology mapping projects scheduled for publication in the next few years. At yearend, a new 1:1,000,000 bedrock geology map for the entire State, the first significant revision since 1911, was in cartographic review. Publication of the new map was scheduled for mid-1982.

Mine-land reclamation programs in 1981 centered on two areas. Zinc roaster waste piles along Brewery Creek in Iowa County were the subject of (1) evaluation for reclamation potential in a study by the Wisconsin Geological and Natural History Survey funded by the State's Investment and Local Impact Fund Board, and (2) revegetation experiments, initiated in 1980, as part of graduate study supported by the University of Wisconsin—Madison.

At the Inspiration Mines, Inc., flotation tailings pile south of Shullsburg, revegetation work by the Wisconsin Geological and Natural History Survey and the University of Wisconsin—Madison proceeded with initial planting of experimental plots. Reclamation planning and vegetation experiments on the tailings pile were in line with the previous owner's (Eagle-Picher Industries, Inc.) apparent intentions to permanently close the Shullsburg Mine properties and reclaim the land area immediately surrounding the old mine property.

The Wisconsin Geological and Natural History Survey and the University of Wisconsin—Madison received a $110,000 Federal contract to evaluate the peat resources of Wisconsin. The study, initially funded for 1 year, will carry over into the 1982 field season.

The Lakes State Office of the Bureau of Land Management released four quadrangle maps in 1981 that cover portions of Wisconsin and show the surface and mineral estate on land owned by the Federal Government. Maps released were Duluth, Port Wing, Sandstone, and Solon Springs.

In fiscal year 1981, the Federal Government allocated the State approximately $498,700 for its share of funds generated by activities on national forest lands (timbering, minerals leasing, recreation, user fees, etc.). This compares with $469,600 the State received in fiscal year 1980. No action was taken by the U.S. Congress in 1981 on the seven areas previously nominated for wilderness designation in the Chequamegon and Nicolet National Forests. A report on one area—Round Lake Wilderness Study Area—was released as USGS Bulletin 1512 during the year. The U.S. Bureau of Mines and USGS evaluated the mineral potential of the proposed wilderness and found the area to contain several bogs of peat and extensive sand and gravel deposits. Distance from markets restricts the commercial value of these resources.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Abrasive Materials.—Baraboo Quartzite Co., Inc., continued to mine quartzite at a small quarry located east of Baraboo, Sauk County. After crushing, the rock was tumbled to remove jagged edges and then screened to about 20 different sizes ranging from sand-sized particles to 4 inches for use as a deburring and burnishing media. The abrasive was packaged in 100-pound bags and shipped to metal-stamping plants in several States and foreign countries. Production was down slightly for the year owing to the depressed economy and slowdowns in the metals industry.

Cement.—The Huron Cement Div. of National Gypsum Co. operated grinding facilities in Superior; Lehigh Portland Cement Co. used its grinding facility in Milwaukee as a distribution terminal only. Cement shipments included types I and II gray and white portland cement and some masonry. Shipments were 18% higher in 1981 compared with those of 1980. Most of the cement was transported in bulk form by truck; the remainder was shipped by rail. Finished portland cement was distributed to ready-mix concrete companies and concrete-products manufacturers. Other users included building material dealers and contractors.

During the year, Martin Marietta Cement expanded its distribution terminal in Madison to better serve the markets in the region. The terminal was to be served by the company's newly expanded Davenport, Iowa, plant, which began operations in

1981.

Clays.—In recent years, Oakfield Shale Brick & Tile Co. has been the State's only producer of common clay and shale from a deposit south of Oakfield, Fond du Lac County. The firm manufactured common and face brick at its onsite plant. The plant operated intermittently, depending on consumer demand, and no production was reported to the U.S. Bureau of Mines for 1981.

Lime.—Although lime production dropped for the third consecutive year, total value increased slightly over that of 1980, reflecting a gain in unit value. Three companies produced lime in Wisconsin. Western Lime & Cement Co. operated three plants—one at Green Bay, Brown County; one at Knowles, Dodge County; and one at Eden, Fond du Lac County. Rockwell Lime Co. operated a plant at Manitowoc, Manitowoc County, and CLM Corp. produced lime at a plant in Superior, Douglas County. Lime from the plants was distributed to consumers in Wisconsin, several adjoining States, and Ontario, Canada. Lime was used in the manufacture of paper and pulp, sewage treatment, and road stabilization; other uses included water purification, mason's lime, and steel production.

During the year, Western Lime moved its headquarters from downtown Milwaukee to West Bend. Construction was also started on a new rotary kiln unit at the firm's Eden plant. CLM installed a new pelletizing machine that compressed reclaimed baghouse dust into salable form. One of the firm's three kilns was shut down for most of the year and was being converted to coal firing.

Peat.—Three companies located in Waukesha County produced peat in 1981. Although production was down for the year, unit values increased slightly. Demilco, Inc., a division of Nitragin Sales Corp., produced and packaged peat for use as a seed inoculant. Certified Peat & Sod, Inc., produced and distributed packaged and bulk peat for general soil improvement. Bogda's Top Soil & Excavation Co. also produced bulk peat for soil improvement.

Demilco's processing operation differs from most operations in the country. Peat is mined by a contractor from company-owned bogs, transported to the nearby plant, and then cleaned, milled, and fed into a gas-fired rotary kiln to reduce moisture content. The peat, with a moisture content ranging from 6% to 12%, was screened into three sizes—minus 15, 50, and 200 mesh. The product was packaged into 80-pound bags and shipped by truck to the firm's Milwaukee plant where nitrogen was added. The product was repackaged, some in pelletized form, and shipped to nurseries throughout the country for use as seed inoculant.

Perlite.—During the year, Midwest Perlite Co. operated a plant at Appleton in Outagamie County, and W. R. Grace & Co. expanded crude perlite imported from out of State at a plant in Milwaukee. W. R. Grace phased out its expanded perlite operations in 1981 because of economic conditions. Output and value dropped about 35% and 19%, respectively, compared with 1980 figures. Most of the perlite produced was for horticultural purposes; lesser quantities were used in plaster and concrete aggregates and cavity fill insulation.

Sand and Gravel.—In late 1980, the U.S. Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but complete data on industrial sand and gravel. Estimates for production of construction sand and gravel for odd-numbered years will be revised and finalized the following year.

For the second year in a row, production of sand and gravel declined, mainly because of reduced construction activity. Value increased slightly over that of 1980. In terms of value, sand and gravel was the leading mineral commodity produced in Wisconsin (stone was the leading commodity produced in 1980). About 95% of the State's sand and gravel output was used in construction, accounting for about 75% of the value; the remainder was used in industrial applications. Most construction sand was transported to markets by truck.

Industrial sand was produced by three companies in five counties. Output increased about 16% over that of 1980; value increased about 38%. Major sales of the sand, in declining order of tonnage, were for foundry applications, hydraulic fracturing, glass containers, and sandblasting. Sand used for blasting purposes was the only type that dropped in unit value from 1980 to 1981. About 59% of the industrial sand output was moved by truck, and the rest, by

rail. The sand is marketed throughout the United States.

During the year, Badger Mining Corp., a major industrial sand producer, constructed a new rail shipping center near Black River Falls. The facility eventually will allow the firm to ship 90 railcars of silica sand each week from its mill to foundries, glass manufacturers, and the oil and gas industry.

Minnesota Frac Sand Co., a division of J. L. Shiely Co. of St. Paul, Minn., announced plans and held public meetings during the year for a proposed silica sand operation near Glenwood City, St. Croix County. The firm conducted feasibility studies and filed for permits from DNR. No decision was announced at yearend as to when mining would begin.

Table 6.—Wisconsin: Sand and gravel sold or used by producers, by use

Use	1980			1981		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Construction:						
Sand	r6,984	r$13,686	r$1.96	NA	NA	NA
Gravel	r14,083	r24,338	r1.73	NA	NA	NA
Total[1] or average	r21,067	r38,025	r1.80	p19,300	p$39,100	$2.03
Industrial sand	r947	r9,546	r10.08	1,100	13,180	11.98
Grand total[1] or average	22,014	r47,571	2.16	p20,400	p52,280	2.56

pPreliminary. rRevised. NA Not available.
[1]Data may not add to totals shown because of independent rounding.

Stone.—In terms of value, stone was the second leading commodity mined in Wisconsin in 1981. Overall production dropped during the year because of the decline in construction. Stone was mined in 47 of the State's 72 counties at 238 quarries. Crushed stone was produced in all 47 counties; 6 counties also had dimension stone operations. Several quarries extracted both dimension and crushed stone. Crushed stone was produced at 219 quarries. Limestone was the most valuable crushed stone produced, followed by traprock, granite, and sandstone. Dane County led the State with 25 crushed stone quarries; Waukesha County operations had the greatest crushed stone value.

Table 7.—Wisconsin: Dimension stone[1] sold or used by producers, by use

Use	1980			1981		
	Short tons	Cubic feet (thousands)	Value (thousands)	Short tons	Cubic feet (thousands)	Value (thousands)
Rough stone:						
Rough blocks	5,026	63	$61	4,805	60	$78
Irregular-shaped stone	4,127	52	199	3,434	43	194
Rubble	10,247	128	177	7,989	101	168
Monumental	1,840	15	453	2,268	21	592
Flagging	4,591	58	148	3,800	48	140
Dressed stone:						
Cut	2,897	36	219	4,388	55	356
Sawed	1,516	19	82	1,196	15	73
House stone veneer	10,890	136	563	8,982	113	488
Monumental	2,430	28	2,537	1,487	17	2,092
Curbing	41	1	1	W	W	W
Flagging	488	6	14	W	W	W
Other[2]	1,333	17	48	1,994	25	77
Total[3]	45,431	559	4,501	40,343	498	4,259

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, granite, and sandstone.
[2]Includes dressed construction and other uses not specified.
[3]Data may not add to totals shown because of independent rounding.

Table 8.—Wisconsin: Crushed stone[1] sold or used by producers, by use

(Thousand short tons and thousand dollars)

Use	1980		1981	
	Quantity	Value	Quantity	Value
Agricultural limestone	837	2,848	696	2,589
Concrete aggregate	1,687	4,331	1,137	3,304
Bituminous aggregate	933	2,358	781	2,075
Macadam aggregate	399	849	263	650
Dense-graded road base stone	6,513	13,517	4,786	10,667
Surface treatment aggregate	2,230	5,055	809	1,820
Other construction aggregate and road stone	4,934	10,316	3,843	8,941
Riprap and jetty stone	380	1,863	356	1,897
Railroad ballast	1,088	3,116	1,349	4,053
Filter stone	68	167	29	152
Manufactured fine aggregate (stone sand)	139	268	10	W
Lime manufacture	135	427	W	W
Flux stone	13	38	W	W
Fill	6	4	W	W
Roofing granules	1,228	4,065	1,052	3,497
Other[2]	14	23	78	316
Total[3]	20,603	49,245	15,189	39,962

W Withheld to avoid disclosing company proprietary data; included with "Other."
[1]Includes limestone, granite, sandstone, and traprock.
[2]Includes stone used in other uses not specified.
[3]Data may not add to totals shown because of independent rounding.

Table 9.—Wisconsin: Crushed stone sold or used by producers, by county

(Thousand short tons and thousand dollars)

County	1980		1981	
	Quantity	Value	Quantity	Value
Brown	1,036	1,825	784	1,540
Buffalo	204	445	91	231
Calumet	139	296	63	122
Clark	--	--	29	58
Crawford	116	169	108	192
Dane	795	2,025	861	2,126
Dodge	740	1,283	403	783
Door	130	256	W	W
Douglas	W	W	182	W
Dunn	40	190	W	W
Fond du Lac	467	1,127	327	918
Grant	690	1,643	626	1,255
Green Lake	55	66	57	88
Iowa	529	1,010	288	598
Jefferson	159	314	220	504
La Crosse	W	W	343	754
Lafayette	501	876	353	715
Manitowoc	767	2,506	311	1,828
Marathon	1,468	2,887	947	2,262
Marinette	493	2,213	369	1,669
Marquette	22	55	--	--
Monroe	760	1,935	477	1,459
Oconto	81	164	49	107
Outagamie	989	2,023	590	1,429
Ozaukee	70	150	79	183
Pepin	13	46	38	101
Pierce	199	500	110	342
Polk	W	2,201	W	W
Richland	88	197	58	131
Rock	340	790	352	707
St. Croix	191	498	147	323
Sauk	715	1,609	824	1,857
Sheboygan	W	W	5	55
Trempealeau	312	880	192	658
Vernon	W	W	99	205
Walworth	W	147	--	--
Washington	47	95	W	W
Waukesha	2,140	4,312	1,512	3,228
Winnebago	1,662	4,377	461	1,320
Wood	104	188	68	132
Undistributed[1]	4,543	9,947	3,766	12,083
Total[2]	20,603	49,245	15,189	39,962

W Withheld to avoid disclosing individual company proprietary data; included with "Undistributed."
[1]Includes Ashland, Bayfield, Columbia, Green, Juneau, Milwaukee, Racine, Shawano, and Waupaca Counties and values indicated by symbol W.
[2]Data may not add to totals shown because of independent rounding.

Dimension stone was extracted at 21 quarries. Waukesha County led the State with eight dimension stone quarries. Granite was the most valuable rock-type mined, followed by limestone and sandstone. Dimension granite was produced only in Marathon County, which also led the State in value of dimension stone produced.

Sulfur (Recovered Elemental).—Murphy Oil Corp. continued to produce sulfur as a byproduct at its refinery in Superior. Less than 400 metric tons was recovered in 1981.

Vermiculite.—Crude vermiculite imported from out of State was exfoliated by two firms during 1981. Koos, Inc., operated a plant in Kenosha, and W. R. Grace, Construction Products Div., a plant in Milwaukee. During the year, W. R. Grace discontinued its exfoliated vermiculite operations because of economic conditions. Tonnage sold decreased about 16%, and sales value decreased about 6%. Major uses of the exfoliated vermiculite were as a chemical fertilizer carrier and for loose fill and block insulation. Other uses included soil conditioning, packing insulation, and concrete and plaster aggregate.

METALS

Iron Ore.—The State's only metallic mineral producer, Jackson County Iron Co., a wholly owned subsidiary of Inland Steel Co., continued to produce iron ore from the Black River Falls Mine in west-central Wisconsin. Taconite pellets were shipped from the plant via the Chicago & Northwestern Railroad to Inland's Indiana Harbor Works steel mill in East Chicago, Ind., a distance of 285 miles. The mine and plant operated at a near record pace until late in the year. Pellet shipments increased about 26% over those of 1980. In November, weak steel demand forced a curtailment of production, and the mine and plant were down for 31 days.

In January, a formal hearing was held on the Jackson County Iron Co. mine permit application, which had been filed the previous year as a requisite of the State's new mining laws. In April, the firm received its metallic mining permit from DNR. The company's reclamation plan was approved and permits received for other improvements, including a seepage collection pond. Also during the year, Jackson County Iron Co. became the first mining firm to pay a net-proceeds tax under the State's new mining tax law.

Zinc-Copper.—Although zinc and copper were not produced during the year, work continued at two of the announced massive sulfide discoveries in the State.

Kennecott Minerals Co., the owner of the Flambeau deposit near Ladysmith, Rusk County, merged with Standard Oil Co. (Ohio) early in the year. Environmental monitoring of air and ground water quality continued at the deposit.

Noranda Exploration, Inc., was essentially inactive at its Pelican deposit, discovered in 1974 in Oneida County. The firm did, however, drill two exploration holes during the year.

Exxon Minerals Co. proceeded with its mine feasibility studies on the Crandon ore body located south of Crandon in Forest County. The reserves at this massive sulfide deposit were stated to be 83.5 million tons averaging 5% zinc, 1.1% copper, 0.4% lead, 1.1 ounces per ton of silver, and 0.03 ounce per ton of gold. In August, a portion of the *Preliminary Project Description* was submitted to DNR. Submittal of the formal mine permit application and the environmental impact report was projected for fall of 1982.

Zinc-Lead.—In February, Inspiration Mines, Inc., an affiliate company of Inspiration Consolidated Copper Co. of Phoenix, Ariz., announced the acquisition of certain properties from Eagle-Picher Industries, Inc., in southwestern Wisconsin. The properties included four permitted mining sites that were inactive owing to economic conditions. Acquired were the Shullsburg Mine and mill located south of Shullsburg, Crawhall Mine west of Shullsburg, Bear Hole Mine northeast of Shullsburg, and Elmo No. 3 west of Cuba City. The total acquisition included 151 acres of surface rights and leases on approximately 10,000 acres of mineral rights in Wisconsin and Illinois. The firm intends to explore the properties, but mining operations will not resume until more favorable economic conditions exist. Inspiration is continuing vegetation planting trials to reclaim land disturbed by previous mining operations.

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[1]State Liaison Officer, Bureau of Mines, Pittsburgh, Pa.

[2]Assistant professor, Minerals Information, Wisconsin Geological and Natural History Survey, Madison, Wis.

[3]Cook, J. New Hope on the Reservations. Forbes, v. 128, No. 10, Nov. 9, 1981, pp. 108-115.

Table 10.—Principal producers

Commodity and company	Address	Type of activity	County
Abrasive stone:			
Baraboo Quartzite Co., Inc	Box 123 Baraboo, WI 53913	Quarry and plant	Sauk.
Cement:			
Lehigh Portland Cement Co	718 Hamilton Mall Allentown, PA 18105	Distribution terminal.	Milwaukee.
National Gypsum Co., Huron Cement Div.	17515 West 9 Mile Rd. Southfield, MI 48075	Grinding plant only	Douglas.
Iron ore:			
Jackson County Iron Co., a subsidiary of Inland Steel Co.:			
Black River Falls	30 West Monroe St. Chicago, IL 60603	Mine, concentrator, agglomerator.	Jackson.
Lime:			
CLM Corp	12th Ave. West & Waterfront Duluth, MN 55802	Quicklime and hydrated lime.	Douglas.
Rockwell Lime Co	Route 2, Box 124 Manitowoc, WI 54220	do	Manitowoc.
Western Lime & Cement Co	141 North Main St., Box 57 West Bend, WI 53095-0057		
Green Bay plant		do	Brown.
Knowles plant		do	Dodge.
Eden plant		do	Fond du Lac.
Peat:			
Bogda's Top Soil & Excavating Co	12600 West Cleveland Ave. New Berlin, WI 53151	Bog and processing plant.	Waukesha.
Certified Peat & Sod, Inc	19000 West Lincoln Ave. New Berlin, WI 53151	do	Do.
Demilco, Inc., a division of Nitragin Sales Corp.	3101 West Custer Ave. Milwaukee, WI 53209	do	Do.
Perlite, expanded:			
Construction Products Div., W. R. Grace & Co.[1]	62 Whittemore Ave. Cambridge, MA 02140	Processing plant	Milwaukee.
Midwest Perlite Co	542 West Linberg Appleton, WI 54911	do	Outagamie.
Sand and gravel:			
Construction sand and gravel:			
American Materials Corp	1 American Ave., Box 338 Eau Claire, WI 54701	4 pits	Barron, Chippewa, Dunn, Eau Claire.
B. R. Amon & Sons	Route 3 Elkhorn, WI 53121	8 pits	Jefferson, Kenosha, Rock, Walworth.
Janesville Sand & Gravel Co	Box 427 Janesville, WI 53545	Pit and plant	Rock.
Johnson Sand & Gravel, Inc	22750 Bluemond Rd. Waukesha, WI 53186	do	Waukesha.
McHenry Sand & Gravel Co., Inc.	Box 511 McHenry, IL 60050	2 pits and plant	Kenosha.
Mann Bros, Inc	Box 48 Elkhorn, WI 53121	9 pits	Walworth and Waukesha.
State Sand & Gravel Co	10833 West Watertown Plank Rd. Milwaukee, WI 53226	Pit and plant	Waukesha.
Industrial sand:			
Badger Mining Corp	Box 97 Fairwater, WI 53931	2 pits	Green Lake and Jackson.
Martin Marietta Corp., Industrial Sand Div.	110 East Main St. Rockton, IL 61072	Pit and plant	Columbia.
Stone:			
Granite:			
Anderson Bros. & Johnson Co	Box 26 Wausau, WI 54401	Quarries and plant	Marathon.
Ben Gottschalk, Inc	Route 1 Mosinee, WI 54455	do	Do.
Lake Wausau Granite Co	Box 397 Wausau, WI 54401	Quarry and plant	Do.
Limestone and dolomite:			
Halquist Stone Co., Inc	N52 W23564 Lisbon Rd. Sussex, WI 53089	Quarries and plant	Waukesha.
Arthur Overgaard Co	Box 87 Elroy, WI 53929	Quarries and plants	Buffalo, Juneau, La Crosse, Monroe.
Vulcan Materials Co., Midwest Div.	Box 6 Countryside, IL 60525	do	Milwaukee, Racine, Waukesha, Winnebago.
Sandstone and quartzite:			
Foley Bros., Inc	Rock Springs, WI 53961	Quarry and plant	Sauk.
Minnesota Mining & Manufacturing Co.	3M Center St. Paul, MN 55101	Quarries and plant	Marathon.
Traprock (basalt):			
GAF Corp	Box 630 Pembine, WI 54156	Quarry and plant	Marinette.
TCI Traprock, Inc	Box 176 Dresser, WI 54009	do	Polk.

See footnotes at end of table.

Table 10.—Principal producers —Continued

Commodity and company	Address	Type of activity	County
Sulfur, recovered elemental:			
Murphy Oil Corp	Box 2066 Superior, WI 54880	Byproduct sulfur recovery plant.	Douglas.
Vermiculite, exfoliated:			
Koos, Inc	4500 13th Ct. Kenosha, WI 51340	Processing plant	Kenosha.

[1] Also exfoliated vermiculite.

The Mineral Industry of Wyoming

This chapter has been prepared under a Memorandum of Understanding between the Bureau of Mines, U.S. Department of the Interior, and the Wyoming Geological Survey for collecting information on all nonfuel minerals.

By Karl E. Starch[1] and Gary B. Glass[2]

The value of nonfuel mineral production in Wyoming in 1981 was $770 million, a 1% increase over that of 1980. This, the smallest year-to-year increase in the past decade and a half, compares with a 29% increase in 1980. The principal element in the State's limited growth in nonfuel minerals was the 3% decline in sodium carbonate output, reversing a long-term upward trend in production of that commodity. Sodium carbonate (natural soda ash) constituted more than three-quarters of the value of all nonfuel minerals produced in the State. The slight fall in sodium carbonate production was partly offset by a reported 25% increase in output and a 41% increase in value of bentonite clay, Wyoming's second most important nonfuel mineral, representing about 13% of total nonfuel mineral production.

Iron ore, third in order of value with less than 5% of the total, dropped 10% in output from that of 1980. Of Wyoming's other minerals, cement production increased more than 25% over that of 1980, stone production declined by about 25%, sand and gravel and gypsum declined slightly, and lime output increased substantially. Wyoming's nonfuel mineral production was strongly weighted toward nonmetallics, with nine nonmetallic commodities produced in 1981, and one metal, iron ore. Small amounts of silver, lead, and zinc were processed in the State.

With about 3% of the total value of nonfuel minerals produced in the Nation, Wyoming ranked 11th among the 50 States. The major source of sodium carbonate, Wyoming ranked first in output of this commodity with nearly 90% of the Nation's natural soda ash production. The State was first in bentonite production with more than 70% of U.S. output and fourth in iron ore production although producing only a minor share.

Of Wyoming's 23 counties, only Hot Springs and Niobrara produced no nonfuel minerals. In 8 counties, sand and gravel was the only or the leading nonfuel mineral produced, and sand and gravel or stone was produced in all 21 counties having nonfuel mineral production. Sweetwater, with its four large trona (sodium carbonate) mines, continued to be the leading mineral-producing county in the State.

The relatively large role the industry played in Wyoming's economy in 1981 can be seen in comparing per capita value of nonfuel mineral production in the State, $1,636, with the national average, $111, a fifteen-fold greater level of importance.

The Wyoming Employment Security Commission reported that the mineral industries employed about 18% or 38,600 of the 208,770 workers covered by the Unemployment Insurance Law (85% of all workers in the State). Of these, about 6,500 worked in nonfuel mineral mining. Although total employment in the State increased 6% between 1980 and 1981 and all mining employment increased 7%, employment in nonfuel mineral mining declined

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

Mineral		1980 Quantity	1980 Value (thousands)	1981 Quantity	1981 Value (thousands)
Clays	thousand short tons	3,081	$71,512	3,855	$100,926
Gem stones		NA	190	NA	250
Gypsum	thousand short tons	312	2,731	299	2,625
Sand and gravel	do	[2]5,454	[2]12,523	[p]5,200	[p]12,400
Stone	do	4,374	14,835	3,224	9,858
Combined value of cement, iron ore, lead (1981), lime, sand and gravel (industrial 1980), silver (1981), sodium carbonate, and zinc (1981)		XX	658,755	XX	644,279
Total		XX	760,546	XX	770,338

[p]Preliminary. NA Not available. XX Not applicable.
[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2]Excludes industrial sand and gravel; value included with "Combined value" figure.

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

(Thousands)

County	1979	1980	Minerals produced in 1980 in order of value
Albany	W	$14,391	Cement, stone, sand and gravel, clays, gypsum.
Big Horn	W	30,440	Clays, gypsum, sand and gravel, lime.
Campbell	W	W	Sand and gravel.
Carbon	$1,000	1,892	Do.
Converse	281	W	Do.
Crook	30,336	19,218	Clays, stone.
Fremont	30,517	W	Iron ore, sand and gravel.
Goshen	W	W	Lime, sand and gravel.
Johnson	W	W	Clays, sand and gravel.
Laramie	W	W	Stone, sand and gravel.
Lincoln	W	154	Sand and gravel, stone.
Natrona	W	W	Sand and gravel, clays.
Park	1,931	1,736	Gypsum, sand and gravel.
Platte	W	W	Stone, iron ore, sand and gravel.
Sheridan	W	W	Sand and gravel.
Sublette	W	30	Sand and gravel, stone.
Sweetwater	W	W	Sodium carbonate, sand and gravel, stone.
Teton	W	W	Sand and gravel, stone.
Uinta	W	W	Sand and gravel, clays.
Washakie	W	W	Clays, lime, sand and gravel.
Weston	W	W	Clays, stone, sand and gravel.
Undistributed[2]	526,108	692,685	
Total	[3]590,176	760,546	

W Withheld to avoid disclosing company proprietary data; included with "Undistributed."
[1]Hot Springs and Niobrara Counties are not listed because no nonfuel mineral production was reported.
[2]Includes gem stones and values indicated by symbol W.
[3]Data do not add to total shown because of independent rounding.

Table 3.—Indicators of Wyoming business activity

		1980	1981[p]	Change, percent
Employment and labor force, annual average:				
Total civilian labor force	thousands	239.3	246.4	+3.0
Unemployment	do	9.8	10.2	+4.1
Employment (nonagricultural):				
Mining[1]	do	35.5	38.2	+7.6
Manufacturing	do	9.6	10.1	+5.2
Contract construction	do	20.7	19.2	-7.3
Transportation and public utilities	do	16.9	17.9	+5.9
Wholesale and retail trade	do	47.0	48.7	+3.6
Finance, insurance, real estate	do	7.3	7.5	+2.7
Services	do	30.2	32.1	+6.3
Government	do	43.0	42.9	-.2
Total nonagricultural employment[1]	do	210.2	216.6	+3.0

See footnotes at end of table.

Table 3.—Indicators of Wyoming business activity —Continued

		1980	1981[p]	Change, percent
Personal income:				
Total	millions	$5,132	$5,794	+12.9
Per capita		$10,875	$11,780	+8.3
Construction activity:				
Number of private and public residential units authorized		3,895	4,110	+5.5
Value of nonresidential construction	millions	$85.4	$85.8	+.5
Value of State road contract awards	do	$55.5	$58.6	+5.6
Shipments of portland and masonry cement to and within the State	thousand short tons	481	506	+5.2
Nonfuel mineral production value:				
Total crude mineral value	millions	$760.5	$770.3	+1.3
Value per capita, resident population		$1,615	$1,636	+1.3
Value per square mile		$7,767	$7,867	+1.3

[p]Preliminary.
[1]Includes bituminous coal and oil and gas extraction.

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

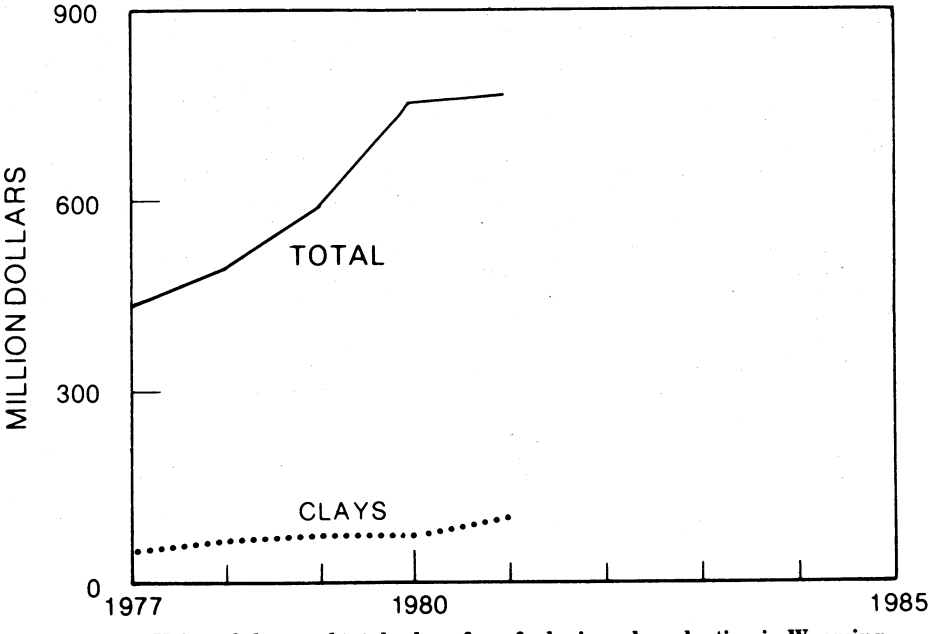

Figure 1.—Value of clays and total value of nonfuel mineral production in Wyoming.

11%. The largest slump was in iron ore- and metal-mining services, which fell from about 1,700 workers in 1980 to 1,350 in 1981; the number of workers in soda ash mining decreased from about 4,600 in 1980 to 4,200 in 1981, whereas bentonite mining employment remained steady at about 800 in both years.

Mining paid the highest weekly wages in the State in 1981, an average of $517.48 for all mining, compared with an average of $329.92 for all industries. At an average $585.59 per week, trona mining was exceeded only by coal mining as the State's highest wage payer; iron ore mining paid $556.47 and bentonite, $394.13. The increase in wages over the year was considerably greater in nonfuel mining than in all mining and other industries. Mining paid the highest average weekly wage in all but three counties in Wyoming in 1981.

Mineral development in 10 of Wyoming's 23 counties led to a statewide 36% increase in assessed valuation. Sweetwater County led the State with a valuation of over $1 billion. Total tax valuation of all real and personal property in Wyoming in 1981 was about $6.2 billion. Of this amount, about $4 billion or 65% was on mineral production, up from $2.5 billion in 1980. About $180 million of the total was on nonfuel minerals, on which about $14 million in ad valorem taxes were paid. Overall, Wyoming recovered approximately $647 million in direct income from ad valorem taxes, severance taxes, State and Federal rental and royalty payments, sale and use taxes on drilling and mining equipment, and State filing fees on mineral leases. About one-third of the revenues to all State funds in 1981 were directly attributable to the mineral industry.

During 1981, geologists from several companies were exploring in Wyoming for silica (glass sand) and hydrofrac sand. No discoveries were announced. Also during 1981, exploration and research was conducted by several companies for zeolites for use as natural molecular sieves. This interest centered in Sweetwater and Fremont Counties. At yearend, this exploration and research was continuing. Molycorp Inc., a division of Union Oil of California, conducted extensive testing of a potential rare-earth mineral deposit in the Bear Lodge Mountains north of Sundance, Crook County. However, by the end of the year, the deposit apparently did not satisfy Molycorp's economic development criteria, and exploration was terminated. Timberline Minerals, Inc., reported copper-molybdenum mineralization on its unpatented Silver Creek mining claims 50 miles south of Cody in the Big Horn Basin. One drill hole indicated copper-molybdenum ore of about 0.20% at 150 to 500 feet. Timberline agreed to acquire a 90% interest in a Phelps Dodge copper-molybdenum prospect 2 miles east of its Silver Creek claims. Results of 22 exploratory drill holes had led Phelps Dodge to speculate that the prospect contained 60 million tons of copper ore at an average grade of 0.31%. Phelps Dodge retained a 10% interest in its claims and acquired a 5% interest in Timberline's Silver Creek claims.

Portions of the severance tax levied on minerals (about 36% of tax collected on trona) are deposited in Wyoming's permanent Mineral Trust Fund, which was established by a 1974 amendment to the Wyoming Constitution. The principal of the fund is set aside for future, unidentified needs; annual interest goes into Wyoming's General Fund. The fund increased from $115 million in 1979 to about $260 million in 1981. The Wyoming Legislative Service projected the Permanent Trust Fund to exceed $909 million and generate more than $53 million in annual income by 1992.

Legislation and Government Programs.—The 46th Legislature of the State of Wyoming, 1981 session, passed a number of legislative acts affecting nonfuel mining during its 40-day session that began January 13, 1981. These acts included the following, all effective May 20, 1981:

H.B. 182 prohibited intoxicating liquor or other controlled substance or an intoxicated person from entering any mine.

H.B. 208 amended existing legislation changing valuation of mineral property from 100% to 80%; enacted a State severance tax to provide the same amount of money as under higher valuation (additional 1-1/2% of gross value); and provided for distributing tax proceeds.

H.B. 382 amended W.S. 35-11-417(d) to apply self-bonding program to all mineral operations.

H.B. 412 required that a covenant to develop a property within a given time period be included in mineral leases.

H.B. 443 provided for an affidavit to hold a mineral lease by virtue of production from that lease.

H.B. 456 established an excise tax of 5.5% of gross value to be levied on sulfur ex-

tracted from natural gas.

S.F. 73 amended various existing acts relating to recording and validating mining claims and modifying mining-location certificate requirements, requires claims to be filed with appropriate county clerk within 60 days of discovery, and provides for relocation of abandoned claims.

S.F. 91 amended the existing legislation to define mining operations and regulate Board of Mines and Office of Inspector of Mines.

S.F. 183 amended W.S. 36-6-101(a) and (b) providing that mineral leases on State lands shall be for 10-year periods.

S.F. 185 provided for State auditing of all State and Federal mineral royalties.

S.F. 235B provided for Wyoming to join the Interstate Mining Compact Commission.

Under a National Science Foundation grant, geologists from the University of Wyoming tested seismic exploration techniques in delineating metallic ore deposits with existing drill holes at known mineral deposits to determine effectiveness of the technique.

The State of Wyoming and the U.S. Bureau of Land Management (BLM) signed a cooperative agreement under which the Land Quality Division of the Wyoming Department of Environmental Quality (DEQ) assumed primary responsibility for reviewing and permitting mining operation plans anywhere in the State; BLM retained responsibility for reviewing and approving access routes on Federal land outside the mine permit or exploration area. BLM is not bound to accept DEQ final approval if BLM concludes that undue degradation of Federal lands would occur.

The State Land Board voted to offer 37 tracts of State land for mineral leasing through competitive bidding, or auction, as an experiment to see whether public sale would yield more revenue than the traditional noncompetitive, simultaneous drawing system. The first auction was held in June. Later in the year, the State Land Commission began revamping its mineral-royalty audit system to lessen the chance of improper payments. A 2- or 3-year process of installing a computerized royalty monitoring system was also planned. The State Land Board also approved a right-of-way request by Chevron U.S.A., Inc., to construct a molten sulfur pipeline across one section of State land. The pipeline would move 1,000 tons per day of molten sulfur 20 miles through an electrically heated surface pipeline from a natural gas processing plant near Kemmerer to a railroad terminal to be constructed jointly by Chevron and Amoco Production Co. Amoco also was constructing a natural gas processing facility with the potential of producing 1,200 tons of sulfur per day, but planned to move output by truck to the rail terminal. Chevron and Amoco were the principal operators in the Carter Creek and Whitney Canyon Gasfields located in the Overthrust Belt between Evanston and Kemmerer from which both produced sour gas.

During fiscal year 1981, Wyoming received $120 million as its share of Federal mineral lease revenues collected in the State for mineral leasing activities on public lands. Payments to Wyoming were second highest among the 23 States that received such payment.

The Geological Survey of Wyoming continued to employ 14 full-time and 6 to 8 part-time employees. Daniel N. Miller, Jr., State geologist since 1969, resigned to become U.S. Department of the Interior Assistant Secretary for Energy and Minerals. Gary B. Glass became State geologist. Survey projects in 1981 included an inventory of geologic hazards in the State; preparation of index maps; geological mapping and geophysical studies of diamondiferous kimberlites; geological mapping and examination of mineral resources in Archean greenstone belts; continued appraisal of Wyoming's base, ferroalloy, ferrous, precious and fissionable metal deposits; compilation of a stratigraphic atlas; and geologic mapping in the Absaroka Range. New publications of the survey included PIC 15, Mining Laws of Wyoming; PIC 16, Helium, a Vital Natural Resource; PR 18, Geological and Geophysical Investigations of Kimberlites in the Laramie Range of southeastern Wyoming.

The U.S. Bureau of Mines, in cooperation with the U.S. Geological Survey, continued appraising the mineral potential of Wyoming lands being considered for inclusion in the Wilderness system. The U.S. District Court for the State of Wyoming ruled that public lands are to remain open to mineral exploration and development unless Congress closes them; that the Secretaries of Agriculture and Interior lacked authority to withhold lands from mineral exploration and development during wilderness study.

REVIEW BY NONFUEL MINERAL COMMODITIES

NONMETALS

Cement.—Output by Wyoming's only cement producer, Monolith Portland Cement Co., at its plant near Laramie, Albany County, increased in 1981 over that of 1980. The company retained a significant portion of the year's output in stock at yearend. Almost all output was of Types I and II general-moderate-heat portland cement; small amounts of oil well and high-sulfur-resistant cement were also produced. Although no masonry cement was reported produced during the year, a small amount was sold out of existing stocks. Most of the output was marketed to ready-mix concrete companies; the balance was sold to concrete product manufacturers, other contractors, and building material dealers. All but a very small amount of cement produced was shipped in bulk; more than one-half was shipped directly to the consumer. Cement shipped to a terminal before going to the ultimate consumer left the plant by railroad; that going directly to the consumer was shipped by truck. A layoff of 32 workers early in the year reduced the work force at the plant to about 105. The expansion and renovation underway at the plant for several years neared completion in 1981. Among items included in the expansion were a $3 million raw slurry grinding mill, a $15 million kiln, a $4.7 million finishing mill, a $2.3 million packhouse, and a $500,000 quality-control laboratory. Monolith produced its own gypsum, limestone, sandstone, and stone from locations within a 40-mile radius of the plant.

The Monolith Portland Cement Co.—whose operations consisted of the Laramie cement plant, the Wyoming Construction Co., and a cement plant and construction company in northern California—had been negotiating to sell some of its holdings for several years. Although a number of potential buyers looked at the Laramie plant, no sale was reported during the year.

Clays.—Again in 1981, clay was Wyoming's second most important nonfuel mineral product; both quantity and value of clay output increased substantially over the 1980 level. Wyoming was third in the Nation in total clay production with 9% of the total and first in the Nation in output of bentonite clay with more than 70% of the total of that type of clay.

Bentonite, an alteration of volcanic ash, occurs in Wyoming in the Big Horn Basin, the southern Powder River Basin, and along the western edge of the Black Hills in the northeast corner of the State. Eight companies produced bentonite in 8 counties at 124 sites. Common clay, produced in Albany and Uinta Counties, constituted about 7% of total clay produced in the State; 90% of the common clay output was used in manufacturing cement, and the balance was fashioned into face brick.

"Wyoming" or "western" bentonite is the sodium type noted for its ability to absorb water and swell to 15 times its dry volume. Bentonite produced in Wyoming in 1981 was used in drilling muds (59%), pelletizing iron ore (21%), foundry sands (16%), waterproof seals (1%), animal feeds (1%), and a variety of lesser uses. Big Horn and Crook Counties were the major sources of bentonite with well over two-thirds of total production; Johnson, Washakie, and Weston were substantial producers; Natrona produced a minor amount.

The unit value of clay ranged from $3.77 to $10.00 per ton for common clay and $16.89 to $38.00 per ton for bentonite clay.

The major producers of bentonite were the American Colloid Co., with 6 mines in Big Horn, Crook, and Weston Counties; Dresser Minerals, a division of Dresser Industries, Inc., with 7 mines in Big Horn County; and Wyo-Ben Products, Inc., with 41 mining sites in Big Horn County. These three leading producers cumulatively accounted for more than 50% of the State's bentonite output in 1981. Other major producers, in order of output, included Kaycee Bentonite Corp.; NL Industries, Inc., Baroid Div.; Federal Bentonite Division of Aurora Industries, Inc.; and International Minerals & Chemical Corp.

A "rush" to stake bentonite claims on 2,300 acres of public land north of Cowley in Big Horn County resulted when BLM removed the land from the Shoshoni Irrigation Project and opened it to mining.

Installation of an additional Raymond mill financed by $2 million of Big Horn County industrial revenue bonds increased milling capacity of the American Colloid plant in Lovell. NL Baroid completed a $20 million bentonite grinding, drying, and packing plant in Lovell, which doubled the company's bentonite production capacity.

Production at the plant began with 30 workers; at full production of 1,000 tons per day, it was expected to employ 65.

Gem Stones.—Geologists of the Wyoming Geological Survey discovered 2 new deposits of kimberlite in Wyoming's Laramie Range in 1981, bringing to about 100 the number of such deposits found in the southern Wyoming area. Only 12 of these occurrences had been determined to contain diamonds. Cominco American Incorporated began operating a $2.5 million pilot plant facility near Fort Collins, Colo., designed to test for diamonds. About 10 employees crushed, sifted, separated, and handpicked diamonds from material excavated from several sites.

Wyoming nephrite, commonly called jade, continued to be found in Carbon, Converse, Fremont, Natrona, and Sweetwater Counties.

Gypsum.—The Jim Walters Corp., Celotex Div., the Georgia-Pacific Corp., and the Wyoming Construction Co. reported producing crude gypsum in Park, Big Horn, and Albany Counties, respectively. Georgia-Pacific and Celotex also calcined gypsum for producing wallboard. The decline in 1981 output, compared with that of 1980, reflected the general fall in demand for building materials.

Helium.—A gas discovery below 10,000 feet in the LaBarge Anticline near LaBarge in southwestern Wyoming was conservatively estimated to contain about 50 billion cubic feet of recoverable helium, the largest such find in recent history. Most of the discovery is on Federal lands, and title of this helium is reserved to the Government. The gas has a low heating value because it is about two-thirds carbon dioxide. These deep zones are not expected to be produced for the major component or the fuel value in the immediate future. Therefore, this discovery is presently classified as a nondepleting helium resource. The U.S. Bureau of Mines is monitoring field development.

Lime.—Holly Sugar Corp. produced quicklime for use in processing sugar beets at Torrington, Goshen County, and at Worland, Washakie County; and The Great Western Sugar Co. at Lovell, Big Horn County. The quantity produced in 1981 was nearly one-quarter more than in 1980, whereas its value was more than 40% greater.

Phosphate Rock.—Stauffer Chemical Co. continued to operate its Leefe phosphate beneficiating plant west of Kemmerer in Lincoln County utilizing phosphate rock mined in Idaho.

Sand and Gravel.—To reduce reporting burdens and costs, the Bureau of Mines implemented new canvassing procedures for its surveys of sand and gravel producers. Beginning with the collection of 1981 production data, the survey of construction sand and gravel producers will be conducted for even-numbered years only; the survey of industrial sand and gravel producers will continue to be conducted annually. Therefore, this chapter contains only preliminary estimates for construction sand and gravel production but contains complete data on industrial sand and gravel. The preliminary estimates for production of construction sand and gravel for odd-numbered years will be revised and completed the following year.

No industrial sand or gravel was reported produced in the State in 1981.

In a significant decision, the U.S. 10th Circuit Court of Appeals reversed a U.S. District Court of Wyoming 1979 ruling that gravel is a mineral and as such subject to mineral reservation. Under the Stock-Raising Homestead Act of 1916, the Federal Government reserved its ownership to all minerals underlying the surface of lands conveyed to private ownership under the act. The 1981 decision, likely to be appealed to the U.S. Supreme Court, involves millions of acres of land in the western States including as much as 13% of the surface area of Wyoming. If the Circuit Court ruling stands, surface landowners can use or sell the gravel on their lands.

Table 4.—Wyoming: Construction[1] sand and gravel sold or used by producers

	1980			1981[p]		
	Quantity (thousand short tons)	Value (thousands)	Value per ton	Quantity (thousand short tons)	Value (thousands)	Value per ton
Sand	1,164	$2,898	$2.49	NA	NA	NA
Gravel	4,291	9,625	2.24	NA	NA	NA
Total or average	[2]5,454	12,523	2.30	5,200	$12,400	$2.38

[p]Preliminary. NA Not available.
[1]A small amount of industrial sand was produced in 1980.
[2]Data do not add to total shown because of independent rounding.

Sodium Carbonate.—Again in 1981, Wyoming was the Nation's, and the world's, major source of sodium carbonate or natural soda ash processed from the ore, trona. As noted in the Mining Engineering, May 1982, industry review of soda ash, approximately 6.7 million tons of soda ash was produced in Wyoming in 1981, down about 3% from that of 1980; this figure represented about 85% of capacity output of the four operations that produced soda ash in Wyoming in 1981. Wyoming's four trona mines and related soda ash processing facilities were all within a few miles of each other near Green River, Sweetwater County, in the southwest corner of the State. These producers and their approximate 1981 soda ash output were FMC Corp., 2.6 million tons; Stauffer Chemical Co. of Wyoming, 1.7 million tons; Allied Chemical Co., 1.5 million tons; and Texasgulf Chemical Co., 0.9 million tons.

About 55% of the soda ash consumed in the United States was used in producing glass; about 23%, in sodium-based chemicals; 5%, in soaps and detergents; 4%, in pulp and paper manufacture; 3%, in water treatment; and 10%, in other smaller uses. The somewhat reduced demand for Wyoming soda ash in 1981 reflected the prevailing national economic condition, particularly the automobile and housing industries' reduced demand for glass. Inventory carryover at the end of 1981 was about 300,000 tons, more than double that carried over from 1980. With the maturity of the U.S. market for soda ash, the highly energy efficient Wyoming natural soda ash producers began looking more toward the export market for future growth. Soda ash prices in the Green River area rose in 1981, from the average $72 per ton (f.o.b. plantsite) in 1980 to about $86 per ton in the January-June 1981 period to $92 per ton in the July-December period. These prices contrasted with about $103 and $106 per ton for the comparable periods for natural soda ash produced at Searles Lake, Calif., the only other U.S. source, and $126 and $132 per ton for synthetic soda ash produced at Syracuse, N.Y., in the only remaining Solvay process plant in the United States.

FMC accounted for about 30% of total U.S. sales of soda ash and about one-third of total U.S. soda ash exports. In March 1981, the company began operating its first longwall mining system installed at a cost of about $8 million. Because the system eliminates the need for roof-support pillars necessary in conventional mining, the longwall unit was expected to have an ore recovery rate of almost 70% instead of the 45% recovery rate of conventional mining. FMC expected that longwall systems would eventually produce 40% of the Westvaco Mine output. About 70% of FMC mine output had been by conventional drill and blast methods; 20%, by continuous miners; and 10%, by three borer miners.

During 1981, FMC received a permit for in situ trona mining and began testing new technology for the solution mining of trona, expecting to spend more than $30 million to test this technology over the next several years. A solution preparation plant, 16 miles of dual 12-inch pipeline, and a terminal facility housing fracturing pumps, low head pumps, and tanks were constructed. Twelve monitoring wells were drilled, and two sets of production wells were interconnected at about 2,200 feet underground. The test operation size was expected to be approximately 20% of the full-scale operation.

FMC planned to use solution mining to expand its refined soda ash capacity by 1 million tons by the mid-1980's to a total of about 3.8 million tons. Vulcan Materials Co. and Allied Chemical acquired permits for similar solution mining research projects. Vulcan, like FMC, began actual field tests, although on a smaller scale. If the tests are successful, solution mining could reduce costs up to 25% by eliminating workers and machines underground, simplifying the refining process, and making possible the recovery of trona reserves at depths that are uneconomical to mine by conventional means. The 1-square-mile area FMC is to solution mine contains 100 million tons of soda ash, more soda ash than had been produced to date by all companies producing the commodity.

With about 1,500 employees, FMC was Wyoming's largest single employer at one site.

At mid-1981, Stauffer Chemical Co. of Wyoming, in partnership with Union Pacific Corp., started up its computer-controlled Refinery Unit No. 5, a mechanical recompression-type crystallizer, which increased its annual production capacity from 1.5 to 1.8 million tons of soda ash. The new No. 2 production shaft, put into service May 6, is a 20-foot-diameter, concrete-lined, circular shaft 890 feet deep. Nearly 700 people were employed at Stauffer's Big Island Mine and refinery.

Allied Chemical Co., mining by three

methods—conventional, longwall, and continuous miner—acquired new mineral leases in 1981 to be used in a solution mining pilot program. The No. 5 ventilation shaft at Allied's Alchem Mine was bottomed out at 1,600 feet on June 1. About 1,170 workers were employed at the mine in 1981. Allied was the only one of the four soda ash producers in the Green River area that also produced synthetic soda ash in Syracuse, N.Y.

Texasgulf Chemical Co. received a siting permit in June for a 1-million-ton-per-year expansion of its Wyoming soda ash operation, which would double its existing capacity. The potential socioeconomic impacts of the proposed expansion generated one of the most extended discussions among State, local, and company officials in Wyoming permitting history. Texasgulf offered financial impact aid to local school districts and communities in a series of measures to mitigate possible effects of its expansion. At midyear, Texasgulf announced the indefinite delay of its expansion plans because of economic conditions. Texasgulf employed about 500 people in the mine and refinery and mined with continuous miners. In July, Société Nationale Elf Aquitaine, an oil company controlled by the French Government, acquired the company.

Through the year, Tenneco Oil Co. and its prime contractor, Brown and Root, Inc., continued constructing the State's fifth trona mine and soda ash plant, also in the Green River area. Two shafts were sunk to a 1,500-foot depth to trona bed No. 17, and by yearend, three continuous miners were in place to start stockpiling trona for a planned plant startup in May 1982. The plant was designed to use local Wyoming coal for all heat requirements; its crystallizer section was built with both traditional triple-effect evaporators and the newer, more efficient mechanical-recompression evaporator. The plant was designed to produce 1 million tons of soda ash per year.

BLM proposed opening more Federal land to sodium leasing in Sweetwater County adjacent to the producing area.

Trona mining paid about $16.2 million in taxes in 1981, about $2.3 million in royalties, $6 million in severance taxes, and about $7.9 million in property taxes. Severance tax on trona was 5.5% of gross value; property or ad valorem tax was about 7.14% of assessed value of trona.

Wyoming's Department of Economic Planning and Development, Industrial Development Division, noted that more than $143 million in industrial revenue bonds (IRB) had been issued by the City of Green River and Sweetwater County to finance development at the four operating trona mines, mostly for pollution control equipment. IRB's were a source of low-interest financing to the companies involved, were tax exempt to holders of the bonds, and exempted equipment purchased from the tax rolls.

Wyoming's 134-billion-ton trona resource, considered the world's largest, occurs in the Wilkins Peak member of the Green River Formation in Sweetwater County. Some 40 separate trona beds are known in the Wilkins Peak member, 25 of which are known to be more than 4 feet thick and minable; some are as thick as 38 feet. Deepest at the southern area of the basin, beds slope gradually upward to the north. Mining activity was concentrated in the northern half of the basin where beds are 8 to 12 feet thick, relatively flat, and about 800 to 1,500 feet deep. The trona underlies 1,000 square miles at depths of 700 to 2,500 feet below the surface. The trona ore was prepared for shipping by being crushed, calcined, dissolved, purified, and crystallized into soda ash.

Stone.—Seven companies and the Wyoming Highway Department produced stone at nine quarries in four counties in Wyoming in 1981. All stone produced was crushed stone; no dimension stone output was reported. Limestone and granite were the major types of stone produced, with limestone constituting about 54% of output, and granite, about 46%. Only limestone was produced in Crook and Platte Counties, whereas both limestone and granite were produced in Albany and Laramie Counties; Laramie County was the major producer with 32% of the total. Albany was second with 29%, followed by Platte and Crook Counties.

Morrison-Knudsen Co., Inc., was the State's largest producer of crushed rock, followed by Guernsey Stone Co. (Peter Kiewit Sons Co.), W. E. Wimmer (Union Pacific Railroad Co.), and Wyoming Construction Co. (Monolith Portland Cement Co.); each operated one quarry in Laramie, Platte, and Albany (two companies) Counties, respectively. Other producers were Summit Materials Co., Great Western Sugar Co., and Reeves, Inc. The four largest producers supplied more than 80% of the total output. Three quarries of less than 100,000 tons per year output accounted for 5.6% of the total;

three quarries ranging from 100,000 to 400,000 tons per year supplied 21.7% of the total; one quarry, between 500,000 and 600,000 tons per year, 18.3%; and one quarry, 800,000 to 900,000 tons per year, 54.4% of the total. About 34% of the output was moved by truck, whereas 66% was shipped by railroad. About 63% of the crushed stone output (including 100% of crushed granite) was used for railroad ballast; 10%, in the manufacture of cement; and 7%, as dense-graded road base. Other major uses included concrete aggregate, fine aggregate, riprap, and sugar refining. Prices ranged from $1.00 per ton for bituminous aggregate to $15.00 per ton for roof aggregate and chips, with an overall average value of $3.05.

Sulfur.—Sulfur was produced as a byproduct of natural gas processing in five counties, Carbon, Fremont, Laramie, Park, and Sweetwater; Park and Sweetwater accounted for more than three-fourths of the total. Producing companies included Amoco Production Co., Colorado Interstate Gas Co., Husky Oil Co., and Sinclair Oil Co. Chevron and Amoco continued developing their two multimillion-dollar gas processing facilities near Evanston, Uinta County. Chevron was considering establishing a fertilizer plant, possibly at Rock Springs, Sweetwater County, using the sulfur from its gas processing operations and phosphate from Vernal, Utah. Western Nuclear, Inc., closed its sulfuric acid plant at Jeffrey City, Fremont County, where it had produced 100 tons of sulfuric acid per day as a byproduct of uranium mining.

METALS

Gold.—No Wyoming gold production was reported to the Bureau of Mines in 1981. However, the State Land Commission received a one-half thimbleful of gold as the first royalty the State had ever received from a State gold mining lease. The holder of a State lease sent the State agency the particles of gold as the State's 5% royalty share of production on 195 grains of gold mined in Fremont County. Mallon Oil Co. again prospected for gold on its mining claims in the Pacific Creek area of Park County. Nugget Exploration of Casper proceeded to work on a small placer operation on about 70 acres of property on Rock Creek southeast of Atlantic City; the area had been dredged previously in the 1930's. Great Western Minerals continued evaluating claims in the Pass Peak area east of Bondurant. Homestake Mining Co. of San Francisco, Calif., held claims in the Atlantic City area. Geologists from the Geological Survey of Wyoming made a significant gold discovery in the Seminoe Mountains greenstone belt during 1981. Assays of selected samples of quartz-vein material contained visible gold, and samples from an altered iron formation ranged between 1 and 3 ounces of gold per ton.

Iron Ore.—The United States Steel Corp. Atlantic City Mine in the southern Wind River Mountains near Lander, Fremont County, was Wyoming's only producer of iron ore in 1981. About 570 people were employed at the operation. The Wyoming State Inspector of Mines Annual Report estimated production from the open pit Atlantic Mine in 1981 at about 1.6 million tons, relatively unchanged from that of 1980. The taconite ore produced was beneficiated, pelletized, and shipped 355 miles to the U.S. Steel Geneva Works near Provo, Utah.

Wyoming's second iron ore mine, the underground Sunrise Mine near Guernsey, Platte County, which shut down in July 1980, was not reopened during the year, because economic conditions did not improve for its owner, CF&I Steel Corp. of Pueblo, Colo. A standby maintenance crew of about 30 people remained on duty at the mine.

Lead, Silver, and Zinc.—Lead, silver, and zinc were recovered by Nedlog Technology Group, Inc., at its Laramie, Albany County, plant from smelter flue dust and dross obtained from a variety of sources outside the State of Wyoming. The plant was operated as a pilot and test facility in 1981, and no commercial work was done.

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[1]State Liaison Officer, U.S. Bureau of Mines, Denver, Colo.

[2]State geologist and executive director, Geological Survey of Wyoming, Laramie, Wyo.

Table 5.—Principal producers

Commodity and company	Address	Type of activity	County
Cement:			
Monolith Portland Cement Co.[1]	Box 40 Laramie, WY 82070	Plant	Albany.
Clays:			
American Colloid Co	Box 818 Belle Fourche, SD 57717	Pits and plants	Big Horn, Crook, Weston.
Dresser Minerals, a division of Dresser Industries, Inc.	Box 832 Greybull, WY 82426	do	Big Horn.
Federal Bentonite, a division of Aurora Industries, Inc.	1002 Greenfield Rd. Montgomery, IL 60538	do	Crook and Weston.
International Minerals & Chemical Corp.	5401 Old Orchard Rd. Skokie, IL 60076	do	Crook.
Kaycee Bentonite Corp	Box 9 Mills, WY 82644	do	Johnson, Natrona, Washakie.
NL Industries, Inc., Baroid Div	Box 1675 Houston, TX 77001	do	Big Horn and Crook.
Wyo-Ben, Inc	Box 1979 Billings, MT 59103	do	Big Horn and Hot Springs.
Gypsum:			
The Celotex Corp	Box 590 Cody, WY 82414	Surface mine and plant.	Park.
Georgia-Pacific Corp	900 SW. 5th Ave. Portland, OR 97204	do	Big Horn.
Wyoming Construction Co.[2]	Box 907 Laramie, WY 82070	Surface mine	Albany.
Iron ore:			
United States Steel Corp	Lander, WY 82520	Open pit mine and plant.	Fremont.
Lime:			
The Great Western Sugar Co.[2]	Box 5308 Denver, CO 80217	Plant	Big Horn.
Holly Sugar Corp	Holly Sugar Bldg. Colorado Springs, CO 80902	do	Goshen and Washakie.
Sodium carbonate:			
Allied Chemical Co.	Box 551 Green River, WY 82935	Underground mine and plant.	Sweetwater.
FMC Corp	Box 872 Green River, WY 82935	do	Do.
Stauffer Chemical Co. of Wyoming	Box 513 Green River, WY 82935	do	Do.
Texasgulf Chemical Co	Box 100 Granger, WY 82934	do	Do.
Stone:			
Guernsey Stone Co	Box 337 Guernsey, WY 82214	Quarry	Platte.
Morrison-Knudsen Co., Inc	Box 1028 Cheyenne, WY 82001	do	Laramie.
Summit Materials Co	Box 1716 Rapid City, SD 57709	do	Crook.
Union Pacific Railroad Co., W. E. Wimmer.	115 West 15th St. Cheyenne, WY 82001	do	Albany.

[1]Also clays.
[2]Also stone.

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